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# Biology of Bolshaya River Sockeye Salmon (*Oncorhynchus nerka*) (West Kamchatka)

by

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## ABSTRACT

Bolshaya River is the second longest river (after Kamchatka River) of Kamchatka peninsula, where sockeye salmon O. nerka (Walbaum) reproduce side by side with different species of salmon (genus Oncorhynchus). There are some factors, which influence on biological characteristics (body length and body weight, coefficients of maturity, fecundity) of Bolshaya River mature sockeye salmon: number of mature West and East Kamchatka pink salmon, Asian sockeye stocks abundance, body length and body weight of smolts of Ozernaya River sockeye stock and (inter) annual climatic changes. Moreover, the influence of above-mentioned factors on various biological characteristics of Bolshaya River sockeye salmon was dissimilar.

Year-to-year investigation doesn't have rather full and reliable statistics on Bolshaya River sockeye stocks harvesting. The reason is that the more numerous Ozernaya River sockeye salmon is caught by trap nets during the definite periods of time simultaneously with Bolshaya River sockeye stock, but in a year, in the capacity of bonus catch to the pink salmon. While trap net catches of sockeye salmon on West Kamchatka are not identified, the detailed study of dynamics of abundance is impossible.


## INTRODUCTION

Bolshaya River is the second longest river (after Kamchatka River) of Kamchatka peninsula, where sockeye salmon O. nerka (Walbaum) reproduce side by side with different species of salmon (genus Oncorhynchus).

Bolshaya River sockeye stock belongs to the minor level local stock because of the absence of rather large and deep lakes in the basin of the river, which are more convenient for sockeye salmon reproduction (Bugayev 1995). On approximate estimation, annual size of commercial harvests of sockeye from this river fluctuate from tens to hundreds of tons (Bugayev 1995).

For the first time the process of reproduction of salmons in the basin of Bolshaya River, including sockeye salmon, was in general described in manuscript written by E.M. Krokhin and F.V. Krogius (1937) and sowed that sockeye salmon in the basin of Bolshaya River is reproduced both in Nachiki Lake and in tributaries and side channels of Bolshaya River. Than R.S. Semko (1954) continued the study of Bolshaya River sockeye salmon and investigated the dynamics of abundance, biological characteristics of producers and seasonal growth of sockeye juveniles in Karymaysky abandoned river channel, lower reaches of the river basin.

In 1970–1980 T.V. Egorova (KamchatNIRO archives) conducted the research on dynamics of abundance and biological characteristics of Bolshaya River sockeye salmon, but didn't do any publication in press.

Lately, the interest in studying the biology and dynamics of abundance of Bolshaya River sockeye salmon is noticeably increased (Bugayev 1995; Bugayev et al. 2001b), what is closely connected with the increase of intensive harvesting of salmonids' reserve in Kamchatka peninsula, which is observed during last decade.

And now it is safe to say about the influence of general factor on the dynamics of abundance of Ozernaya and Kamchatka Rivers sockeye salmon – change of pink salmon O. gorbuscha (Walbaum) number fluctuations in Kamchatka. Change of West Kamchatka dominant pink salmon brood years from odd years to even years and connected with that increase of sockeye abundance of Asian coast led to the necessity of studying sockeye brood years during the definite periods: growing and feeding at sea to 1984 (inclusive) and from 1985 to present (Bugayev and Dubynin 2000; Bugayev 2001; Bugayev and Dubynin 2002).

The dates used in the work over Bolshaya River sockeye salmon belong to the second period (1986–1999 years). In this article we discussed factors, influencing on biological characteristics, and some problems concerning the dynamics of abundance.

## MATERIAL AND METHODS

Our research is based of data on biological analysis of mature Bolshaya River sockeye salmon from commercial harvests, done by KamchatNIRO and Kamchatrybvod specialists in 1986–1999, and the results of multiple air registration procedures over sockeye producers in the basin of the river, annually conducted by KamchatNIRO (earlier KoTINRO) specialists – A.G. Ostroumov, K.Yu. Nepomnyashy, A.V. Maslov in 1957–2000.

Collection of scale, age determination of mature sockeye individuals was executed according to the methods presented earlier (Clutter and Whitesel 1956; Bugayev 1995).

The statistical analysis and processing of data was done on personal computer “Pentium III” using the program “STATISTICA” (Borovikov and Borovikov 1998).

For regression analysis we (Bugayev, 1995) for many years use on the whole Spearmen’s correlation coefficients of ranges, which in contradistinction to correlation coefficient can be used irrespective of character distribution law (Lakin 1990). This characteristic was used in the work.

In their work author pay much attention to polyfactor regression analysis of combined influence of examined factors, which presuppose linear dependence between dependent variables. To gain more stable assessments of model characteristics and to reduce standard error, logarithmizing of variables is used in statistics (Borovikov and Borovikov 1998).

In this work we transformed all initial characteristics into natural logarithms by authors’ recommendation (Borovikov and Borovikov 1998).

Some factors, which influence on biological characteristics and dynamics of abundance of sockeye salmon in Ozernaya and Kamchatka rivers (Bugayev and Dubynin 2002) are listed in Table 1, and the characteristics in Bolshaya River will be shown below.

When studying the biological characteristics of sockeye stocks, as a characteristics of year-to-year climate change in Kamchatka in this work we took average air temperature in June–August in Ust-Kamchatsk (at the seaside of North-West part of Pacific ocean, which is the place of Asian sockeye stocks feeding). This characteristic proved to be well in our previous investigations (Bugayev and Ostroumov 1986; Bugayev 1987; Bugayev 1995; Bugayev and Dubynin 2002).

In program "STATISTICA" using forward stepwise regression method of inclusion based on materials of 1985-1998 (during 1999-year estimation some useful for analysis materials have not been received yet) we calculated coefficients of multiple correlation and regression ecuations (Borovikov and Borovikov 1998):

1. Between mean body length and body weight of mature Bolshaya River sockeye salmon (total data on all age groups) and environmental factors and abundance of fish.

2. Between mean coefficients of maturity of mature early and late sockeye males and females from Bolshaya River (total data on all age groups) and environmental factors and abundance of fish.

3. Between mean absolute fecundity of early and late sockeye males from Bolshaya River (total data on all age groups) and environmental factors and abundance of fish.

Without any doubt, combination of factors influencing on body length and body weight formation, coefficients of maturity and females' fecundity of separate age groups of Bolshaya River sockeye salmon can be various, but the analysis of that influence on separate age groups wasn't the problem of this research.

In this article under the statistic analysis were used the following conventional signs: $r_s$ - Spearmen's correlation coefficients of ranges, R - coefficient of multiple correlation, P - probability of occurrence; n – number of years of observation, N – sample size of fishes.

# RESULTS

**Spatial structure of populations**. Investigators – Bugayev, Ostroumov, Nepomnyashy and Maslov (2001b), studying the population structure of Bolshaya River sockeye stocks, on the basis of conception about population structure of sockeye salmon (Bugayev 1983, 1995) consider that in Bolsaya River, the basin of Nachiki Lake, the second level local stock lacustrine sockeye salmon ("BN" stock) is reproduced, and in channels and tributaries – freshwater second level local stocks making the group of second level local stock sockeye salmon ("BR" group). "BN" stock and "BR" group forms early and late sockeye salmon (temporal races), which we regard as structural components of second level local stock.

Data on feeding migration of "BR" group sockeye juveniles from tributaryes of Bolshaya River to Nachiki Lake is not registered, that, probably, is connected both with considerable length of Plotnikov River flown out of the lake and big speed of current in the river.

Into consideration, except Nachiki Lake, there is rather large Tolmachevskoye Lake in the basin of the river, where because of the Tolmacheva River's waterfalls the anadromous form of sockeye salmon doesn't exist. In 1985 in Tolmachevo Lake was made an introduction of 80 producers of kokanee (freshwater form of sockeye salmon) from Kronotskoye Lake, and 800 underyearlings of kokanee from the same lake were released in 1988. During the last years Tolmachevskoye Lake kokanee became of local commercial significance (Kurenkov 1999).

**Anadromous migration**. On our observations, anadromous migration of Bolshaya River sockeye salmon continues from the beginning of May to the end of August. According to annual biostatistical materials gathered by Kamchatrybvod and KamchatNIRO specialists, in commercial amount Bolshaya River sockeye salmon is met since the end of May till mid August.

At the end of June-beginning of July in the lower portions in drainages of Bolshaya River every year an obviously marked reduction of sockeye catches (during some years even full lack of it for several days) is registered that connected with separate runs of early and late sockeye.

V.F. Bugayev (1995), according to the date of catch, divide Bolshaya River sockeye salmon into early run sockeye (May–June) and late run sockeye (July-August).

**Age structure**. Mature sockeye individuals of Bolshaya River are on the whole in age-1.3, more rarely in age-2.3 (Semko 1954; Bugayev 1995). Moreover, in R.S. Semko's data (1954) during 1935-1947 it is not indicated to what early sockeye or late sockeye his materials belong to, but V.F. Bugayev (1995) using united materials of 1957-1971 determined only early run sockeye's age.

Our investigations of age structure of early and late sockeye from Bolshaya River began just in 1986 and last up to the present. As the determinations of

Bolshaya River sockeye salmon's age (to 1985 inclusive) during 1973-1985, which kept in the archives of KamchatNIRO, are executed by other specialists, we didn't use these materials.

As materials about sockeye age determined by other investigators can contain considerable mistakes in age determination of freshwater fish, so it can be the evidence of our careful approach to the usage of archives' data. So the tests' results of age determination of sockeye salmon can be also the evidence of it (Myers 1998).

Table 2 shows that among Bolshaya River sockeye salmon (united data on males and females) of both early and late runs on average individuals in age-1.3 prevail, but if proportion of individuals in age-1.3 among early sockeye was 46.5% in 1986-1999, so late sockeye – 68.4%. Bolshaya River early sockeye individuals in age-2.3 amount 25.8%, and late sockeye – only 6% (Table 2). It should be marked that during some years among early run fish age-2.3 individuals predominate in numbers over age-1.3 fish.

According to the data of table 3, among early sockeye from lifts of 1986-1999 period females mean 49.0% (min – 25.8%, max – 61.5%, n=10 years), late sockeye – 54.3% (min – 39.4%, max – 62.5%, n=13 years).

The analysis of age composition of males and females shows (Table 3) that in 1986-1999 among early sockeye all individuals with 1 and 2 seawater years are males. Among late sockeye all individuals with 1 seawater year are males, but among individuals with 2 seawater years females can be met.

Among age-1.3 individuals of early sockeye, the amount of males and females is approximately equal – 23.6% and 22.7%, respectively; among late salmon individuals the amount of males is smaller than females – 31.7% and 36.7%, respectively (Table 3).

Among early and late sockeye salmon with 4 seawater years both males and females can be met, but the last ones are met more often. Among both early and late sockeye salmon with 5 seawater years only females were met (Table 3).

The analysis of middle-aged males and females of Bolshaya River sockeye salmon based on date of 1986-1999 showed that early sockeye has more long both freshwater and seawater life history than late sockeye individuals.

So mean length of freshwater life period of early sockeye (both sexes) was – 1.255, late – 0.966; seawater life period of early sockeye – 3.133, late – 3.024 years.

On materials of 1986–1999 we studied interrelationships between freshwater and seawater lives of Bolshaya River sockeye salmon (with division into early and late sockeye salmon).

It was observed that early sockeye males and females have very low and apocryphal rank correlation coefficients ($r_s$=-0.115-0.067, P>0.05, n=10).

The presence of low positive correlation between the indications under consideration (males - $r_s$=0.509, females - $r_s$=0.465, both sexes - $r_s$=0.396, P>0.05,

n=13) can be just presupposed, because it was wrong in available materials. In all cases the regression lines had well marked trend between the indications.

**Body length and body weight**. Body length and body weight of Bolshaya River early and late sockeye males and females in 1986-1999 are listed in Tables 4 and 5 in accordance with belonging to the separate and more numerous age groups. Till now the materials about body length and body weight of Bolshaya River sockeye salmon in 1973-1990 were published without any division into age groups (Bugayev 1995).

It was proposed earlier (Bugayev 1995) that the number of West Kamchatka pink salmon makes influence both on body length of mature Bolshaya River and Ozernaya River sockeye salmon. The problem concerning the influence of North-East Kamchatka pink salmon on body size of Bolshaya River sockeye salmon is still unsolved, because of the absence of data on some years (Bugayev 1995).

On our data (Bugayev 1995) in 1973-1989 (absence of any information for 1984 year), mean body length of early sockeye males (females) was 56.43 cm (56.22 cm), late – 63.65 cm (61.19 cm); mean body weight of early sockeye males (females) was 2.239 kg (2.138 kg), late – 3.257 kg (2.845 kg).

Tables 4-5 show that in 1986-1999 mean body length and body weight of Bolshaya River early sockeye is lower than late sockeye individuals. So mean body length of early sockeye males (females) was 59.73 cm (56.75 cm), late ones – 65.09 cm (62.51 cm); mean body weight of early sockeye males (females) was 2.52 kg (2.12 kg), late ones – 3.36 kg (2.89 kg).

Adducing of comparison shows that in 1973–1983 body length and body weight of Bolshaya River sockeye males and females (except one occasion of late sockeye body weight) was lower than in 1986–1999.

Without any doubt, a complex of factors makes influence on body length and body weight as of Ozernaya and Kamchatka sockeye salmon (Bugayev and Dubynin 2002), so of the Bolshaya River sockeye salmon.

The analysis showed that body length of the Bolshaya River early sockeye males (BOLLMEA) was influenced by the following factors (Table 1):

**LnBOLLMEA = 3.0991 + 0.0241*LnPINE – 0.0745*LnRUNKAM – 0.0281*LnOZZR + 0.0719*LnRUNKAMBF + 0.3004*LnLSMKUBF – 0.0820* *LnTVOZ – 0.0011*LnPINEBF; R = 1.000, P < 0.01, n = 9;**

females (BOLLFEA):

**LnBOLLFEA = 4.1217 + 0.0516*LnWSMKUBF – 0.0802*LnTVOZBF; R = 0.713, P > 0.05, n = 9.**

Factors influencing on body weight of the Bolshaya River early sockeye males (BOLLMEA):

**LnBOLWMEA = 2.3927 – 0.1725*LnRUNKAM + 0.0511*LnPINE – 0.1438*LnWSMKU – 0.1323*LnWSMKUBF + 0.1148*LnTVOZBF – 0.0137* *LnPINWEBF – 0.0050*LnPINWE; R = 1.000, P < 0.05, n = 9;**

females (BOLWFEA):

**LnBOLWFEA = 1.2040 – 0.0620*LnRUNKAM; R = 0.720, P < 0.05.**

Factors influencing on body length of the Bolshaya River late sockeye males (BOLLMLT):

**LnBOLLMLT = 3.1443 + 0.1116*LnOZRUNBF + 0.0444*LnOZRUN – 0.1670*LnTVOZBF + 0.0297*LnPINWE; R = 0.962, P < 0.05, n = 9;**

females (BOLLFLT):

**LnBOLLFLT = 3.5607 – 0.0453*LnPINWE – 0.0121*LnPINWEBF – 0.0168*LnPINEBF + 0.0444*LnPINWEBF – 0.1167*LnTVOZBF + 0.0194* *LnOZRUBF + 0.1709*LnLSMKU; R = 1.000, P > 0.05, n = 9.**

Factors influencing on body weight of the Bolshaya River late sockeye males (BOLWMLT):

**LnBOLWMLT = - 0.0894 + 0.2389*LnWSMKUBF + 0.2713* *LnOZRUNBF – 0.0488*LnPINWBF – 0.5190*LnTVOZBF + 0.1348* *LnPINWEBF – 0.0744*LnPINEBF – 0.0541*LZRKABF; R = 1.000, P < 0.01, n = 9;**

females (BOLWFLT):

**LnBOLWFLT = - 2.9709 – 0.0009*LnPINWE – 0.0465*LnPIWBF + 0.2233*LnOZRUNBF – 0.1132*LnPINEBF + 1.0080*LnTVOZ + 0.0395* *LnPINWEBF + 0.0091*LnRUNKAMBF; R = 1.000, P < 0.01, n = 9.**

Last investigations showed (Bugayev and Dubynin 2002; Bugayev et al. 2001a, 2003) that sockeye salmon of some West Kamchatka rivers (Palana, Khayruzova, Icha, Krutogorova, Vorovskaya, Kihchik and Ozernaya) in some cases has high and authentic correlations between body length and body weight, but in other cases – hasn't. It was proposed (Bugayev et al. 2003) that this situation is firstly connected with influence of West Kamchatka pink salmon abundance on growth of West Kamchatka sockeye salmon, as during the seawater period of life these species are food competitors (Andrievskaya 1975; Birman 1985; Karpenko 1998 and others).

Presence or absence of high correlation between body length and body weight of mature sockeye salmon from different West Kamchatka rivers is exceptionally interesting and important in studying seawater period of life. We consider the above mentioned factors (Bugayev et al. 2003) to be the fragments of more wide regularities, which will be discovered in future.

In connection with the above mentioned, for accumulation of necessary materials firstly about West Kamchatka sockeye salmon, in this work (on data of Tables 4-5) we conducted the analysis of interrelationships between body length and body weight of mature Bolshaya River sockeye salmon in 1986-1999.

So, in 1986-1999 Spearmen's rank correlation coefficients value between mean annual characteristics (Tables 4-5) of body length and body weight of Bolshaya River early sockeye males (females) (without division into age groups) were $r_s$=0.857, P<0.01, n=10 ($r_s$= 0.412, P>0.05, n=10); late sockeye – $r_s$=0.874, P<0.001, n=13 ($r_s$=0.940, P<0.001, n=13).

In 1986-1999 Spearmen's rank correlation coefficients value between body length and body weight characteristics of age-1.3 early sockeye males (females) were $r_s$=0.891, P<0.001, n=10 ($r_s$=0.709, P<0.05, n=10); late sockeye – $r_s$=0.720, P<0.01, n=13 ($r_s$=0.564, P<0.05, n=13).

To calculate Spearmen's rank correlation coefficients of sockeye males (females) (without division into age groups) for 1973-1983 period we used Bugayev's (1995) data on Bolshaya River sockeye salmon. During this period rank correlation coefficients value between body length and body weight characteristics of early sockeye males (females) were $r_s$=0.850, P<0.01, n=9 ($r_s$=-0.218, P>0.05, n=9); late sockeye – $r_s$=0.900, P<0.001, n=11 ($r_s$=0.456, P>0.05, n=11).

The observed difference in correlation between body length and body weight characteristics of mature Bolshaya River early and late sockeye males and females during 1973-1983 and 1986-1999 we connect with year-to-year variations in seawater life conditions of fish (Bugayev and Dubynin 2000; Bugayev 2001; Bugayev and Dubynin 2002).

**Coefficients of maturity**. Materials about coefficients of maturity of Bolshaya River early and late sockeye salmon (united data on all age groups) for 1973-1989 years were published earlier (Bugayev 1995); for all that, it is worth to make a note of absence of materials for some years. coefficients of maturity of Bolshaya River early and late sockeye salmon in 1986-1999 are listed in Table 6.

Coefficients of maturity of Bolshaya River early sockeye males (BOLGDMEA) were influenced by the following factors (Table 1):

**LnBOLGDMEA = 7.7664 + 0.1002*LnPINW – 2.2565*LnTVOZ + 0.0295*LnPINWE – 0.0437*LnPINWEBF + 0.0480*LnPINWEBF – 0.9783* LnLSMKUBF + 0.3384*LnOZZR; R = 1.000, P < 0.01, n = 9;**

females (BOLGDFEA):

**LnBOLGDFEA = -17.1367 + 3.2747*LnLSMKU + 0.4292*LnPINWE + 0.2033*LnTVOZBF + 0.4611*LnOZZRBF – 0.2178*LnRUNKAM – 0.6426* *LnWSMKUBF + 0.0854*LnOZRUN; R = 1.000, P < 0.05, n = 9.**

Coefficients of maturity of Bolshaya River late sockeye males (BOLGDMLT) were influenced by the following factors:

**LnBOLGDMLT = -6.5348 + 0.6689*LnWSMKU + 0.2174*LnPINWE + 0.3467*LnOZZR + 0.1689*LnOZZRBF + 0.4468*LnWSMKUBF + 0.0568* *LnRUNKAM + 0.0609*LnRUNKAMBF; R = 1.000, P < 0.05, n = 9;**

females (BOLGDFLT):

**LnBOLGDFLT = 0.6238 + 0.0430*LnPINWBF + 0.0435*LnPINW + 0.1815*LnPINW?BF – 0.0717*LnPINEBF + 0.0350*LnOZRUNBF – 0.2456* *LnTVOZBF + 0.2646*LnLSMKUBF; R = 0.999, P > 0.05, n = 9.**

**Fecundity**. Data on fecundity of Bolshaya River early and late sockeye salmon according to the united data on separate age groups of 1986-1990 years were published earlier (Bugayev 1995). Complete materials about annual fecundity of Bolshaya River early and late sockeye salmon in 1986-1999 are listed in Table 7.

Absolute fecundity of Bolshaya River early sockeye females (BOLEGEA) is influenced by the following factors (Table 1):

**LnBOLEGEA = 1.3281 – 1.2591*LnRUNKAM + 0.9263*ZRKAM + 1.7356*LnLSMKUBF + 0.1349*LnOZZR; R = 0.993, P < 0.001, n = 9;**

late sockeye (BOLEGLT):

**LnBOLEGLT = -1.6574 + 0.8988*LnLSMKUBF – 0.3812* *LnRUNKAMBF + 1.0486*LnWSMKUBF + 0.0772*LnPINW?BF + 0.6185* *LnZRKAMBF + 0.1972*Ln OZRUNBF + 0.0057*LnOZZR; R = 1.000, P < 0.05, n = 9.**

**Periods of spawning**. According to the materials of 1981-1990, among producers spawned in the Bolshaya River (united data on second level local stock – "BN" and second level local group – "BR") during some years early sockeye amounted 10.2-89.3 (on average – 55.1) %, late sockeye – 10.7-89.7 (on average – 44.9) %. In 1930-1940 the correlation between early and late sockeye salmon of Bolshaya River was different and amounted 25-30% and 70-75%, respectively (A.G. Ostroumov personal communication; Bugayev 1995).

These examples are evidence of rather intense year-to-year variation of correlation of Bolshaya River early and late sockeye salmon escapement. The last is connected both with number fluctuations of sockeye salmon early and late temporal races from this river and, probably, with year-to-year intensity of commercial harvests (its peculiarities for Bolshaya River sockeye salmon will be discussed below).

Proceeding from many years' data, spawning of Bolshaya River early sockeye starts in the beginning-middle of July and finishes in the beginning-end of August; mass spawning – from the middle of July to the end of first decade of August (A.G. Ostroumov personal communication; Bugayev 1995). Spawning of late sockeye starts in the end of July-end of August and finishes in the beginning of September-end of October; mass spawning – from the middle of August to the end of second decade of September (A.G. Ostroumov personal communication; Bugayev 1995).

**Growth and downstream migration of juveniles**. We don't have real data on growth of fry and downstream migration of sockeye smolts in the basin of Bolshaya River. Literature (Semko 1954) contains the information about seasonal fattening of sockeye juveniles from Karymaisky abandoned river channel, but this information doesn't envelope the whole variability of sockeye juveniles' growth in the basin of Bolshaya River, where the juveniles feed and grow both in lakes and river. Judging by age composition of mature fish, a part of juveniles roll down the sea as underyearlings. (Tables 2-3; Semko 1954; Bugayev 1995).

**Dynamics of abundance**. In contradiction to large and some small sockeye stocks in Kamchatka peninsula, for which there is no problem to evaluate size of coastal and inland catches, that allows to estimate total runs of mature fish to the estuary of river of spawning, the problem of reliable evaluation of coastal and inland catches is still unsolved (Bugayev 1995; Bugayev et al. 2001b).

It connected with complex migrations along the West Kamchatka coast (Birman and Konovalov 1968; Konovalov 1971, Birman 1985) accomplished by the biggest stock in Asia – mature sockeye salmon from Ozernaya River, the estuary of which is situated to the south of Bolshaya River, and trap net catches of sockeye salmon, which are between estuaries of Ozernaya and Bolshaya rivers, probably, contain individuals from Ozernaya River. Ozernaya River sockeye stock

dominate greatly in abundance over Bolshaya River sockeye individuals (M.M. Selifonov personal communication).

Identification of sockeye salmon (by scale structure) from trap net catches in the district of Bolshaya River estuary (area ? 160b) for belonging to Ozernaya River sockeye stock or Bolshaya River sockeye stock was firstly conducted just in 2001, that is why it's too prematurely to tell about any regularity. Nevertheless, it is worth to make a note of 100% presence of Bolshaya River sockeye salmon in catches (A. V. Bugayev – scientist of KamchatNIRO personal communication).

We explain high occurrence of Bolshaya River sockeye individuals in ? 160b trap net catches by its close location to the estuary of Bolshaya River and absence of Ozernaya River sockeye runs to that place. We consider, that during the next years it is necessary to collect more representative materials from some trap nets, which are located both to the south and to the north of Bolshaya River, for more reliable conclusions about number correlation between Ozernaya River sockeye salmon and Bolshaya River sockeye salmon in marine trap net catches.

Apart from anything else, as for other local stocks in Kamchatka (Bugayev 1995; Bugayev and Dubynin 2000; Bugayev and Dubynin 2002), there is a problem of estimation of stock mature part for Bolshaya River sockeye salmon at sea, which is the place of drift catch zone of Russian economic zone.

During the last years, with appearance of great amount of fishery companies in the basin of Bolshaya River and dramatic increase of poaching, to tell about real year-to-year estimation of sockeye catches in this river and to restore previous period became more problematic.

Taking into account the above mentioned, as earlier (Bugayev 1995; Bugayev et al. 2001b), we will evaluate just year-to-year escapement of Bolshaya River sockeye salmon, that allow to do some conclusions about the dynamics of abundance of sockeye salmon in this river.

Unfortunately, we still don't have all necessary information about separate escapement of Bolshaya River early and late sockeye salmon. As it have already been mentioned earlier, we regard early and late runs of sockeye salmon (Bugayev 1983, 1995) as structural components of local stocks with different degrees of complication as S.M. Konovalov (1980) did.

As it shown on Fig. 1, in 1957-2000 escapement of Bolshaya River sockeye salmon has undergone sizable changes. So, 1957-1967 period of time is marked by high escapement, and in 1967-1983 we observe a period of stable low escapement. During the next 1984-2000 years we can observe the increase of escapement, but with some years of low escapement.

The basic peculiarity of dynamics of abundance of West Kamchatka rivers' sockeye salmon is number fluctuations of these stocks, which are mostly in one phase: number of almost all West Kamchatka rivers' sockeye salmon simultaneously increase or decrease, that is completely relate to Bolshaya and Ozernaya rivers sockeye salmon (Bugayev 1995).

So, earlier it was made a note of high positive reliable correlation between number of sockeye runs to the estuaries of Ozernaya River and escapement in the basin of the Bolshaya River – $r_s$=0.893, P<0.01 (Bugayev 1995).

We consider the reason of one-directional fluctuations of sockeye abundance in most West Kamchatka rivers to be the result of one-directional changes in survival of individuals from different stocks during seawater life period, which determines the dynamics of their abundance as a whole along this coast (Bugayev 1995).

The second reason can be the fact that with the increase of Ozernaya River sockeye abundance the total press of catches on second level local stocks of West Kamchatka sockeye salmon goes down.

Besides, total number of West Kamchatka pink salmon can influence the escapement – during the years of its high abundance the total press of catches on Bolshaya River sockeye salmon (and other sockeye salmon stocks) goes down. As the result, more sockeye producers can pass to the spawning grounds. Fig. 1 shows that in 1993-2000 during even years (high number of pink salmon), local peaks of sockeye abundance were observed, and during odd years (low number of pink salmon) – local falls.

The problem concerning the exact number of escapement of Bolshaya River sockeye salmon is still unsolved, but to our opinion it's approximately 100-150 thousands of fish. The optimum of Bolshaya River sockeye escapement is definitely less than 300 thousands of fish, the evidence of which is Fig. 1, when from 329.5 thousands of producers spawned out in 1990, in 1995 (the return of basic age-1.3 group) returned only 50.5 thousands of producers. In one's turn, 92 thousands of producers spawned out in 1985 gave exceptionally high returns in 1990 (Fig.1). Another high returns - 221.0 thousands of fish - were gained in the result of spawning of 81.5 thousands of fish in 1984.

As it was shown on the example of Kamchatka River sockeye salmon (Bugayev and Ostroumov 1986; Bugayev 1987; Bugayev 1995), lacustrine and river sockeye stocks have rather distinct dynamics of abundance, that's why from this point of view they should be examined separately.

Fig. 2 shows that high returns of sockeye salmon to the spawning grounds of Bolshaya River in 1990 were provided by group of river stocks - "BR", but not by lacustrine stock "BN" (Nachiki Lake). The last favours the necessity of separate study of dynamics of "BN" stock and "BR" group abundance in the basin of Bolshaya River. On the basis of data shown on Fig. 2, it can be presupposed that since the end of 1980s till nowadays there were principal changes in structure of all Bolshaya River sockeye stock, when the number of sockeye group of second level river stock ("BR") began to predominate the second level lacustrine stock of sockeye salmon ("BN").

These changes in structure of all Bolshaya River sockeye stock (Fig. 2) are considerably connected with changes in number of odd and even brood years of

West Kamchatka pink salmon, registered from 1985 to present. (Bugayev 1995; Bugayev and Dubynin 2000; Bugayev 2001; Bugayev et al. 2001; Bugayev and Dubynin 2002).

## CONCLUSION

On the example of Kamchatka and Ozernaya Rivers' local sockeye stocks the investigators (Bugayev and Dubynin 2002) have already demonstrated a number of examples of complex influence of environment and abundance of fish on biological characteristics and dynamics of abundance of sockeye individuals, which are evidence of complex causative-consecutive connections of natural origin.

This investigation showed that the biological characteristics (body length and body weight, coefficients of maturity, fecundity) were influenced by the following factors: number of mature West and East Kamchatka pink salmon, number of principal Asian sockeye stocks, body length and body weight of Ozernaya River sockeye smolts and year-to-year climate changes. Moreover, the influence of above mentioned factors on various biological characteristics of Bolshaya River sockeye salmon was not synonymous.

In connection with absence of data on number of brood years and stock mature part of Bolshaya River sockeye salmon, on this level of research it's impossible to judge about the strength of influence of true sockeye abundance in this river on biological characteristics of individuals.

The revealed in this work factors influencing on biological characteristics of mature Bolshaya River sockeye salmon fully coincide with earlier determined factors influencing on biological characteristics of Ozernaya and Kamchatka Rivers sockeye stocks (Bugayev and Dubynin 2002).

The results of this work permit to plan feature research of Bolshaya River sockeye salmon not only in complex with investigations of other sockeye stocks, but and another species of Pacific salmon in Kamchatka peninsula.

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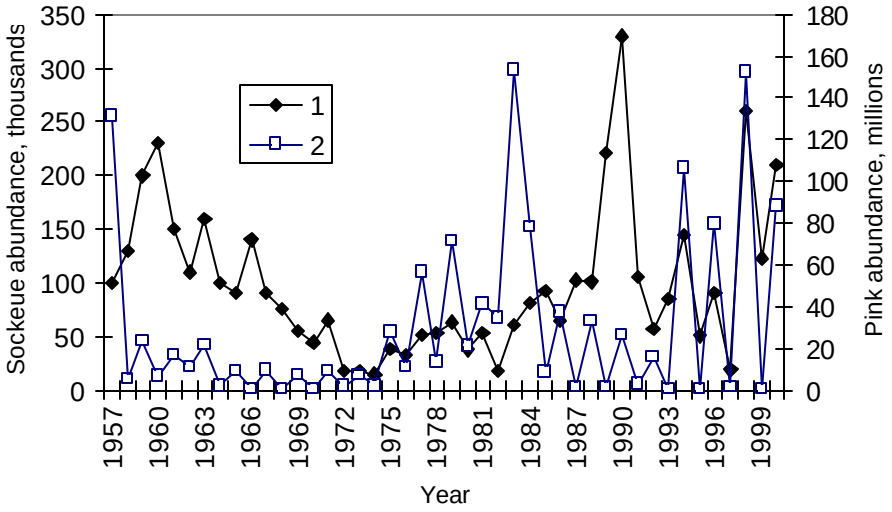


Fig. 1. Total number of early sockeye and late sockeye escapement in the basin of Bolshaya River (1), and total runs of pink salmon to the shores of West Kamchatka after passing the drift net catch zone (2) in 1957-2000.

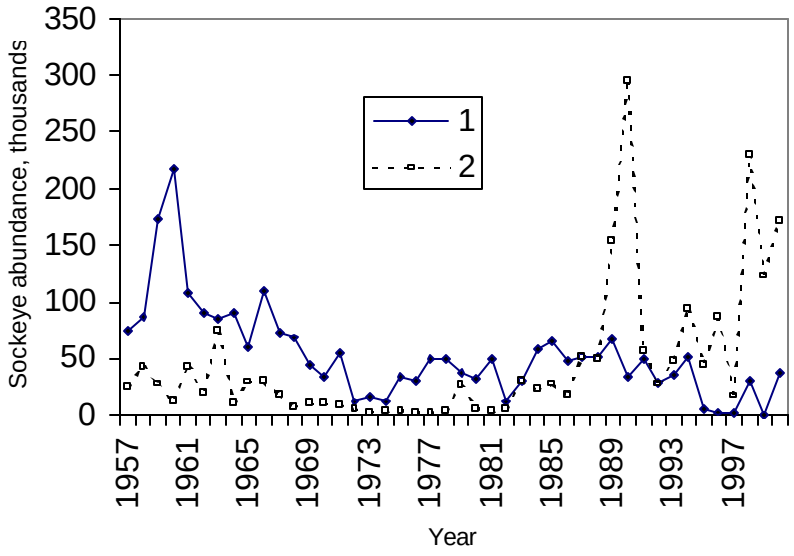


Fig. 2. Number of "BN" stock (1) and "BR" group (2) sockeye salmon escapement in the basin of Bolshaya River in 1957-2000 (date of early sockeye and late sockeye salmon are united).

Table 1

Some factors influencing on biological characteristics and dynamics of abundance of Ozernaya and Kamchatka rivers sockeye salmon (Bugayev, Dubynin, 2002)

| Factors' codes | Description |
|---|---|
| | Air temperature |
| TVOZ | Mean air temperature in June-July in Ust-Kamchatsk during the year of research, ?C |
| TVOZBF | Mean air temperature in June-July in Ust-Kamchatsk during the last year, ?C |
| | Ozernaya River sockeye salmon |
| LSMKU | Body length of Kuril Lake sockeye smolts at the age 2+ returned during the year of research, mm |
| LSMKUBF | Body length of Kuril Lake sockeye smolts at the age 2+ from which an Ozernaya sockeye stock returned at the previous year, mm |
| WSMKU | Body weight of Kuril Lake sockeye smolts at the age 2+ from which an Ozernaya sockeye stock returned during the year of research, g |
| WSMKUBF | Body weight of Kuril Lake sockeye smolts at the age 2+ from which an Ozernaya sockeye stock returned at the previous year, g |
| OZZR | Number of stock mature part of Ozernaya River before the drift net catch at sea during the year of research, thousands of fish |
| OZZRBF | Number of stock mature part of Ozernaya River before the drift net catch at sea at the previous year, thousands of fish |
| OZRUN | Number of runs of sockeye salmon to the estuary of Ozernaya River during the year of research, thousands of fish |
| OZRUNBF | Number of runs of sockeye salmon to the estuary of Ozernaya River at the previous year, thousands of fish |
| | Kamchatka River sockeye salmon |
| ZRKAM | Number of stock mature part of Kamchatka River before the drift net catch at sea during the year of research, thousands of fish |
| ZRKAMBF | Number of runs of sockeye salmon to the estuary of Kamchatka River during the year of research, thousands of fish |
| RUNKAM | Number of runs of sockeye salmon to the estuary of Kamchatka River during the year of research, thousands of fish |
| RUNKAMBF | Number of runs of sockeye salmon to the estuary of Kamchatka River at the previous year, thousands of fish |
| | Pink salmon abundance |
| PINW | Number of mature West Kamchatka pink salmon at sea after passing a drift net catch zone during the year of research, millions of fish |
| PINWBF | Number of mature West Kamchatka pink salmon at sea after passing a drift net catch zone at the previous year, millions of fish |
| PINE | Number of mature North-East Kamchatka pink salmon at sea after passing a drift net catch zone during the year of research, millions of fish |
| PINEBF | Number of mature North-East Kamchatka pink salmon at sea after passing a drift net catch zone at the previous year, millions of fish |
| PINWE | Total number of mature North-East Kamchatka pink salmon at sea after passing a drift net catch zone during the year of research, millions of fish |
| PINWEBF | Total number of mature West and North-East Kamchatka pink salmon at sea after passing a drift catch zone at the previous year, millions of fish |

Table 2

Age composition of mature Bolshaya River sockeye salmon from catches in 1986-1999, %

| Year | 0.2 | 0.3 | 0.4 | 0.5 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 3.2 | 3.3 | 3.4 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Early run | | | | | | | | | |
| 1986 | - | 4.3 | - | - | - | 7.4 | 74.3 | 5.3 | - | - | 0.9 | 6.2 | 1.8 | - | - | - | - | 229 |
| 1987 | - | 0.4 | - | - | - | 6.2 | 58.0 | 11.0 | - | - | 0.4 | 23.5 | 0.4 | - | - | - | - | 226 |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | - | 23.7 | 0.6 | - | - | - | 53.7 | 15.2 | - | - | - | 3.5 | 1.5 | - | - | - | - | 343 |
| 1990 | - | - | 1.9 | - | - | 1.9 | 27.8 | 25.9 | - | - | - | 31.5 | 11.1 | - | - | - | - | 54 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | - | 3.0 | - | - | - | 1.0 | 69.4 | 12.2 | - | - | | 12.2 | 2.0 | - | - | - | - | 98 |
| 1994 | - | 8.1 | - | - | - | - | 50.0 | 6.2 | - | - | 0.7 | 29.5 | 5.4 | - | - | - | - | 146 |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | - | - | - | - | - | 3.2 | 35.5 | 9.7 | - | - | 6.5 | 41.9 | 3.2 | - | - | - | - | 31 |
| 1997 | - | 1.0 | - | - | - | 1.0 | 31.7 | 3.9 | - | - | 2.9 | 53.9 | 4.8 | - | - | 1.0 | - | 104 |
| 1998 | - | 11.2 | 0.9 | - | 2.8 | 0.9 | 35.5 | 19.7 | - | - | - | 24.4 | 4.6 | - | - | - | - | 107 |
| 1999 | - | - | 5.8 | - | - | 9.3 | 26.8 | 17.5 | - | - | - | 31.3 | 8.1 | - | - | 1.2 | - | 86 |
| Mean 1986-1999 | - | 5.1 | 0.9 | - | 0.3 | 3.1 | 46.3 | 12.8 | - | - | 1.1 | 25.8 | 4.4 | - | - | 0.2 | - | - |

Note. N – sample size of fishes (Tables 2-3).

Table 2 finished

Age composition of mature Bolshaya River sockeye salmon from catches in 1986-1999, %

| Year | 0.2 | 0.3 | 0.4 | 0.5 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 3.2 | 3.3 | 3.4 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Late run | | | | | | | | | |
| 1986 | - | 0.5 | - | - | - | 2.7 | 87.8 | 4.3 | - | - | 0.5 | 3.2 | 0.5 | - | - | 0.5 | - | 188 |
| 1987 | - | 2.0 | 0.6 | - | - | 5.4 | 74.8 | 7.1 | - | 0.3 | 0.3 | 9.4 | - | - | - | - | - | 310 |
| 1988 | - | 1.1 | 1.1 | - | - | - | 74.1 | 16.8 | - | - | - | 5.7 | 1.1 | - | - | - | - | 89 |
| 1989 | - | 10.6 | 1.5 | - | - | 1.5 | 71.2 | 6.0 | - | - | - | 9,1 | - | - | - | - | - | 66 |
| 1990 | - | 4.5 | - | - | - | 1.0 | 66.5 | 15.5 | 0.5 | - | 1.0 | 8.5 | 1.5 | 0.5 | - | 0.5 | - | 200 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | 2.1 | - | - | - | 4.2 | 83.9 | 6.3 | - | - | - | 3.5 | - | - | - | - | - | 143 |
| 1993 | 0.8 | 9.0 | 1.6 | 0.8 | - | 0.8 | 70.8 | 4.9 | - | - | - | 11.4 | - | - | - | - | - | 123 |
| 1994 | - | 5.3 | - | - | - | - | 89.4 | 5.4 | - | - | - | - | - | - | - | - | - | 94 |
| 1995 | - | 7.0 | 4,2 | - | - | 7.0 | 63.9 | 11.1 | 1.4 | - | 1.4 | 4.2 | - | - | - | - | - | 72 |
| 1996 | - | 22.9 | - | - | - | 1.6 | 58.7 | 3.3 | - | - | - | 13.6 | - | - | - | - | - | 244 |
| 1997 | 0.8 | 9.3 | 3.7 | - | 0.4 | 8.5 | 48.6 | 15.9 | - | - | 3.3 | 8.9 | 0.4 | - | - | - | 0.4 | 270 |
| 1998 | 10.3 | 8.9 | 1.5 | - | 0.7 | 12.6 | 61.8 | 0.7 | - | - | 2.2 | 0.7 | - | - | 0.7 | - | - | 136 |
| 1999 | 4.8 | 22.6 | 4.1 | - | 1.0 | 21.1 | 40.3 | 4.5 | - | - | 1.3 | 0.3 | - | - | - | - | - | 291 |
| Mean 1986-1999 | 1.3 | 8.2 | 1.4 | 0.1 | 0.2 | 5.1 | 68.4 | 7.9 | 0.1 | + | 0.8 | 6.0 | 0.3 | + | 0.1 | 0.1 | + | - |

Note. "+" – less 0.1% (Tables 2-3).

Table 3

Age composition of mature Bolshaya River sockeye salmon males and females from catches in 1986-1999, %

| Year | 0.2 | | 0.3 | | 0.4 | | 0.5 | | 1.1 | 1.2 | | 1.3 | | 1.4 | | 1.5 | | 2.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | ????? | female | male |
| | | | | | | | | Early run | | | | | | | | | | |
| 1986 | - | - | 0.4 | 3.9 | - | - | - | - | - | 7.4 | - | 29.3 | 45.0 | 1.8 | 3.5 | - | - | - |
| 1987 | - | - | - | 0.4 | - | - | - | - | - | 6.2 | - | 26.1 | 31.9 | 3.5 | 7.5 | - | - | - |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | - | - | 8.5 | 15.2 | 0.3 | 0.3 | - | - | - | - | - | 23.9 | 29.8 | 4.1 | 13.1 | - | - | - |
| 1990 | - | - | - | - | - | 1.9 | - | - | - | 1.9 | - | 3.7 | 24.1 | 14.8 | 11.1 | - | - | - |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | - | - | 1.0 | 2.0 | - | - | - | - | - | 1.0 | - | 35.7 | 33.7 | 2.0 | 10.2 | - | - | - |
| 1994 | - | - | 4.1 | 4.1 | - | - | - | - | - | - | - | 28.1 | 21.9 | 1.4 | 4.8 | - | - | - |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | - | - | - | - | - | - | - | - | - | 3.2 | - | 32.3 | 3.2 | 3.2 | 6.5 | - | - | - |
| 1997 | - | - | 1.0 | - | - | - | - | - | - | 1.0 | - | 17.3 | 14.4 | 3.9 | - | - | - | - |
| 1998 | - | - | 7.5 | 3.7 | - | 0.9 | - | - | 2.8 | 0.9 | - | 19.6 | 15.9 | 4.7 | 15.0 | - | - | - |
| 1999 | - | - | - | - | 3.5 | 2.3 | - | - | - | 9.3 | - | 19.8 | 7.0 | 4.7 | 12.8 | - | - | - |
| Mean 1986-1999 | - | - | 2.2 | 2.9 | 0.4 | 0.5 | - | - | 0.3 | 3.1 | - | 23.6 | 22.7 | 4.4 | 8.4 | - | - | - |

Table 3 finished 1

Age composition of mature Bolshaya River sockeye salmon males and females from catches in 1986-1999, %

| Year | 2.2 | | 2.3 | | 2.4 | | 2.5 | | 3.2 | | 3.3 | | 3.4 | | Total , % | | N | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | Female | male female |
| | | | | | | | | | | Early run | | | | | | | | | |
| 1986 | 0.9 | - | 3.1 | 3.1 | 0.9 | 0.9 | - | - | - | - | - | - | - | - | 43.7 | 56.3 | 100 | 129 | 229 |
| 1987 | 0.4 | - | 11.5 | 12.0 | 0.4 | - | - | - | - | - | - | - | - | - | 48.2 | 51.8 | 109 | 117 | 226 |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | - | - | 1.2 | 2.3 | 0.6 | 0.9 | - | - | - | - | - | - | - | - | 38.5 | 61.5 | 132 | 211 | 343 |
| 1990 | - | - | 14.8 | 16.7 | 3.7 | 7,4 | - | - | - | - | - | - | - | - | 38.9 | 61.1 | 21 | 33 | 54 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | - | - | 5.1 | 7.1 | 1.0 | 1.0 | - | - | - | - | - | - | - | - | 45.9 | 54.1 | 45 | 53 | 98 |
| 1994 | 0.7 | - | 9.6 | 19.9 | 2.7 | 2.7 | - | - | - | - | - | - | - | - | 46.6 | 53.4 | 68 | 78 | 146 |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | 6.5 | - | 25.8 | 16.1 | 3.2 | - | - | - | - | - | - | - | - | - | 74.2 | 25.8 | 23 | 8 | 31 |
| 1997 | 2.9 | - | 32.7 | 21.2 | 1.9 | 2.9 | - | - | - | - | - | 1.0 | - | - | 60.6 | 39.4 | 63 | 41 | 104 |
| 1998 | - | - | 12.2 | 12.2 | 3.7 | 0.9 | - | - | - | - | - | - | - | - | 51.4 | 48.6 | 55 | 52 | 107 |
| 1999 | - | - | 22.0 | 9.3 | 2.3 | 5.8 | - | - | - | - | - | 1.2 | - | - | 61.6 | 38.4 | 53 | 33 | 86 |
| Mean 1986-1999 | 1.1 | - | 13.8 | 12.0 | 2.1 | 2.3 | - | - | - | - | - | 0.2 | - | - | 51.0 | 49.0 | | | |

Table 3 finished 2

Age composition of mature Bolshaya River sockeye salmon males and females from catches in 1986-1999, %

| Year | 0.2 | | 0.3 | | 0.4 | | 0.5 | | 1.1 | 1.2 | | 1.3 | | 1.4 | | 1.5 | | 2.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | male | female | male | female | male | female | male | female | male |
| | | | | | | | | | Late run | | | | | | | | | |
| 1986 | - | - | 0.5 | - | - | - | - | - | - | 2.7 | - | 42.0 | 45.8 | 1.1 | 3.2 | - | - | - |
| 1987 | - | - | 1.0 | 1.0 | 0.3 | 0.3 | - | - | - | 4.8 | 0.6 | 31.9 | 42.9 | 1.9 | 5.2 | - | - | 0.3 |
| 1988 | - | - | - | 1.1 | - | 1.1 | - | - | - | - | - | 34.8 | 39.3 | 11.2 | 5.6 | - | - | - |
| 1989 | - | - | 1.5 | 9.1 | 1.5 | - | - | - | - | 1.5 | - | 34.9 | 36.3 | 1.5 | 4.5 | - | - | - |
| 1990 | - | - | 2.5 | 2.0 | - | - | - | - | - | 0.5 | 0.5 | 29.5 | 37.0 | 4.5 | 11.0 | - | 0.5 | - |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | 0.7 | 1.4 | - | - | - | - | - | 2.1 | 2.1 | 38.5 | 45.4 | 2.1 | 4.2 | - | - | - |
| 1993 | 0.8 | - | 4.9 | 4.1 | 0.8 | 0.8 | - | 0.8 | - | 0.8 | - | 35.0 | 35.8 | 0.8 | 4.1 | - | - | - |
| 1994 | - | - | 2.1 | 3.2 | - | - | - | - | - | - | - | 54.3 | 35.1 | 4.3 | 1.1 | - | - | - |
| 1995 | - | - | 2.8 | 4.2 | 1.4 | 2.8 | - | - | - | 5.6 | 1.4 | 26.4 | 37.5 | 1.4 | 9.7 | - | 1.4 | - |
| 1996 | - | - | 9.0 | 13.9 | - | - | - | - | - | 1.2 | 0.4 | 27.1 | 31.6 | 0.8 | 2.5 | - | - | - |
| 1997 | 0.4 | 0.4 | 3.7 | 5.6 | - | 3.7 | - | - | 0.4 | 4.1 | 4.4 | 23.0 | 25.6 | 3.7 | 12.2 | - | - | - |
| 1998 | 8.8 | 1.5 | 1.5 | 7.4 | - | 1.5 | - | - | 0.7 | 7.4 | 5.2 | 22.1 | 39.7 | | 0.7 | - | - | - |
| 1999 | 4.5 | 0.3 | 8.2 | 14.4 | - | 4.1 | - | - | 1.0 | 18.7 | 2.4 | 13.7 | 26.6 | 1.4 | 3.1 | - | - | - |
| Mean 1986-1999 | 1.1 | 0.2 | 3.0 | 5.2 | 0.3 | 1.1 | - | 0.1 | 0.2 | 3.8 | 1.3 | 31.7 | 36.7 | 2.7 | 5.2 | - | 0.1 | + |

Table 3 finished 3

Age composition of mature Bolshaya River sockeye salmon males and females from catches in 1986-1999, %

| Year | 2.2 | | 2.3 | | 2.4 | | 2.5 | | 3.2 | | 3.3 | | 3.4 | | Total, % | | N | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | Male | ????? | female | male | male female |
| | | | | | | | | | Late run | | | | | | | | | | |
| 1986 | 0.5 | - | 1.6 | 1.6 | 0.5 | - | - | - | - | - | 0.5 | - | - | - | 49.5 | 50.5 | 93 | 95 | 188 |
| 1987 | - | 0.3 | 5.5 | 3.9 | - | - | - | - | - | - | - | - | - | - | 45.8 | 54.2 | 142 | 168 | 310 |
| 1988 | - | - | 3.4 | 2.3 | - | 1.1 | - | - | - | - | - | - | - | - | 49.4 | 50.6 | 44 | 45 | 89 |
| 1989 | - | - | 1.5 | 7.6 | - | - | - | - | - | - | - | - | - | - | 42.4 | 57.6 | 28 | 38 | 66 |
| 1990 | 1.0 | - | 3.5 | 5.0 | 1.0 | 0.5 | - | 0.5 | - | - | 0.5 | - | - | - | 42.5 | 57.5 | 85 | 115 | 200 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | 3.5 | - | - | - | - | - | - | - | - | - | - | 43.4 | 56.6 | 62 | 81 | 143 |
| 1993 | - | - | 5.7 | 5.7 | - | - | - | - | - | - | - | - | - | - | 48.8 | 51.2 | 60 | 63 | 123 |
| 1994 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 60.6 | 39.4 | 57 | 37 | 94 |
| 1995 | - | 1.4 | - | 4.2 | - | - | - | - | - | - | - | - | - | - | 37.5 | 62.5 | 27 | 45 | 72 |
| 1996 | - | - | 6.6 | 7.0 | - | - | - | - | - | - | - | - | - | - | 44.7 | 55.3 | 109 | 135 | 244 |
| 1997 | 0.7 | 2.6 | 3.3 | 5.6 | - | 0.4 | - | - | - | - | - | - | - | 0.4 | 39.3 | 60.7 | 106 | 164 | 270 |
| 1998 | 0.7 | 1.5 | - | 0.7 | - | - | - | - | - | 0.7 | - | - | - | - | 41.2 | 58.8 | 56 | 80 | 136 |
| 1999 | 1.0 | 0.3 | 0.3 | - | - | - | - | - | - | - | - | - | - | - | 48.8 | 51.2 | 142 | 149 | 291 |
| Mean 1986-1999 | 0.3 | 0.5 | 2.4 | 3.6 | 0.1 | 0.2 | - | + | - | 0.1 | 0.1 | - | - | + | 45.7 | 54.3 | | | |

Table 4

Body length of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, cm

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | female |
| Early run | | | | | | | | | | | | | | | | |
| 1986 | 63.00 | 57.11 | 45.88 | - | 61.15 | 57.01 | 66.00 | 59.75 | 45.00 | - | 61.29 | 58.14 | 65.50 | 57.50 | 58.54 | 57.25 |
| 1987 | - | 56.00 | 46.79 | - | 61.41 | 56.64 | 65.00 | 60.23 | 46.00 | - | 62.58 | 56.59 | 69.00 | - | 60.00 | 57.15 |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | 62.97 | 57.71 | - | - | 62.13 | 58.16 | 64.71 | 61.13 | - | - | 61.75 | 57.75 | 63.50 | 62.33 | 62.61 | 58.71 |
| 1990 | - | - | 43.00 | - | 52.00 | 54.15 | 65.94 | 58.50 | - | - | 59.87 | 55.22 | 62.00 | 59.00 | 60.83 | 55.91 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | 52.00 | 58.00 | 44.00 | - | 60.40 | 55.67 | 64.50 | 58.10 | - | - | 62.20 | 56.57 | 63.00 | 60.00 | 60.29 | 56.41 |
| 1994 | 58.83 | 55.33 | - | - | 60.10 | 56.75 | 65.00 | 59.86 | 47.00 | - | 61.36 | 56.86 | 66.50 | 60.25 | 60.57 | 57.14 |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | - | - | 47.00 | - | 58.10 | 57.00 | 64.00 | 58.50 | 45.00 | - | 60.25 | 56.80 | 63.00 | - | 57.69 | 57.25 |
| 1997 | 51.00 | - | 48.00 | - | 60.67 | 56.20 | 65.50 | - | 45.67 | - | 62.29 | 56.59 | 64.00 | 45.00 | 60.89 | 55.59 |
| 1998 | 59.37 | 55.25 | 44.00 | - | 59.05 | 54.59 | 61.20 | 56.50 | - | - | 60.54 | 56.15 | 61.50 | 58.00 | 58.25 | 55.75 |
| 1999 | - | - | 46.69 | - | 57.24 | 54.50 | 64.63 | 56.73 | - | - | 60.11 | 55.06 | 61.00 | 58.30 | 57.66 | 56.38 |
| Mean 1986-1999 | 57.86 | 56.57 | 45.67 | - | 59.23 | 56.07 | 64.65 | 58.81 | 45.73 | - | 61.22 | 56.57 | 63.90 | 57.55 | 59.73 | 56.75 |

Note. In Tables 3-6 in column “Mean” is dates of all age groups (same Table 2).

Table 4 finished

Body length of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, cm

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | Male | female |
| Late run | | | | | | | | | | | | | | | | |
| 1986 | 76.00 | - | 50.80 | - | 69.63 | 64.49 | 71.50 | 66.83 | 57.00 | - | 69.33 | 64.33 | 72.00 | - | 68.54 | 64.63 |
| 1987 | 68.00 | 62.67 | 50.40 | 50.00 | 66.20 | 63.64 | 69.50 | 65.44 | - | 55.00 | 65.65 | 61.50 | - | - | 64.49 | 63.65 |
| 1988 | - | 64.00 | - | - | 66.26 | 63.09 | 70.20 | 64.60 | - | - | 58.00 | 61.50 | - | 67.00 | 66.59 | 63.33 |
| 1989 | 65.00 | 64.17 | 56.00 | - | 67.74 | 62.21 | 69.00 | 63.33 | - | - | 60,00 | 63.80 | - | - | 67.14 | 62.81 |
| 1990 | 68.40 | 66.25 | 55.00 | 56.00 | 68.05 | 63.55 | 70.22 | 66.68 | 58.00 | - | 67.71 | 61.70 | 73.00 | 65.00 | 67.95 | 63.87 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | 56.00 | 62.50 | 53.00 | 56.33 | 65.65 | 62.43 | 67.33 | 64.00 | - | - | - | 61.80 | - | - | 64.97 | 62.28 |
| 1993 | 65.67 | 62.00 | 50.00 | - | 66.91 | 62.57 | 72.00 | 62.00 | - | - | 65.00 | 60.43 | - | - | 66.00 | 62.27 |
| 1994 | 68.50 | 61.67 | - | - | 66.86 | 62.12 | 67.75 | 66.00 | - | - | - | - | - | - | 66.98 | 62.19 |
| 1995 | 65.50 | 62.33 | 53.00 | 57.00 | 67.68 | 62.44 | 74.00 | 64.14 | - | 55.00 | - | 62.00 | - | - | 65.78 | 62.67 |
| 1996 | 68.50 | 63.97 | 54.00 | 58.00 | 67.36 | 63.18 | 66.00 | 64.67 | - | - | 66.87 | 63.71 | - | - | 67.13 | 63.47 |
| 1997 | 65.30 | 61.00 | 51.82 | 53.83 | 65.55 | 61.77 | 67.40 | 63.48 | 52.00 | 51.86 | 65.78 | 61.87 | - | 69.00 | 63.70 | 61.29 |
| 1998 | 64.50 | 60.90 | 53.10 | 55.29 | 66.50 | 60.24 | - | 60.00 | 58.00 | 56.50 | - | 60.00 | - | - | 59.77 | 59.76 |
| 1999 | 63.13 | 60.55 | 50.85 | 54.43 | 65.08 | 69.45 | 68.00 | 63.11 | 48.67 | 56.00 | 67.00 | - | - | - | 57.19 | 60.46 |
| Mean 1986-1999 | 66.21 | 62.67 | 52.54 | 55.11 | 66.88 | 63.17 | 69.41 | 64.18 | 54.73 | 54.87 | 65.,04 | 62.06 | 72.50 | 67.00 | 65.09 | 62.51 |

Table 5

Body weight of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, kg

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | Male | female | male | female | male | female | male | female |
| | | | | | | | | Early run | | | | | | | | |
| 1986 | 3.00 | 2.14 | 1.11 | - | 2.60 | 2.14 | 2.99 | 2.45 | 1.09 | - | 2.55 | 2.28 | 3.26 | 2.20 | 2.35 | 2.17 |
| 1987 | - | 1.70 | 1.36 | - | 2.55 | 2,.3 | 3.11 | 2.39 | 1.03 | - | 2.69 | 1.98 | 3.52 | - | 2.47 | 2.07 |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | 2.85 | 2.14 | - | - | 2.70 | 2.21 | 3.15 | 2.58 | - | - | 2.38 | 2.21 | 3.01 | 2.76 | 2.78 | 2.28 |
| 1990 | - | - | 1.00 | - | 1,82 | 2.05 | 1.60 | 2.64 | - | - | 2.81 | 2.09 | 3.31 | 2.56 | 2.97 | 2.23 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | 1.49 | 2.07 | 0.91 | - | 2.49 | 1.96 | 2.87 | 2.20 | - | - | 2.84 | 2.02 | 2.94 | 2.45 | 2.50 | 2.01 |
| 1994 | 2.40 | 1.78 | - | - | 2.33 | 2.00 | 2.92 | 2.35 | 1.04 | - | 2.54 | 2.00 | 3.30 | 2.32 | 2.43 | 2.03 |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | - | - | 1.12 | - | 2.31 | 2.08 | 3.20 | 2.31 | 0.97 | | 2.59 | 2.10 | 3.04 | - | 2.31 | 2.15 |
| 1997 | 1.56 | - | 1.21 | - | 2.67 | 2.11 | 3.48 | - | 1.10 | - | 2.79 | 2.16 | 2.86 | 1.37 | 2.68 | 2.08 |
| 1998 | 2.52 | 2.00 | 0.93 | - | 2.45 | 1.92 | 2.62 | 2.11 | - | - | 2.55 | 2.02 | 2.49 | 1.94 | 2.37 | 2.02 |
| 1999 | - | - | 1.26 | - | 2.34 | 1.90 | 3.11 | 2.17 | - | - | 2.59 | 1.98 | 2.83 | 2.48 | 2.37 | 2.15 |
| Mean 1986-1999 | 2.30 | 1.97 | 1.11 | - | 2.43 | 2.04 | 2.91 | 2.36 | 1.05 | - | 2.63 | 2.08 | 3.06 | 2.26 | 2.52 | 2.12 |

Table 5 finished

Body weight of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, kg

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | female |
| Late run | | | | | | | | | | | | | | | | |
| 1986 | 5.71 | - | 1.46 | - | 3.95 | 3.14 | 4.64 | 3.70 | 1.85 | - | 3.67 | 3.06 | 3.84 | - | 3.80 | 3.17 |
| 1987 | 3.64 | 2.79 | 1.41 | 1.52 | 3.46 | 2.99 | 4.01 | 2.72 | - | 1.82 | 3.27 | 2.62 | - | - | 3.55 | 2.96 |
| 1988 | - | 2.88 | - | - | 3.41 | 2.93 | 4.21 | 3.22 | - | - | 2.36 | 2.67 | - | 3.74 | 3.52 | 2.98 |
| 1989 | 3.13 | 3.03 | 1.87 | - | 3.64 | 2.87 | 3.73 | 2.94 | - | - | 2.43 | 3.11 | - | - | 3.54 | 2.93 |
| 1990 | 3.80 | 2.53 | 1.85 | 1.82 | 3.91 | 3.10 | 4.34 | 3.51 | 2.90 | - | 3.81 | 2.68 | 4.81 | 3.39 | 3.90 | 3.12 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | 2.06 | 3.01 | 1.75 | 2.13 | 3.47 | 2.93 | 3.88 | 3.10 | - | - | - | 2.87 | - | - | 3.38 | 2.91 |
| 1993 | 3.35 | 2.86 | 1.16 | - | 3.64 | 2.97 | 4.84 | 2.98 | - | - | 3.28 | 2.59 | - | - | 3.50 | 2.92 |
| 1994 | 3.85 | 2.89 | - | - | 3.60 | 2.85 | 3.80 | 3.45 | - | - | - | - | - | - | 3.62 | 2.87 |
| 1995 | 3.18 | 2.66 | 1.52 | 2.21 | 3.46 | 2.75 | 4.40 | 2.86 | - | 1.74 | - | 2.75 | - | - | 3.21 | 2.77 |
| 1996 | 3.79 | 3.08 | 1.84 | 2.31 | 3.62 | 2.98 | 3.43 | 3.28 | - | - | 3.50 | 3.03 | - | - | 3.59 | 3.02 |
| 1997 | 3.43 | 2.73 | 1.59 | 1.76 | 3.26 | 2.80 | 3.31 | 3.01 | 1.25 | 1.68 | 3.32 | 2.81 | - | 3.94 | 3.03 | 2.73 |
| 1998 | 3.38 | 2.56 | 1.78 | 1.92 | 3.39 | 2.51 | - | 2.76 | 1.98 | 1.94 | - | 2.61 | - | - | 2.59 | 2.45 |
| 1999 | 3.16 | 2.73 | 1.64 | 1.99 | 3.47 | 2.74 | 3.85 | 3.13 | 1.37 | 2.05 | 4.13 | - | - | - | 2.47 | 2.75 |
| Mean 1986-1999 | 3.54 | 2.81 | 1.62 | 1.96 | 3.56 | 2.89 | 4.04 | 3.13 | 1.87 | 1.85 | 3.31 | 2.80 | 4.33 | 3.69 | 3.36 | 2.89 |

Table 6

Coefficients of maturity of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, %

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | female |
| Early run | | | | | | | | | | | | | | | | |
| 1986 | 2.33 | 6.62 | 4.97 | - | 2.87 | 6.92 | 2.24 | 7.22 | 5.75 | - | 2.74 | 6.22 | 2.46 | 6.36 | 3.24 | 6.87 |
| 1987 | - | 7.64 | 5.29 | - | 3.22 | 7.75 | 3.30 | 7.34 | 5.82 | - | 2.98 | 7.52 | 1.70 | - | 3.44 | 7.64 |
| 1988 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1989 | 2.55 | 7.31 | - | - | 2.64 | 7.12 | 2.61 | 7.00 | - | - | 3.25 | 6.29 | 1.77 | 5.05 | 2.63 | 7.07 |
| 1990 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1993 | 6.71 | 6.66 | 3.29 | - | 2.88 | 7.11 | 2.24 | 7.30 | - | - | 2.58 | 7.03 | 2.04 | 5.31 | 2.89 | 7.09 |
| 1994 | 3.73 | 8.52 | - | - | 3.59 | 7.78 | 2.58 | 8.82 | 4.23 | - | 3.41 | 7.96 | 2.78 | 7.42 | 3.50 | 7.98 |
| 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1996 | - | - | 6.25 | - | 3.18 | 4.81 | 2.94 | 5.95 | 4.60 | - | 3.24 | 5.23 | 2.63 | - | 3.42 | 5.36 |
| 1997 | 4.75 | - | 4.47 | - | 3.02 | 6.78 | 3.63 | - | 5.67 | - | 2.83 | 7.09 | 2.75 | 8.22 | 3.12 | 7.07 |
| 1998 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1999 | - | - | 4.14 | - | 2.42 | 6.35 | 2.88 | 6.10 | - | - | 2.35 | 6.41 | 1.97 | 6.39 | 2.64 | 6.35 |
| Mean 1986-1999 | 4.01 | 7.35 | 4.74 | - | 2.98 | 6.83 | 2.80 | 7.10 | 5.21 | - | 2.92 | 6.72 | 2.26 | 6.46 | 3.11 | 6.93 |

Note. Coefficient of maturity (%) = Weight of gonads*100 / Body weight.

Table 6 finished

Coefficients of maturity of males and females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1986-1999, %

| Year | 0.3 | | 1.2 | | 1.3 | | 1.4 | | 2.2 | | 2.3 | | 2.4 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | male | female | male | female | male | female | male | female | male | Female |
| | | | | | | | | Late run | | | | | | | | |
| 1986 | 6.13 | - | 6.76 | - | 2.85 | 9.60 | 4.09 | 7.81 | 7.57 | - | 2.99 | 10.01 | 1.56 | - | 3.17 | 9.50 |
| 1987 | 3.79 | 10.80 | 6.29 | 15.14 | 3.51 | 10.15 | 3.21 | 9.15 | - | 10.99 | 3.56 | 6.45 | - | - | 3.82 | 9.85 |
| 1988 | - | 10.42 | - | - | 2.98 | 8.92 | 2.71 | 8.78 | - | - | 3.42 | 11.02 | - | 7.89 | 2.95 | 9.12 |
| 1989 | 2.55 | 11.24 | 4.27 | - | 3.17 | 9.59 | 3.48 | 8.98 | - | - | 2.47 | 8.24 | - | - | 3.18 | 9.62 |
| 1990 | 2.55 | 11.73 | 4.80 | 5.49 | 2.94 | 8.90 | 2.84 | 8.33 | 4.60 | - | 2.62 | 8.25 | 3.32 | 8.65 | 2.94 | 8.84 |
| 1991 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1992 | 2.91 | 8.16 | 5.70 | 6.58 | 3.43 | 9.08 | 3.00 | 9.00 | - | - | - | 8.33 | - | - | 3.51 | 8.91 |
| 1993 | 3.20 | 10.34 | 5.17 | - | 3.03 | 8.22 | 3.30 | 8.08 | - | - | 2.23 | 6.12 | - | - | 3.03 | 8.18 |
| 1994 | 2.75 | 7.75 | - | - | 3.90 | 9.23 | 4.02 | 9.57 | - | - | - | - | - | - | 3.86 | 9.12 |
| 1995 | 6.18 | 10.06 | 5.43 | 9.50 | 3.55 | 8.81 | 3.64 | 7.76 | - | 5.75 | - | 12.36 | - | - | 4.02 | 8.79 |
| 1996 | 3.10 | 9.16 | 4.57 | 8.66 | 2.95 | 8.55 | 2.89 | 9.48 | - | - | 2.98 | 10.11 | - | - | 3.03 | 8.94 |
| 1997 | 3.02 | 10.36 | 4.51 | 9.81 | 3.01 | 9.73 | 3.15 | 10.39 | 3.84 | 8.60 | 2.44 | 11.21 | - | 6.40 | 3.13 | 10.31 |
| 1998 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1999 | 3.15 | 9.83 | 4.99 | 8.60 | 3.16 | 9.41 | 3.59 | 9.11 | 5.30 | 4.87 | 2.38 | - | - | - | 4.14 | 9.38 |
| Mean 1986-1999 | 3.58 | 9.99 | 5.25 | 9.11 | 3.21 | 9.18 | 3.33 | 8.87 | 5.33 | 7.55 | 2.79 | 9.21 | 2.44 | 7.65 | 3.40 | 9.21 |

Table 7

Absolute fecundity of females from the most numerous age groups of mature Bolshaya River sockeye salmon from catches in 1987-1999, thousands of eggs

| Year | 0.3 | 1.2 | 1.3 | 1.4 | 2.2 | 2.3 | 2.4 | Mean |
|---|---|---|---|---|---|---|---|---|
| | | | | Early run | | | | |
| 1987 | 2241 | - | 3278 | 3713 | - | 3159 | - | 3305 |
| 1988 | - | - | - | - | - | - | - | - |
| 1989 | 4059 | - | 4124 | 4215 | - | 4005 | 3876 | 4118 |
| 1990 | - | - | 5149 | 4631 | - | - | - | 5095 |
| 1991 | - | - | - | - | - | - | - | - |
| 1992 | - | - | - | - | - | - | - | - |
| 1993 | 3148 | - | 3839 | 3868 | - | 3820 | 3646 | 3812 |
| 1994 | 3057 | - | 3426 | 4223 | - | 3497 | 3953 | 3523 |
| 1995 | - | - | - | - | - | - | - | - |
| 1996 | - | - | 3295 | 3211 | - | 3094 | - | 3148 |
| 1997 | - | - | 3604 | - | - | 3832 | 2856 | 3678 |
| 1998 | 2754 | - | 2930 | 3227 | - | 2970 | 2900 | 3013 |
| 1999 | - | - | 2848 | 2810 | - | 2738 | 3126 | 2892 |
| Mean 1987-1999 | 3052 | - | 3610 | 3737 | - | 3389 | 3393 | 3620 |
| | | | | Late run | | | | |
| 1987 | 4317 | 5316 | 5140 | 5353 | 3310 | 4572 | - | 5093 |
| 1988 | - | - | - | - | - | - | - | - |
| 1989 | 5846 | - | 4345 | 5489 | - | 4097 | - | 4663 |
| 1990 | 4009 | 3180 | 5022 | 5480 | - | 3744 | 5725 | 4984 |
| 1991 | - | - | - | - | - | - | - | - |
| 1992 | 4782 | 4066 | 4832 | 4918 | - | 4539 | - | 4030 |
| 1993 | 4115 | - | 4681 | 4475 | - | 3814 | - | 4517 |
| 1994 | 7578 | - | 5585 | 6765 | - | - | - | 5831 |
| 1995 | - | - | - | - | - | - | - | - |
| 1996 | 4850 | 4100 | 4807 | 5158 | - | 5177 | - | 4875 |
| 1997 | 4174 | 3490 | 4381 | 4419 | 3698 | 4040 | 3881 | 4249 |
| 1998 | 4041 | 3716 | 4332 | 3863 | 3817 | 4884 | - | 4217 |
| 1999 | - | - | - | - | - | - | - | - |
| Mean 1987-1999 | 4857 | 3978 | 4792 | 5102 | 3608 | 4358 | 4803 | 4718 |

Note. Date of 1986 is absent.