NPAFC
Doc. No. 1271
Rev. No.

ORIGIN AND DISTRIBUTION OF LOCAL STOCKS OF IMMATURE CHUM SALMON *ONCORHYNCHUS KETA* IN THE WESTERN BERING SEA DURING THE SUMMER AND FALL OF 2004 AND 2006

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Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by the

RUSSIAN NATIONAL SECTION

October 2010

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Bugaev, A.V., E.A. Zavolokina, A.V. Zavolokin, L.O. Zavarina, I.N. Kireev, A.O. Shubin, Yu.I. Ignatyev, S.F. Zolotukhin, N.F. Kaplanova, and M.V. Volobuev. 2009. Origin and distribution of local stocks of immature chum salmon *Oncorhynchus keta* in the western Bering Sea during the fall of 2004 and 2006. NPAFC Doc. 1271. 30 pp. (Available at http://www.npafc.org).

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ABSTRACT

Results of identification of regional complexes of immature chum salmon local stocks on the data of trawl survey accomplished by R/V TINRO in the course of the Bering-Aleutian Salmon International Survey (BASIS) in the Western Bering Sea (the EEZ RF) in September-October 2004 and August-October 2006 have represented. The part of the immature individuals for the period of sampling was over 90% in the total catch of this species. The study was carried out inside the boundaries of districts used in the TINRO-Center to provide biocenological monitoring. The districts were also united into the “northern” (districts 2-8) and the “southern” (districts 9-12) groups.

Differentiation was made on the base of scale structure. The total aged sample size in the mixed marine samples of immature chum salmon was 3985 fishes, 3411 of them were identified. The age groups 0.1, 0.2 and 0.3 were used to analyzing, the groups in the whole included more than 99% of immature chum salmon in the trawl catches. The baseline data base included 8039 chum salmon individuals from the age group 0.3 + 0.4. This pool was used to analysis of chum salmon scale phenotypic diversity in Asia and North America. 2400 individuals were literally engaged to be identified as representatives of the principle chum salmon production sites in the North Pacific Ocean.

The baselines have formed through the cluster analysis. The analysis provides 7 chum salmon stock complexes outlined: 1) of South-East Sakhalin + the south-west continental coast of the Sea of Okhotsk; 2) of West and South-West Kamchatka + North-West Kamchatka; 3) of North-East Kamchatka; 4) of the north and north-west continental coast of the Sea of Okhotsk; 5) of Chukotka; 6) of West Alaska + North-West Alaska; 7) of the west and east coasts of Hokkaido + the north coast of Honshu. The resolution ability of the baseline data base was 87,47% (the age group 0.3 + 0.4).

As a result the identification we accomplished provides the ratio between the regional complexes of the immature chum salmon local stocks (the age groups 0.1 + 0.2 + 0.3) in the Western Bering Sea in September-October 2004, as next: 1) the “northern” group (districts 3-8) - Russia – 60.1%, Japan – 30.7%, the USA – 9.2%; 2) the “southern” group (district 12) – Russia – 70.8%, Japan – 21.0%, the USA – 8.2%. In August-October 2006 the ratio between the complexes was as: 1) the “northern” group (districts 2-8) - Russia – 63.8%, Japan – 31.9%, the USA – 4.3%; 2) the “southern” group (districts 9-12) – Russia – 82.4%, Japan – 16.3%, the USA – 1.3%.

On the base of estimations of the immature chum salmon abundance in the districts of the Western Bering Sea obtained by experts of TINRO-Centre and of the results of the identification demonstrated we can estimate relative abundance of principle complexes of stocks of this species in the course of fall feeding in the Bering Sea part of the EEZ RF. The estimation obtained for September-October 2004 is: 1) the “northern” group (districts 3-8) - Russia – 71.09 mil. fishes, Japan – 36.27 mil. fishes, the USA – 10.94 mil. fishes; 2) the “southern” group (district 12) – Russia – 48.29 mil. fishes, Japan – 14.29 mil. fishes, the USA– 5.63 mil. fishes. For August-October 2006 the estimation is: 1) the “northern” group (districts 2-8) - Russia – 195.35 mil. fishes, Japan – 97.52 mil. fishes, the

USA – 13.19 mil. fishes; 2) the "southern" group (districts 9-12) – Russia – 90.96 mil. fishes, Japan – 18.01 mil. fishes, the USA – 1.43 mil. fishes.

Actually in the Bering Sea part of the EEZ RF for the period of trawl surveys by R/V TINRO Russian stocks of immature chum salmon provided 64.0% (119.38 mil. fishes) in 2004 and 68.8% (286.31 mil. fishes) in 2006. Japan stocks in 2004 and 2006 provided 27.1% (50.56 mil. fishes) and 27.7% (115.53 mil. fishes) respectively. The share of American stocks was the least in both cases: 8.9% (16.57 mil. fishes) in 2004 and 3.5% (14.62 mil. fishes) in 2006.

INTRODUCTION

The results we have obtained in the course of the population-biological study of chum salmon represent a continue of the work on the identification of local stocks of Pacific Salmon on the Bering-Aleutian Salmon International Survey (BASIS) Program in the Western Bering Sea launched in 2002. As for chum salmon, now we have obtained data for the period 2002-2003 (Bugaev et al., 2008). In this publication we demonstrate results of the identification of the origin and distribution of the local stocks of chum salmon foraging in the Bering Sea part of the Exclusive Economical Zone of Russia (EEZ of Russia) on the data from the trawl surveys by the R/V TINRO in September-October 2004 and August-October 2006. The publication should provide an instrument to estimate regional stock abundance dynamics and ratio between the stock complexes of foraging chum salmon from Russia, Japan and North America during the summer and fall migrations in 2002-2006.

MATERIAL AND METHODS

Chum salmon scale samples and biological data collected by specialists of TINRO-Centre in the trawl surveys of the R/V TINRO in the Western Bering Sea in September-October 2004 and August-October 2006 were used as a material or mixed samples. The data sampling was provided by the standard scheme according to the Bering-Aleutian Salmon International Survey program (BASIS). We also used the system of the districts currently applied to provide biocenological studies in the EEZ of Russia on the Far East (Shuntov 1986; Volvenko 2003). As usually the samples were selected into two groups: the first one («northern») to characterize chum salmon from the districts 1-8, the second one («southern») – from the districts 9-12. The estimation of the ratio between the abundance and the biomass for each species of Pacific Salmon in the Western Bering Sea was accomplished by specialists from TINRO-Centre on the base of the Pacific Salmon spatial distribution data for the EEZ of Russia in September-October 2004 and August-October 2006 (NPAFC secretariat 2005; Temnykh et al. 2007).

The population-biological studies were provided on the base of chum salmon scale structure analysis. The total sample size of the mixed scale pools from the trawl samples is demonstrated in the Table 1. The sample we used includes: 780 aged and 739 identified individuals for 2004 and 3205 aged and 2672 identified individuals for 2006.

The baseline scale samples from chum salmon spawners were collected by our colleagues from KamchatNIRO, SakhNIRO, MagadanNIRO, KhBranchTINRO, ChukotTINRO, Sevvostrybvod, Fish and Wildlife Service (Anchorage, Alaska, US) and National Salmon Resource Center (Sapporo, Japan) in the river and coastal catches of Asian and American shores in June-September 2005-2006 (Figure 1). It should be noted that in this our study we had the baseline data pool formed from the scale pools of 2005 and 2006. The composition and the sample size of the scale samples was irregular from year to year, therefore the combination of the baselines 2005 and 2006 we have applied allowed us totally grasp the phenotype diversity of chum salmon scale criteria for all principle regions of salmon production in Russia (Far East), Japan (Hokkaido and Honshu) and North America (Alaska). The composition and the size of the scale baseline samples is demonstrated in the Table 2.

We do not provide a detailed description of the aspects of the method used in this publication, because it was provided before (Bugaev et al. 2008). Although it is important to note here, that all standard schemes of the method were same ones to provide comparable data.

RESULTS AND DISCUSSION

Distribution of the catches, stock abundance assessment and age structure

Carrying out the ecosystem surveys in the Western Bering Sea in 2004 and 2006 was mainly in the fall. The survey in 2004 was carried out from September 26 to October 23 and the survey in 2006 - from August 24 to October 04. The distribution of chum salmon revealed was different for 2004 and 2006 in view of the serious difference in the time of carrying out the surveys (Figure 2).

In 2006 from late August till early October chum salmon individuals were spread widely and met everywhere in the area studied. The maximal densities of chum salmon were observed in the Aleutian Hollow and nearby the Cape Navarin (southward from the Anadyrsky Gulf). As it was demonstrated in the studies carried out before (Zavolokina, Zavolokin 2007), the area mentioned usually receives the waters of the Central Bering Sea Current altogether with an intense run of foraging chum salmon from the central part of the Bering Sea. The Commander Hollow and the Anadyrsky Gulf showed a lower density of chums salmon individuals, however, the distribution of chum salmon in the area was also wide to provide the occurrence of chum salmon everywhere in the catches.

The late fall survey in 2004, accomplished almost a month later, comparing to that in 2006, indicated that most likely the major pool of foraging chum salmon had already left the Russian waters: the abundance of chum salmon in the principle square of the water area was poor, the "core" density of fish was at the boundary of the EEZ of Russia and the most dense aggregations had moved to the South or to the South-East. In the coastal area, especially in the north-west part of the sea, the catches of chum salmon were very poor.

As a result of the trawl-survey made we had estimated the stock abundance of chum salmon by all stages of the life cycle (young postcatadromous fish – immature fish – mature fish) in the upper epipelagic zone of the Western Bering Sea in September-October of 2004 and in August-October of 2006 (Table 3). It can be seen from the data demonstrated that the summary abundance of immature chum salmon in all statistic districts in 2004 was 186.51 million individuals or 88.2% in the total number of fish in the trawl catches. In 2006 the summary abundance was 416.46 million individuals or 90.6% as a percentage. The abundance in 2006 was evidently more than as 2 times as higher comparing to that in 2004. Most likely the difference can take place due to the difference from year to year in the time of making the survey.

In the Table 4 we provided the assessments of chum salmon abundance by the periods of maturation in the «northern» and «southern» groups of the biostatistical districts in the Bering Sea part of the EEZ of Russia. The assessments served as a ground to figure out the intraspecific structure of chum salmon in this region. As it follows from the table, the immature individuals dominated in both - the «northern» and the «southern» districts - during the whole period of the observations. In 2004 the maximum number of foraging chum salmon of 118.30 million individuals (96.7%) was observed in the districts 3-8. To the South, in the district 12 the occurrence was visibly lower – 68.21 million individuals (84.1%). The trend in 2006 was similar. In the «northern» group of the districts (2-8) the abundance of the immature individuals found was 306.06 million individuals (96.5%), and in the «southern» group (9-12) – 110.40 million individuals (77.4%).

Juvenile postcatadromous fish were the next in the frequency in the trawl catches. It should be noted that in all cases their abundance was the higher the more southward. In general, the effect depended on the mass juvenile migration from the rivers of the Karaginsky Gulf, providing more than 70% of chum salmon stock abundance in the North-East part of Kamchatka. The occurrence of mature individuals was minimal everywhere in view of the time of making the trawl surveys.

In general the dominant role of the immature chum salmon in the Western Bering Sea during the summer-fall migrations can be seen clearly. Hence we have it assumed that the principle issue to be analyzed here should concern the foraging stock, and we provided analysis of the age structure of the immature chum salmon from the trawl catches of the R/V TINRO in 2004 and 2006 (Table 5).

It can be seen from the data that the absolute dominance (70.49%) in the «northern» group of districts (3-8) in September-October of 2004 was provided by the individuals in the age 0.1. The next frequent group in the catches (23.23%) was provided by the fish 0.2. The individuals of chum salmon in the age 0.3 and 0.4 demonstrated the minimal occurrence (respectively 6.01 and 0.27%). In the «southern» district 12 the part of 0.1 individuals was lower (63.53%). However, the part of 0.2 individuals was expectedly increased (29.95%). The occurrence of 0.3 and 0.4 individuals, similarly to that in the «northern» districts, was minimal (5.55 and 0.97%).

In August-October in 2006 the effects from the immature chum salmon 0.1 in the «northern» districts 2-8 were visibly less, comparing to the effects in 2004. The part of the individuals was 58.01%. The fish from the age group 0.2, similarly to the cases mentioned above, were the second frequent also – 33.06%. The individuals from the groups 0.3 and 0.4 were less frequent – 8.32 and 0.61 %. It should be underlined that the part of the individuals from the group 0.3 in the «northern» district was maximal during the whole period of the observation in 2004 and 2006. In the «southern» group of the districts 9-12 the trends were same as mentioned before. The dominance (65.42%) was provided by the group 0.1. The next (29.35%) was the group 0.2. The groups 0.3 and 0.4 provided the minimal representation (5.16 and 0.07% respectively).

As a result of this chapter we should say that the summary percent of the age groups of the immature chum salmon (0.1 + 0.2 + 0.3) available for the analysis was over 99% in all the biostatistics districts. Such level is enough to obtain an objective view of chum salmon local stocks distribution from scale criteria.

Analysis of scale phenotype diversity, creation of the baselines and assessment of the baseline resolution ability

On the base of the cluster analysis of the centroids of the local chum salmon stocks scale criteria average meanings on the data for 2005-2006 we have estimated the diversity of the scale phenotypes in the Pacific Ocean. In contrast to our earlier works (Bugaev et al. 2008) we have included now into the baseline basis pool the data on the mature chum salmon scale criteria united for the ages 0.3 + 0.4. It was made, as in our earlier works we had revealed similarity in the cluster distribution of particular baselines in the pools of the age groups 0.3 and 0.4.

It can be seen from the dendrograms that 11 particular local stocks or groups (clusters) can be identified on the regional principle. Here we name them according to their order of distribution in the join tree: 1) the South-West Sakhalin; 2) the South-East Sakhalin + South-West continental shore of the Okhotsk Sea (including the Amur River); 3) North-West Kamchatka; 4) Chukotka; 5) West and South-West Kamchatka; 6) North-West Alaska; 7) the North and North-West continental shore of the Okhotsk Sea; 8) North-East Kamchatka; 9) the North-East continental shore of the Okhotsk Sea; 10) West Alaska; 11) the West and East coasts of Hokkaido + the North coast of Honshu (Figure 3).

These stocks were obtained on two criteria: 1) the geographical membership of the dominant baseline in the cluster and 2) the commercial importance of the local stocks making the cluster up. Unfortunately, in this work, like in the case of the baselines of 2003 (Bugaev et al. 2008), we did not have the scale standards representing the Kurile Islands. The gap is especially sensible when we mean having no standards of the highly abundant stocks from the southern part of the archipelago. Therefore we cannot declare simply the level of similarity or difference to the other regional clusters of local stocks. At the macrolevel the stocks of chum salmon from the South Kurile Islands demonstrate a high scale structure similarity to the Sakhalin and Southern Okhotsk Sea complexes or Japan complex.

Comparing the results of the cluster analysis of the baseline basis pool of 2005-2006 to the results obtained in 2003 separately by the age groups 0.3 and 0.4 (Bugaev et al. 2008), we should note visible similarity in the character of distribution of scale criteria of the regional groups of chum salmon local stocks. In both cases we have obtained almost similar clusters. It should be noted also that the pools of the baselines for 2003 and 2005-2006 are very similar in the composition being statistically authentic in the size of samples, what makes possible to provide an adequate comparison.

Generally the view of the distribution of chum salmon local stocks scale criteria at the geographical macrolevel was quite stable for the period from 2003 to 2006. Such stability allows us to make more or lass certain maintenance about the possibility of the use of the criteria for identification of the groups of fish of different ages in the ocean mixed samples. It is most likely that potential error hardly can be high at the macrolevel discussed. In principle, the deviations whatever they were can vary within the standard error of the scale intraspecific composition identification method itself. Moreover, if we take into account current limitations of the baseline sample size (Millar’s program includes 2400 baseline samples at a maximum) to provide necessary calculations, we have to figure out the most important systemic clusters, which include chum salmon local stocks from the most abundant regions in Asia and North America.

The Figure 4 demonstrates the cluster distribution of the regional complexes of stocks already framed from the primary scale baselines. In the dendrograms we can see a certain similarity of chum salmon scale structure between some regional complexes of stocks in some cases. For instance, it can be seen between the stocks spawning in the northern continental shore of the Okhotsk Sea and in North-East Kamchatka. A similar phenomenon also can be observed between the stocks of Japan and the stocks of Sakhalin and of the South Okhotsk Sea region. The North-West Alaskan chum salmon stock is very similar in the scale structure to the West Kamchatkan stocks. Actually we do not intend to clime an identity of the scale baselines used, but we suggest the relative similarity between the baselines at the level of out simulation, because every compound of this base is a cluster. Moreover, the trend similar to described we already have observed at the level of macrocomplexes in our earlier studies. Taking into account that the trend is inevitable and transforming depending on the level, we have formed a secondary pool of the baselines on the principles of geographical closeness of regions and commercial role of local stocks making a cluster up.

Among the complexes of chum salmon local stocks revealed we had concentrated our attention to the clusters representing 7 principle regions: 1) the South-East Sakhalin + the South-West continental shore of the Okhotsk Sea; 2) West and South-West Kamchatka + North-West Kamchatka; 3) North-East Kamchatka; 4) the northern and north-western continental shore of the Okhotsk Sea; 5) Chukotka; 6) West Alaska + North-West Alaska; 7) the west and east coasts of Hokkaido + the north coast of Honshu (Figure 4, Table 6). This simulation provided taking into account the scale phenotypical diversity and demonstrated the structure of the distribution of the principle chum salmon stocks in the North Pacific. Table 7 provides the average meanings of the scale criteria of the regional groups of chum salmon local stocks to make up the baseline identification model for 2005-2006.

The mean accuracy of the baseline model was estimated with the method of the dependent simulation (Table 7). The identification accuracy found from the data obtained was 87.47%. The minimal accuracy was estimated for the cluster «the South-East Sakhalin + the South-West continental shore of the Okhotsk Sea» - 83.95%, and the maximal accuracy – for the cluster «the west and east coasts of Hokkaido + the north coast of Honshu» - 91.12%. The identification potential error can be 9-16%.

Identification, distribution and stock abundance assessment of local stocks

At this stage we provided assessments made on the results of chum salmon local stocks identification or on the base of statistical parameters. The initial results can demonstrate the intraspecific differentiation separately for the age groups 0.1, 0.2 and 0.3. It should be noted that statistically authentic results were obtained for the fish of the groups 0.1 and 0.2, contributing to the trawl catches more than 90%. Some later we provided all assessments for the groups on the base of the summary contribution of every identified regional complex of the local stocks, what resulted in getting a general view of distribution in the Bering Sea part of the EEZ of Russia.

Similar results of the identification of the groups of the local stocks of the immature chum salmon from the age groups 0.1, 0.2 and 0.3 on the trawl survey data by the R/V TINRO in September-October of 2004 we have demonstrated at the Table 8 and in the Figure 5. The general view of the distribution of the regional complexes of Asian and American chum salmon by all age groups in the «northern» and «southern» groups of the biostatistical districts is more impressive visually in figure 7. It can be seen from the view that in 2004 the dominance in the trawl catches was provided by the stocks of the Sakhalin-Southern Okhotsk Sea region (including the Amur River) and Japanese archipelago. The contribution of these stocks was respectively 38.2–39.7% and 21.0-30.7%. At that the contribution of the part of Japanese chum salmon from the North was more high. Besides these complexes the Asian stocks were represented by the fish from all regions of Russian Far East, including the West Kamchatka (4.2-6.6%), the East Kamchatka (3.3-10.5%), the Okhotsk Sea (5.9-10.0%), Chukotka (5.5-7.0%). The stocks of Alaska also demonstrated their visible presence (8.2-9.2%).

The Figure 6 demonstrates the ratio between the local stocks of foraging chum salmon from the countries providing the principle (90-95%) stock abundance of the species in the North Pacific. It can be seen from the scheme, that Russian stocks visibly dominated in the Western Bering Sea in September-October of 2004 in the «northern (3-8) and «southern» (12) districts, contributing in average 64.0% (60.1-70.8%). The next impressive contributor was Japan – 27.1% (21.0-30.7%). The contribution of the US averagely was 8.9 % (8.2-9.2%).

We have demonstrated the results of the identification of the mixed marine samples of immature chum salmon in the Bering Sea part of the EEZ of Russia in August-October of 2006 at the Table 9 and in the Figure 7. Like in 2004, the dominant role (45.3-71.6%) of the Sakhalin stocks and the stocks of the south continental shore of the Okhotsk Sea in this region is obvious. Over that the fish of this complex demonstrate true dominance in the «southern» districts. Presence of Japan chum salmon (2.8 – 31.9%) is more visible in the «northern» districts. To the South it has been reduced to 16.3%. The part of the other Asian stocks demonstrates extensive fluctuations in both districts - «southern» and «northern» - of the Western Bering Sea: the stocks of West Kamchatka can contribute 2.0-3.8%, the stocks of East Kamchatka – 2.6-5.2%, the Northern Okhotsk Sea stocks – 1.1-1.7%, and the stocks of Chukotka – 4.5-8.4%. The contribution of these stocks is maximal in the «northern» districts. The part of the stock complex of Alaska is visibly less (1.3-4.3%), comparing to that in 2004.

When we analyzed the results on the ratio between the stock complexes by the countries-principle providers of chum salmon production the absolute dominance (averagely 68.8 % in the range 63.8-82.4%) of Russian chum salmon in the Bering Sea part of the EEZ of Russia in August-October 2006 could be seem clearly (Figure 8). Japanese chum salmon was next (averagely 27.7% in the range 16.3-31.9%). The percentage in both cases was very similar to that in 2004. The North American stocks demonstrated visible reduce of their occurrence in the area mentioned (averagely to 3.5% in the range1.3-4.3%).

On the base of the data obtained in the course of the identification we have estimated the abundance of the immature stock of chum salmon stocks of Russia, Japan and North America in the Bering Sea part of the EEZ of Russia in 2004 and 2006 (Table 10). In September-October of 2004 the abundance of Russian stocks was 119.38 million individuals, of Japan stocks – 50.56 million individuals and of North American – 16.57 million individuals. In August-October of 2006 the abundance of the stocks of Russia, Japan and North America was respectively 286.31, 115.53 and 14.62 million individuals.

Some moments can be figured out generally:

Russian stocks visibly dominated in 2004 and 2006, Japan and North American stocks occupied the next positions respectively;

the percent of fish from Russian stocks was higher in the «southern» part of the Bering Sea part of the EEZ of Russia, whereas the percent of fish from Japan and North America was higher in the «northern» part;

the complex of the Sakhalin stocks and stocks of the southern continental shore of the Okhotsk Sea dominated among the Russian stocks every time. This complex also can represent the populations of the South Kurile Islands.

It can be seen from the comparison of the new (for 2004 and 2006) and old data (for the fall period in 2002 and 2003) that the character of the distribution of the stocks of Russia, Japan and North America observed in 2002, 2004 and 2006 was similar (Figure 9). In these years the ratio in the order “up-down” was as next: 1) Russia (64.0-68.8%), 2) Japan (27.1-34.2%) and 3) North America (0.3-8.9%). In September-October of 2003 the maximal percent (52.8%) of Japan stocks was observed. Russian and North American chum salmon stocks were respectively the second (44.4%) and the third (2.8%) in the catches. The maximal percent of Russian stocks and North American stocks was observed in 2006 and 2004 respectively.

A comparison made between the in fact assessed abundance of Russian, Japan and North American stocks in the Western Bering Sea for the period of making fall surveys in 2002-2006 revealed us a wide scattering of the data. The maximal abundance (298.12 million individuals) of Russian stocks was recorded for the fall in 2002, and the minimal (119.38 million individuals) - in 2004. The abundance of Japan stocks also fluctuated widely. The peak (179.62 million individuals) was observed in 2003, and the hollow (50.56 million individuals) - in 2004. The abundance of the North American stocks was lower every time being compared to that of Russian or Japan stocks. Over that the maximal abundance (16.57 million individuals) was observed in 2004, and the minimal (1.37 million individuals, what makes an impression about the level) - in 2002.

In the whole the views of the ratio and the abundance distribution of the immature chum salmon stocks of Russia, Japan and North America for the fall period in 2004 and 2006 can be reckoned as comparable to the data for 2002-2003. The high abundance and frequency of Russian stocks (especially in 2006) in the Western Bering Sea fully agrees to the recent data obtained by Japanese scientists on the base of genetic studies (of the mtDNA and SNP markers) in January-February and April-May of 2006 in the central and eastern districts of the North Pacific (Sato et al. 2006, 2007). Hence, the fact that the average part of Russian chum salmon in Alaska Gulf in winter reached 30% and dominated (60-70%) in spring everywhere in the Aleutian district of the central part of the Pacific Ocean can in general explain the principle role of Russian stocks in the Western Bering Sea for the fall 2006. Perhaps the role has been principle because the abundance of Japan chum salmon was reducing for the period 2003-2007 (Fisheries Agency of Japan 2004, 2005, 2006, 2007, 2008).

Moreover, according to the expert assessments provided by Khabarovsk Branch TINRO in 2008 the run (the catch + the density in the spawning grounds) of early and late chum salmon in the Amur River was 24.9 million individuals or 70.7 thousand tons. This level of the abundance for this chum salmon stock is similar to the historical maximum of the catches in 1909-1913. Thus, the high stock abundance level of the Amur River chum salmon stock in 2008 can explain the absolute dominance of Russian stocks and of the Sakhalin-South Okhotsk Sea complex in particular in the Western Bering Sea in the whole (August-September 2006). Over that we can observe the absolute correspondence of the immature and spawning chum salmon of the Amur River in the age composition of the catches: in 2006 the contribution of the age group 0.1 + 0.2 was over 90% and in 2008 the contribution of the age group 0.3 + 0.4 was 90%.

Several years ago our colleagues from NPAFC already demonstrated the scheme of the feeding migrations of Japan chum salmon in the North Pacific in the Working Groups and Annual Meeting NPAFC (Sato et al. 2004; Urawa, 2004; Urawa et al. 2004, 2005). The scheme shows a cyclic character of the immature stock migrations: to the east part of the North Pacific, to the Bering Sea and than to the West or South-West. It is most likely that Russian chum salmon stocks can also have the cyclic character of the feeding migration, especially those stocks which demonstrate the ecology of feeding similar to the ecology of Japan stocks. These stocks are, first of all, the stocks of the Sakhalin, Southern Kurile Islands, Amur River and south-western continental part around the Okhotsk Sea. We believe that the scheme of migration described is a determining factor over the formation of the population composition of the immature chum salmon during the summer-fall migrations in the Western Bering Sea as the Sakhalin-South Okhotsk Sea complex dominated in the trawl catches in 2002-2006.

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Appendix figures and Tables

Table 1. The details of the immature chum salmon samples used

Year	Biostatistical districts	Period	N trawls	Coordinates	Size of scale materials, number of fish	
					Age	Identification
2004	3-8	5.10-23.10	20	56°59' - 63°03' N 171°02' - 179°35' E	366	358
	12	26.09-11.10	26	53°52' - 59°58' N 163°56' - 172°59' E	414	381
Total					780	739
2006	2-8	24.08-19.09	34	56°27'-64°29' N 170°52'-179°54' E	1791	1486
	9-12	11.09-04.10	40	54°06'-60°16' N 163°48'-172°47' E	1414	1186
Total					3205	2672

Table 2. The sample size and the composition of chum salmon scale baselines (age 0.3 and 0.4) used for the population biological analysis, number of fish

River/stock	2005		2006		Total
	0.3	0.4	0.3	0.4	
RUSSIA					
Sakhalin district					
r. Taranai	-	-	80	-	80
r. Kalininka	-	-	38	109	147
Mordvinov Bay	-	-	50	11	61
r. Naiba	99	-	93	36	228
r. Poronai	87	-	76	60	223
r. Tym’	-	-	33	34	67
Khabarovsk district					
r. Koppi	-	-	75	75	150
r. Amur (early + late)	100	100	-	-	200
r. Kol’-1	95	47	75	35	252
r. Tugur	109	41	-	-	150
r. Uda	-	-	108	79	187
r. Aldoma	100	59	-	-	159
r. Okhota	-	-	50	102	152
Magadan district					

r. Kukhtui	-	-	30	49	79
r. Taui	-	-	85	110	195
r. Yama	-	-	101	102	203
r. Nayakhan	-	-	103	103	206
Kamchatka district					
r. Paren’	50	21	-	-	71
r. Penzhina	100	88	-	-	188
r. Palana	81	85	-	-	166
r. Voyampolka	-	29	-	-	29
r. Khairuzova	66	21	-	-	87
r. Icha	99	35	-	-	134
r. Krutogorova	90	34	-	-	124
r. Vorovskaya	96	62	-	-	158
r. Kol’-2	32	-	-	-	32
r. Kikhchik	92	37	-	-	129
r. Utka	83	16	-	-	99
r. Bolshaya	103	71	-	-	174
r. Opala	110	13	-	-	123
r. Avacha	44	41	-	-	85
r. Zhupanova	13	42	-	-	55
r. Kamchatka	105	104	100	100	409
r. Khailulya	100	100	47	103	350
r. Rusakova	-	-	34	41	75
r. Ivashka	-	-	31	50	81
r. Dranka	-	-	61	109	170
r. Karaga	-	-	68	97	165
r. Kichiga	-	-	32	103	135
r. Apuka	-	-	86	51	137
Chukotka district					
r. Anadyr’	-	-	100	43	143
USA					
Alaska					
r. Yukon	100	100	100	100	400
r. Kuskokwim	100	90	-	-	190
r. Nushagak	100	38	50	100	288
JAPAN					
Hokkaido					
r. Nishibetsu	50	28	-	-	78
r. Abashiri	100	41	-	-	141
r. Tokachi	100	61	-	-	161
r. Urappu	100	58	-	-	158
r. Tokushibetsu	100	69	-	-	169
r. Ishikari	36	75	-	-	111
Honshu					
r. Gakko	51	100	-	-	151
r. Tsugaruishi	100	34	-	-	134
Total	2791	1740	1706	1802	8039

Table 3. The abundance of chum salmon in the upper epipelagial of the Western Bering Sea in September-October, 2004 and August-October, 2006, million of fish

Year	Status	CC	Biostatistical districts								Total
			Northern group						Southern group		
			2	3	4	5	7	8	9	12	
2004	Juveniles	0.4	-	0.90	-	1.23	-	0.79	-	19.20	22.12
	Immature	0.3	-	0.13	-	1.12	0.20	116.85	-	68.21	186.51
	Mature	0.3	-	-	-	-	-	1.05	-	1.70	2.75
2006	Juveniles	0.4	-	-	-	-	0.02	0.64	0.57	25.02	26.25
	Immature	0.3	0.06	12.14	0.24	25.26	6.95	261.41	3.03	107.37	416.46
	Mature	0.3	0.67	2.41	0.41	2.22	0.88	3.87	0.08	6.67	17.21

Note. CC – coefficient of catch.

Table 4. The abundance ratio at the principle stages of maturation in the course of ocean feeding in September-October, 2004 and August-October, 2006

Year	Biostatistical districts	Status						Total, millions of fish
		Juveniles		Immature		Mature		
		Millions of fish	%	Millions of fish	%	Millions of fish	%	
2004	3-8 (Northern group)	2.92	*2.4*	118.30	*96.7*	1.05	*0.9*	122.27
	12 (Southern group)	11.20	*13.8*	68.21	*84.1*	1.70	*2.1*	81.11
2006	2-8 (Northern group)	0.66	*0.2*	306.06	*96.5*	10.46	*3.3*	317.18
	9-12 (Southern group)	25.59	*17.9*	110.40	*77.4*	6.75	*4.7*	142.74

Table 5. The age composition of immature chum salmon in the Western Bering Sea in September-October, 2004 and August-October, 2006

Year	Biostatistical districts	N	AGE, %			
			0.1	0.2	0.3	0.4
2004	3-8 (Northern group)	366	70.49	23.23	6.01	0.27
	12 (Southern group)	414	63.53	29.95	5.55	0.97
2006	2-8 (Northern group)	1791	58.01	33.06	8.32	0.61

	9-12 (Southern group)	1414	65.42	29.35	5.16	0.07

Table 6. The principle regional complexes of scale baselines outlined to use for identification of local stocks of immature chum salmon in the Western Bering Sea in September-October, 2004 and August-October, 2006

Country	Regions	Clusters	River/stock	N
Russia	Sakhalin and Khabarovsk districts	SE Sakhalin + SW continental coast of Okhotsk sea	r. Taranai	50
			r. Amur (early + late)	200
			r. Naiba	100
			r. Poronai	100
	Total			450
	Kamchatka district	W and SW Kamchatka + NW Kamchatka	r. Bolshaya	50
			r. Opala	50
			r. Vorovskaya	50
			r. Kikhchik	50
			r. Khairuzova	50
			r. Icha	50
			r. Krutogorova	50
		NE Kamchtka	r. Ivashka	50
			r. Dranka	50
			r. Karaga	50
			r. Khailulya	50
			r. Apuka	50
			r. Kichiga	50
	Total			650
	Magadan and Khabarovsk districts	N and NW continental coast of Okhotsk sea	r. Aldoma	100
			r. Kukhtui	79
			r. Taui	121
			r. Okhota	100
	Total			400
	Chukotka district	Chukotka	r. Anadyr’	100
	Total			100
USA	Alaska	W Alaska + NW Alaska	r. Yukon (early + late)	200
			r. Kuskokwim	100
			r. Nushagak	100
	Total			400
Japan	Hokkaido and Honshu	W and E Hokkaido + N Honshu	r. Abashiri	50
			r. Ishikari	50
			r. Tokushibetsu	50

			r. Nishibetsu r. Tokachi r. Gakko r. Urappu r. Tsugaruishi	50 50 50 50 50
	Total			400

Note. N – North, S – South, E – East, W – West, NE – North-East, NW – North-West, SE – South-East, SW – South-West.

Table 7. The scale baseline data base dependent simulation in the outlined regional complexes of local stocks of 0.3 + 0.4 chum salmon, MLE/SD

Clusters	N	1	2	3	4	5	6	7
1. SE Sakhalin + SW continental coast of Okhotsk sea	450	**0.8395**	0.0305	0.0243	0.0135	0.0078	0.0284	0.0169
		0.0847	0.0490	0.0395	0.0267	0.0163	0.0459	0.0345
2. W and SW Kamchatka + NW Kamchatka	350	0.0441	**0.8468**	0.0184	0.0204	0.0388	0.0180	0.0040
		0.0525	**0.0895**	0.0307	0.0320	0.0595	0.0294	0.0086
3. NE Kamchatka	300	0.0347	0.0215	**0.8610**	0.0763	0.0151	0.0055	0.0025
		0.0456	0.0328	**0.0976**	0.0875	0.0248	0.0111	0.0060
4. N and NW continental coast of Okhotsk sea	400	0.0121	0.0350	0.0703	**0.8655**	0.0144	0.0043	0.0042
		0.0234	0.0475	0.0810	**0.0939**	0.0235	0.0100	0.0078
5. Chukotka	100	0.0120	0.0529	0.0214	0.0227	**0.9236**	0.0068	0.0001
		0.0202	0.0579	0.0310	0.0315	**0.0655**	0.0122	0.0015
6. W Alaska + NW Alaska	400	0.0190	0.0131	0.0018	0.0002	0.0003	**0.8753**	0.0611
		0.0294	0.0191	0.0078	0.0017	0.0032	**0.0878**	0.0782
7. W and E Hokkaido + N Honshu	400	0.0386	0.0002	0.0028	0.0014	0.0000	0.0617	**0.9112**
		0.0476	0.0011	0.0062	0.0044	0.0000	0.0731	**0.0801**
Mean accuracy, %								**87.47**

Table 8. The maximum likelihood estimation (MLE), the standard deviation (SD) and the confidential intervals (CI – 95%) obtained in the course of identification of local stocks of immature chum salmon from the trawl catches by R/V TINRO in the Western Bering Sea in September-October in 2004

Biostatistical districts	Age	N	Clusters	MLE	SD	CI-95%
3-8 (northern group)	0.1	256	SE Sakhalin + SW continental coast of Okhotsk sea	0.3658	0.0534	0.2410-0.4675
			W and SW Kamchatka + NW Kamchatka	0.0533	0.0316	0.0000-0.1414
			NE Kamchatka	0.0335	0.0320	0.0000-0.1168
			N and NW continental coast of Okhotsk sea	0.0832	0.0301	0.0166-0.1429
			Chukotka	0.0610	0.0197	0.0218-0.1067
			W Alaska + NW Alaska	0.0827	0.0349	0.0120-0.1536
			W and E Hokkaido + N Honshu	0.3205	0.0435	0.2406-0.4190
	0.2	81	SE Sakhalin + SW continental coast of Okhotsk sea	0.4877	0.0778	0.3285-0.6364
			W and SW Kamchatka + NW Kamchatka	-	-	-

			NE Kamchatka	0.0218	0.0320	0.0000-0.0899
			N and NW continental coast of Okhotsk sea	-	-	-
			Chukotka	0.1161	0.0395	0.0350-0.2004
			W Alaska + NW Alaska	0.1163	0.0576	0.0110-0.2409
			W and E Hokkaido + N Honshu	0.2581	0.0741	0.1102-0.3988
	0.3	21	SE Sakhalin + SW continental coast of Okhotsk sea	0.3671	0.1774	0.0000-0.6159
			W and SW Kamchatka + NW Kamchatka	0.0300	0.0939	0.0000-0.2752
			NE Kamchatka	0.0154	0.0706	0.0000-0.1774
			N and NW continental coast of Okhotsk sea	-	-	-
			Chukotka	0.0351	0.0520	0.0000-0.1590
			W Alaska + NW Alaska	0.1978	0.1075	0.0000-0.4565
			W and E Hokkaido + N Honshu	0.3546	0.1397	0.1009-0.6244
12 (southern group)	0.1	230	SE Sakhalin + SW continental coast of Okhotsk sea	0.3483	0.0540	0.2378-0.4708
			W and SW Kamchatka + NW Kamchatka	0.0593	0.0350	0.0000-0.1646
			NE Kamchatka	0.1143	0.0429	0.0001-0.2119
			N and NW continental coast of Okhotsk sea	0.1084	0.0370	0.0345-0.1995
			Chukotka	0.0486	0.0210	0.0003-0.0954
			W Alaska + NW Alaska	0.1096	0.0328	0.0465-0.1717
			W and E Hokkaido + N Honshu	0.2115	0.0393	0.1316-0.2820
	0.2	121	SE Sakhalin + SW continental coast of Okhotsk sea	0.4671	0.0736	0.2995-0.6062
			W and SW Kamchatka + NW Kamchatka	0.0788	0.0528	0.0000-0.2204
			NE Kamchatka	0.0641	0.0530	0.0000-0.1565
			N and NW continental coast of Okhotsk sea	0.1038	0.0500	0.0065-0.2100
			Chukotka	0.0776	0.0344	0.0065-0.1531
			W Alaska + NW Alaska	0.0274	0.0232	0.0000-0.0770
			W and E Hokkaido + N Honshu	0.1812	0.0476	0.0937-0.2855
	0.3	30	SE Sakhalin + SW continental coast of Okhotsk sea	0.3435	0.1976	0.0000-0.6102
			W and SW Kamchatka + NW Kamchatka	0.0221	0.1553	0.0000-0.3963
			NE Kamchatka	0.1863	0.1015	0.0000-0.3441
			N and NW continental coast of Okhotsk sea	-	-	-
			Chukotka	0.0415	0.0416	0.0000-0.1593
			W Alaska + NW Alaska	0.1048	0.1102	0.0000-0.3371
			W and E Hokkaido + N Honshu	0.3018	0.1366	0.0392-0.5794

Table 9. The maximum likelihood estimation (MLE), the standard deviation (SD) and the confidential intervals (CI – 95 %) obtained in the course of identification of local stocks of immature chum salmon from the trawl catches b R/V TINRO in the Western Bering Sea in August-October in 2006

Biostatistical districts	Age	N	Clusters	MLE	SD	CI-95%
2-8 (northern group)	0.1	859	SE Sakhalin + SW continental coast of Okhotsk sea	0.5727	0.0287	0.4990-0.6459
			W and SW Kamchatka + NW Kamchatka	0.0499	0.0185	0.0103-0.1222
			NE Kamchatka	0.0331	0.0140	0.0000-0.0625

			N and NW continental coast of Okhotsk sea	0.0153	0.0113	0.0000-0.0414
			Chukotka	0.0737	0.0119	0.0436-0.1013
			W Alaska + NW Alaska	0.0123	0.0103	0.0000-0.0418
			W and E Hokkaido + N Honshu	0.2430	0.0214	0.1946-0.2880
	0.2	483	SE Sakhalin + SW continental coast of Okhotsk sea	0.3017	0.0371	0.2315-0.4069
			W and SW Kamchatka + NW Kamchatka	0.0262	0.0197	0.0000-0.0816
			NE Kamchatka	0.0733	0.0176	0.0235-0.1016
			N and NW continental coast of Okhotsk sea	-	-	-
			Chukotka	0.0891	0.0164	0.0527-0.1286
			W Alaska + NW Alaska	0.0991	0.0251	0.0417-0.1490
			W and E Hokkaido + N Honshu	0.4106	0.0338	0.3284-0.4786
	0.3	144	SE Sakhalin + SW continental coast of Okhotsk sea	0.2502	0.0560	0.1084-0.3634
			W and SW Kamchatka + NW Kamchatka	-	-	-
			NE Kamchatka	0.0966	0.0432	0.0000-0.1876
			N and NW continental coast of Okhotsk sea	0.0210	0.0309	0.0000-0.1048
			Chukotka	0.1324	0.0338	0.0623-0.1980
			W Alaska + NW Alaska	0.0256	0.0335	0.0000-0.0925
			W and E Hokkaido + N Honshu	0.4742	0.0568	0.3649-0.5707
9-12 (southern group)	0.1	783	SE Sakhalin + SW continental coast of Okhotsk sea	0.8122	0.0224	0.7366-0.8481
			W and SW Kamchatka + NW Kamchatka	-	-	-
			NE Kamchatka	-	-	-
			N and NW continental coast of Okhotsk sea	0.0160	0.0081	0.0000-0.0373
			Chukotka	0.0266	0.0077	0.0093-0.0414
			W Alaska + NW Alaska	-	-	-
			W and E Hokkaido + N Honshu	0.1452	0.0198	0.1116-0.2015
	0.2	337	SE Sakhalin + SW continental coast of Okhotsk sea	0.5456	0.0451	0.4369-0.6401
			W and SW Kamchatka + NW Kamchatka	0.0712	0.0329	0.0092-0.1713
			NE Kamchatka	0.0907	0.0249	0.0154-0.1399
			N and NW continental coast of Okhotsk sea	-	-	-
			Chukotka	0.0893	0.0211	0.0406-0.1351
			W Alaska + NW Alaska	0.0391	0.0196	0.0000-0.0772
			W and E Hokkaido + N Honshu	0.1641	0.0288	0.1100-0.2232
	0.3	66	SE Sakhalin + SW continental coast of Okhotsk sea	0.4365	0.0906	0.2424-0.6066
			W and SW Kamchatka + NW Kamchatka	-	-	-
			NE Kamchatka	-	-	-
			N and NW continental coast of Okhotsk sea	0.1033	0.0468	0.0000-0.1826
			Chukotka	0.0573	0.0396	0.0000-0.1630
			W Alaska + NW Alaska	0.0305	0.0475	0.0000-0.1496
			W and E Hokkaido + N Honshu	0.3724	0.0827	0.2187-0.5237

Table 10. The abundance of Asian and North American chum salmon principle complexes in the Western Bering Sea on the data from the trawl catches by R/V TINRO in September-October, 2004 and August-October, 2006

Year	Districts	Age			Complexes stocks					
					Russia		Japan		USA	
		group	%	Million of fish	%	Million of fish	%	Million of fish	%	Million of fish
2004	3-8	0.1	70.49	83.39	*59.8*	49.87	*32.0*	26.68	*8.2*	6.84
		0.2	23.23	27.48	*63.0*	17.32	*25.9*	7.12	*11.1*	3.04
		0.3 + 0.4	6.28	7.43	*52.5*	3.90	*33.3*	2.47	*14.2*	1.06
	Total		**100**	**118.30**	***60.1***	**71.09**	***30.7***	**36.27**	***9.2***	**10.94**
	12	0.1	63.53	43.33	*67.9*	29.42	*21.3*	9.23	*10.8*	4.68
		0.2	29.95	20.43	*79.3*	16.20	*18.2*	3.72	*2.5*	0.51
		0.3 + 0.4	6.52	4.45	*60.0*	2.67	*30.0*	1.34	*10.0*	0.44
	Total		**100**	**68.21**	***70.8***	**48.29**	***21.0***	**14.29**	***8.2***	**5.63**
All districts				**186,51**	***64.0***	**119.38**	***27.1***	**50.56**	***8.9***	**16.57**
2006	2-8	0.1	58.01	177.55	*74.4*	132.10	*24.3*	43.14	*1.3*	2.31
		0.2	33.06	101.18	*49.0*	49.58	*41.0*	41.48	*10.0*	10.12
		0.3 + 0.4	8.93	27.33	*50.0*	13.67	*47.2*	12.90	*2.8*	0.76
	Total		**100**	**306.06**	***63.8***	**195.35**	***31.9***	**97.52**	***4.3***	**13.19**
	9-12	0.1	65.42	72.22	*85.4*	61.68	*14.6*	10.54	-	-
		0.2	29.35	32.40	*79.8*	25.86	*16.3*	5.28	*3.9*	1.26
		0.3 + 0.4	5.23	5.78	*59.1*	3.42	*37.9*	2.19	*3.0*	0.17
	Total		**100**	**110.40**	***82.4***	**90.96**	***16.3***	**18.01**	***1.3***	**1.43**
All districts				**416.46**	***68.8***	**286.31**	***27.7***	**115.53**	***3.5***	**14.62**

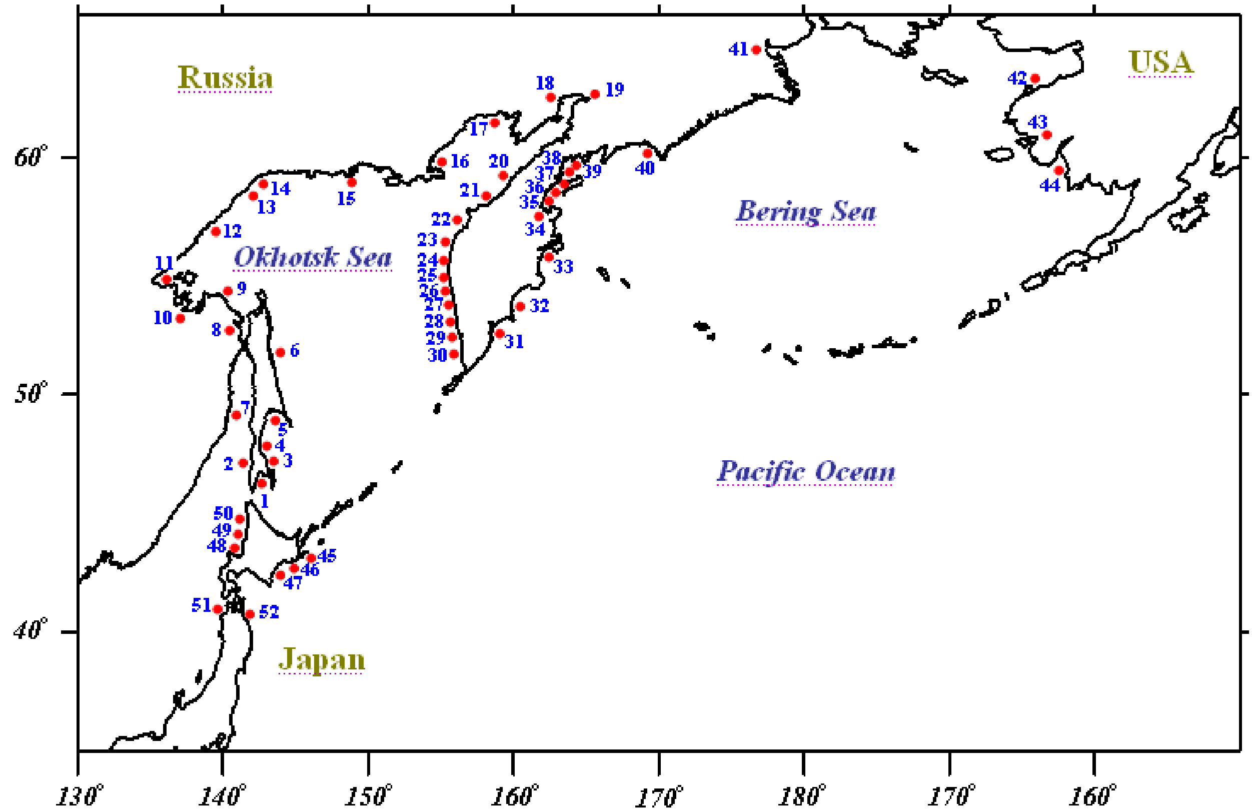

Fig. 1. The scheme-map of chum salmon spawning streams, where from the scale samples were used as a baseline material in 2005-2006: I – RUSSIA - a) Sakhalin Region - 1 – Taranai R., 2 – Kalininka R., 3 – Mordvinova Gulf, 4 – Naiba R., 5 – Poronai R., 6 – Tym' R.; b) Khabarovsk region - 7 – Koppi R., 8 – Amur R., 9 – Kol'-1 R., 10 – Tugur R., 11 – Uda R., 12 – Aldoma R., 13 – Okhota R.; c) Magadan Region – 14 – Kukhtui R., 15 – Taui R., 16 – Yama R., 17 – Nayakhan R.; d) Kamchatka region – 18 – Paren' R., 19 – Penzhina R., 20 – Palana R., 21 – Voyampolka R., 22 – Khairuzova R., 23 – Icha R., 24 – Krutogorova R., 25 – Vorovskaya R., 26 – Kol'-2 R., 27 – Kikhchik R., 28 – Utka R., 29 – Bolshaya R., 30 – Opala R., 31 – Avacha R., 32 – Zhupanova R., 33 – Kamchatka R., 34 – Khailula R., 35 – Rusakova R., 36 – Ivashka R., 37 – Dranka R., 38 – Karaga R., 39 – Kichiga R., 40 – Apuka R.; e) Chukotka Region – 41 – Anadyr' R.; f) II – the USA (Alaska) – 42 – Yukon R., 43 – Kuskokwim R., 44 – Nushagak R.; g) III - JAPAN (the islands Hokkaido and Honshu) – 45 – Nishibetsu R., 46 – Abashiri R., 47 – Tokachi R., 48 – Urappu R., 49 – Tokushibetsu R., 50 – Ishikari R., 51 – Gakko R., 52 – Tsugaruishi R.

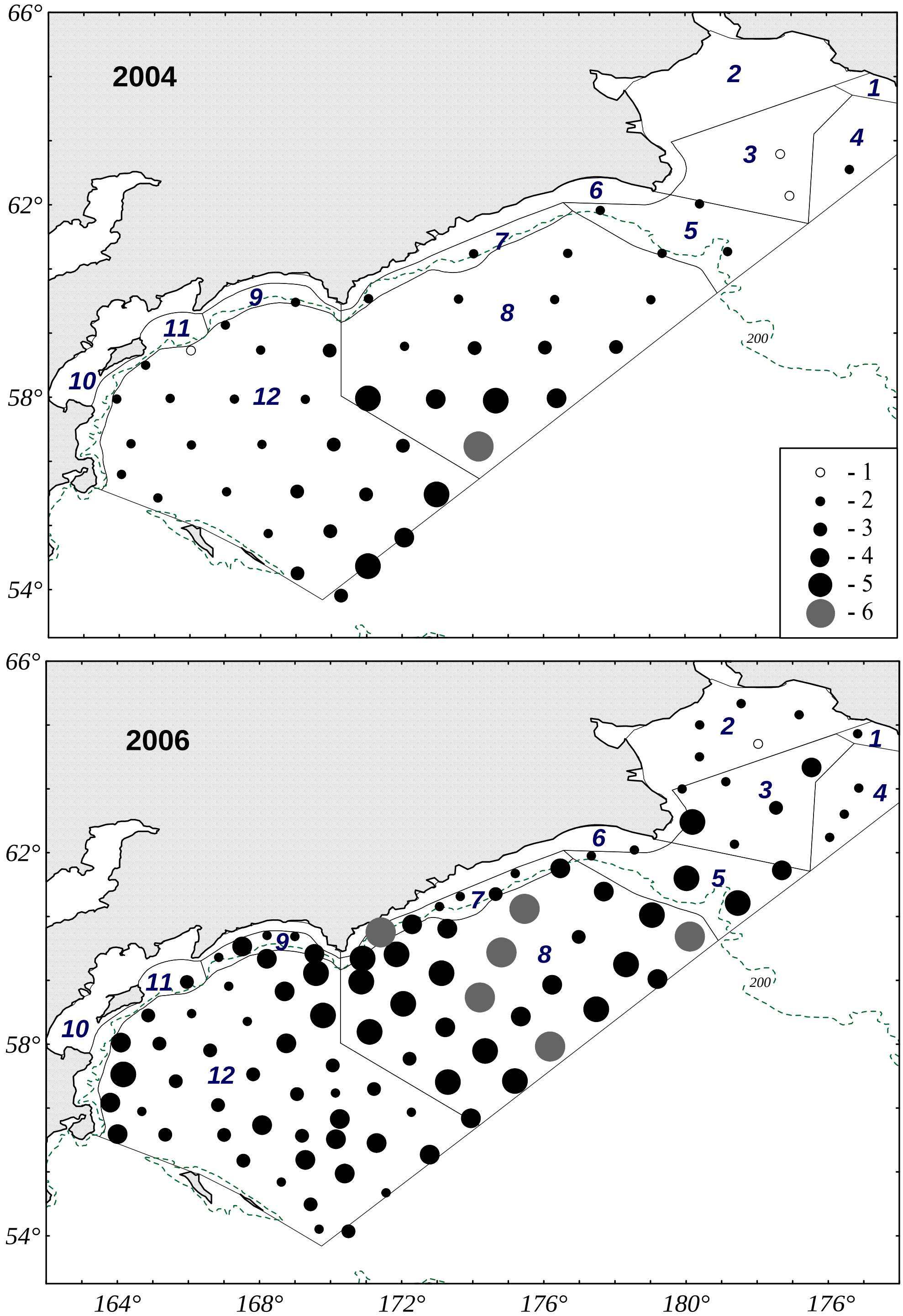

Fig. 2. The spatial distribution of chum salmon (without juvenile post-catadromal fishes) in the Western Bering Sea in September-October 2004 and August-October 2006. Conventional signs: 1 – no catch; 2 – < 200; 3 – 201-500; 4 – 501-1000; 5 – 1001-2000; 6 – > 2000 sp./km^2. The boundaries of the Bering Sea part of the EEZ of Russia and of the biostatistical districts 1-12 have outlined

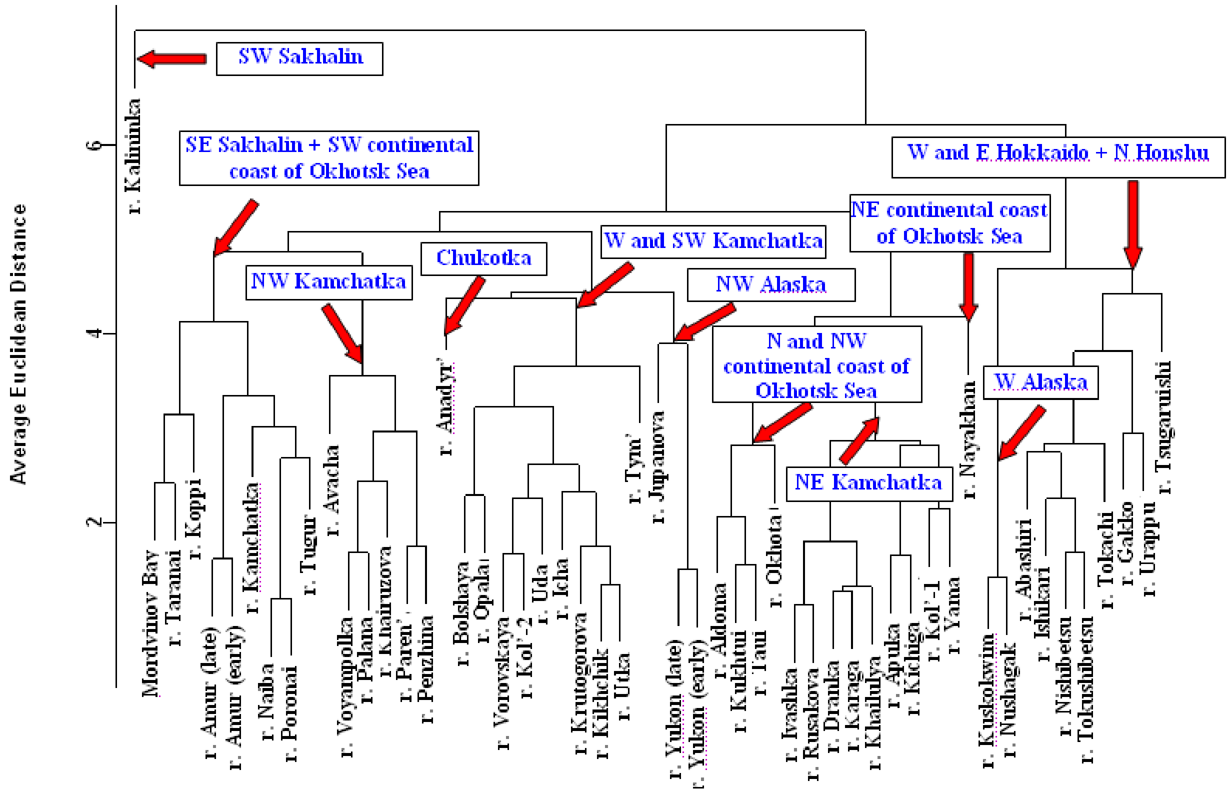

Fig. 3. The cluster distribution of the centroids of the average meanings of 0.3 + 0.4 chum salmon scale baselines used in the work for 2005-2006. Conventional abbreviations: W – the West, N – the North, E – the East, S – the South, NW – the North-West, NE – the North-East, SW – the South-West, SE – the South-East

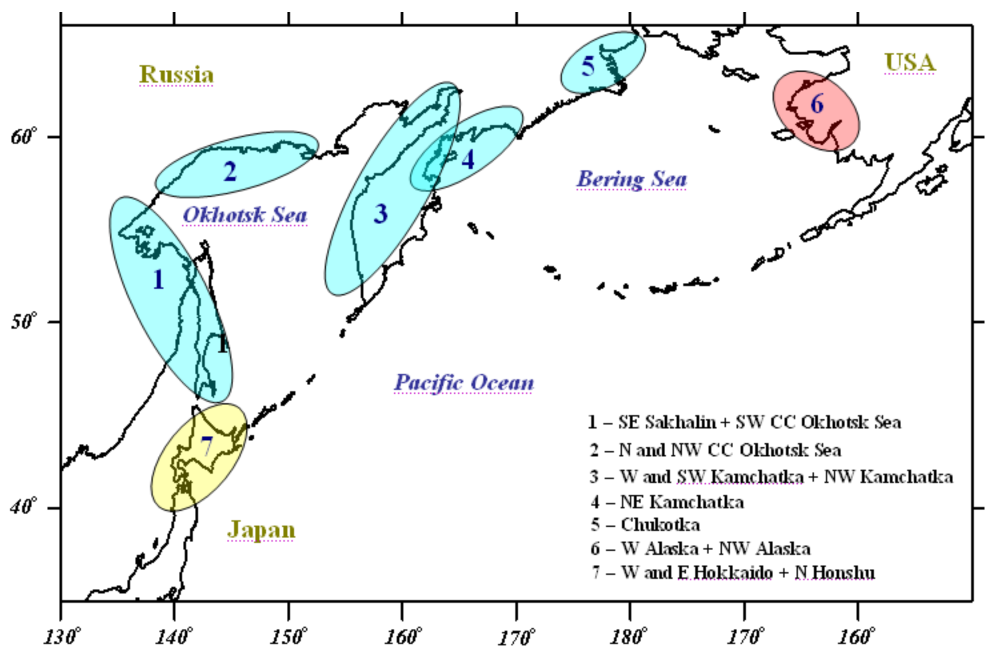

Fig. 4. The principle outlined regional stock complexes of chum salmon, where from the scale samples were used as baselines for identification of local stocks in the mixed samples from the trawl catches by R/V TINRO in 2004 and 2006. Conventional abbreviations: W – the West, N – the North, E – the East, S – the South, NW – the North-West, NE – the North-East, SW – the South-West, SE – the South-East, CC – the continental coast

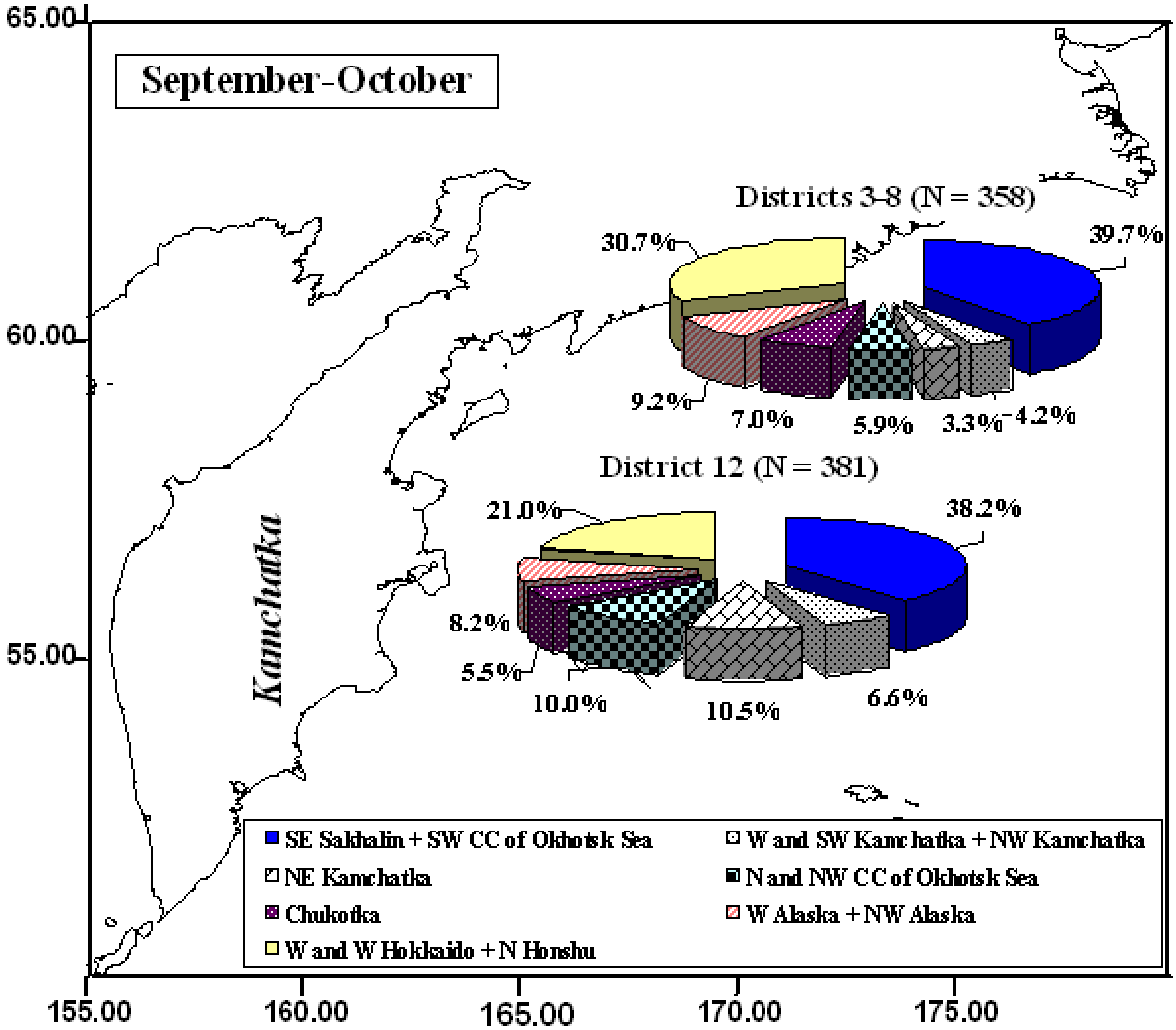

Fig. 5. The distribution of the identified local stock complexes of immature chum salmon by all age groups (0.1 + 0.2 + 0.3) in the "northern" (3-8) and the "southern" (12) biostatistical districts of the Western Bering Sea on the data from the trawl catches by R/V TINRO in 2004

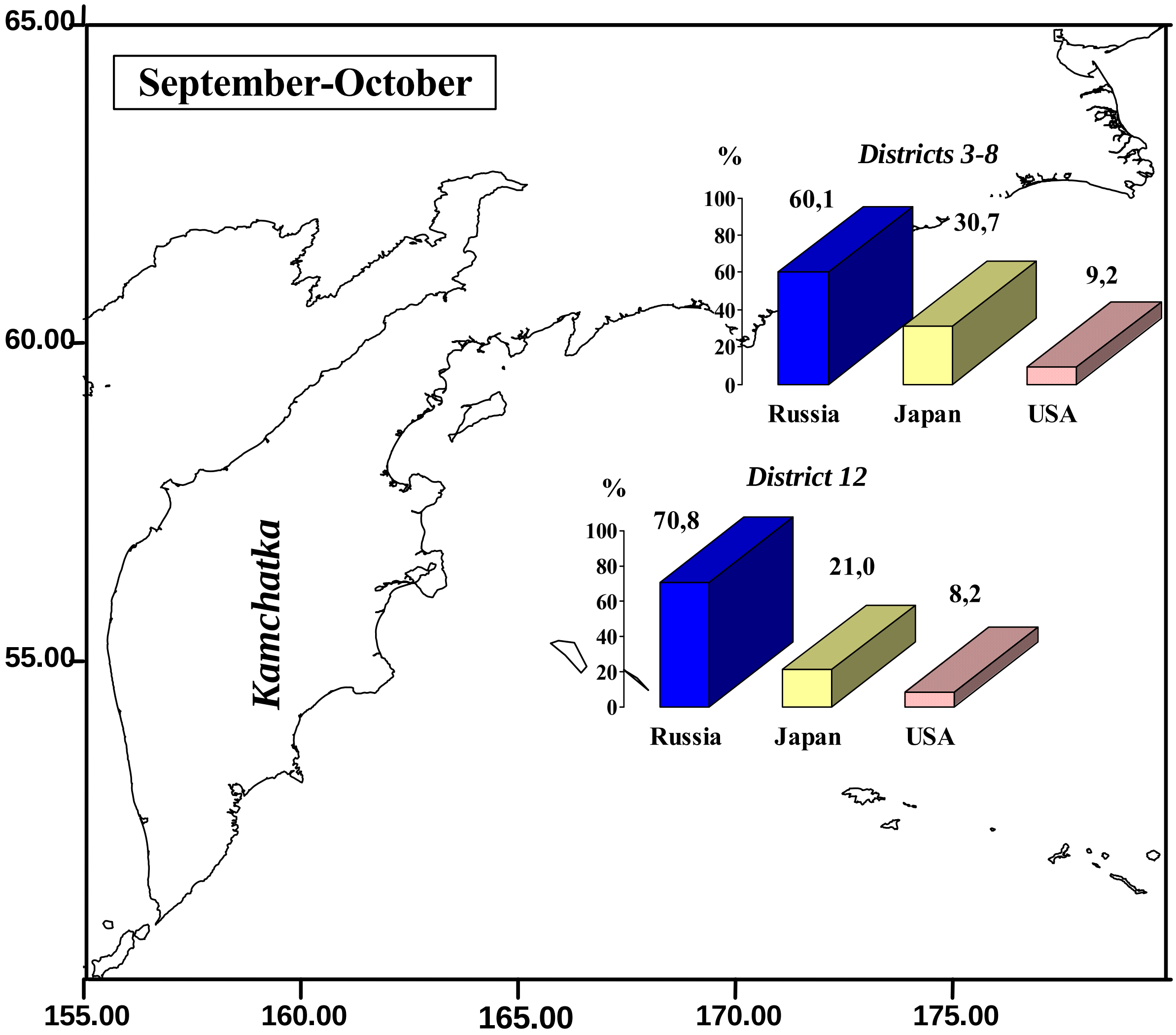

Fig. 6. The ratio between the complexes of immature chum salmon stocks in the countries of principle production of this species in the Western Bering Sea (the EEZ RF) on the data of the trawl surveys by R/V TINRO in 2004

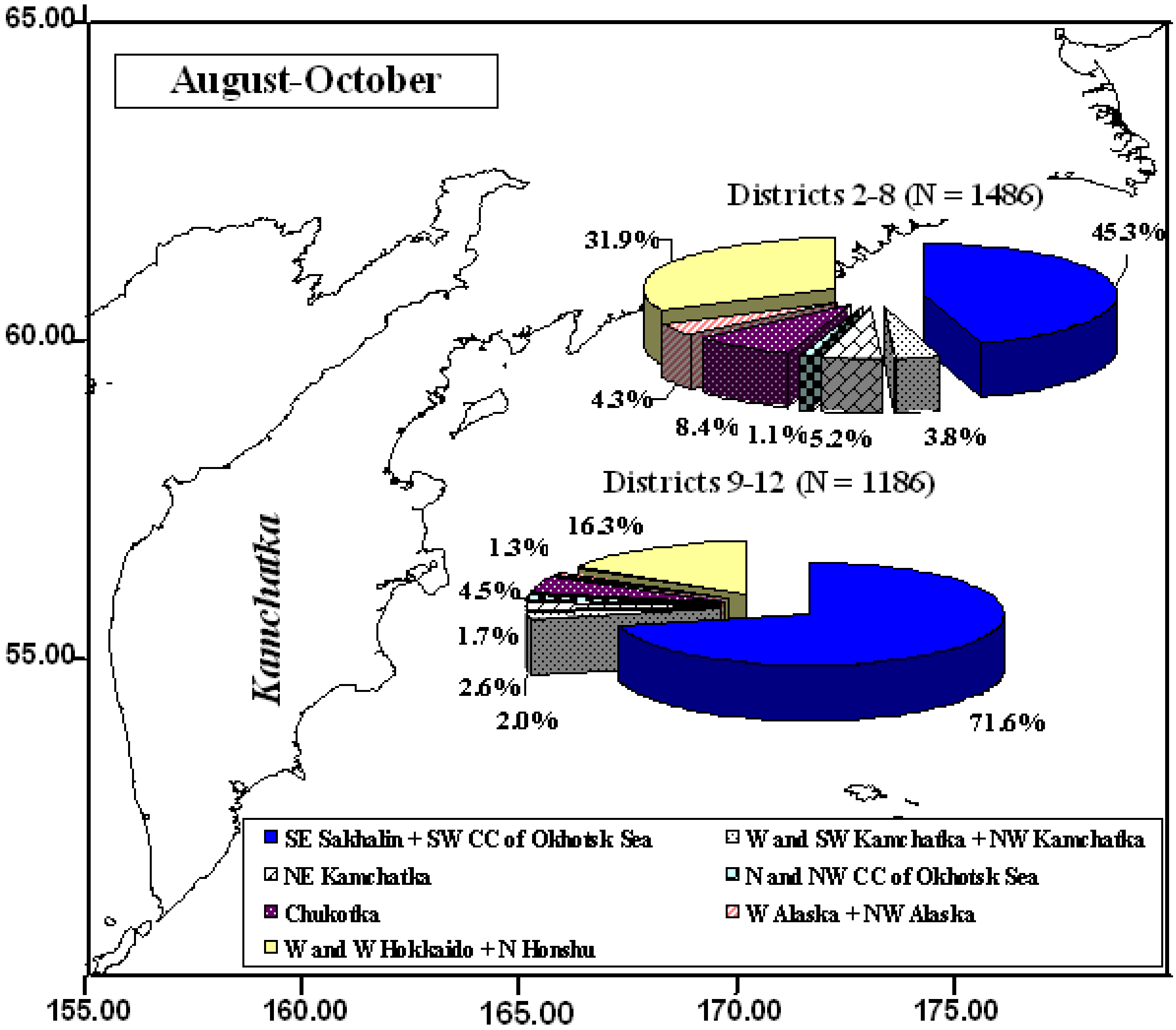

Fig. 7. The distribution of the identified local stock complexes of immature chum salmon by all age groups (0.1 + 0.2 + 0.3) in the “northern” (2-8) and the “southern” (9-12) biostatistical districts of the Western Bering Sea on the data from the trawl catches by R/V TINRO in 2006

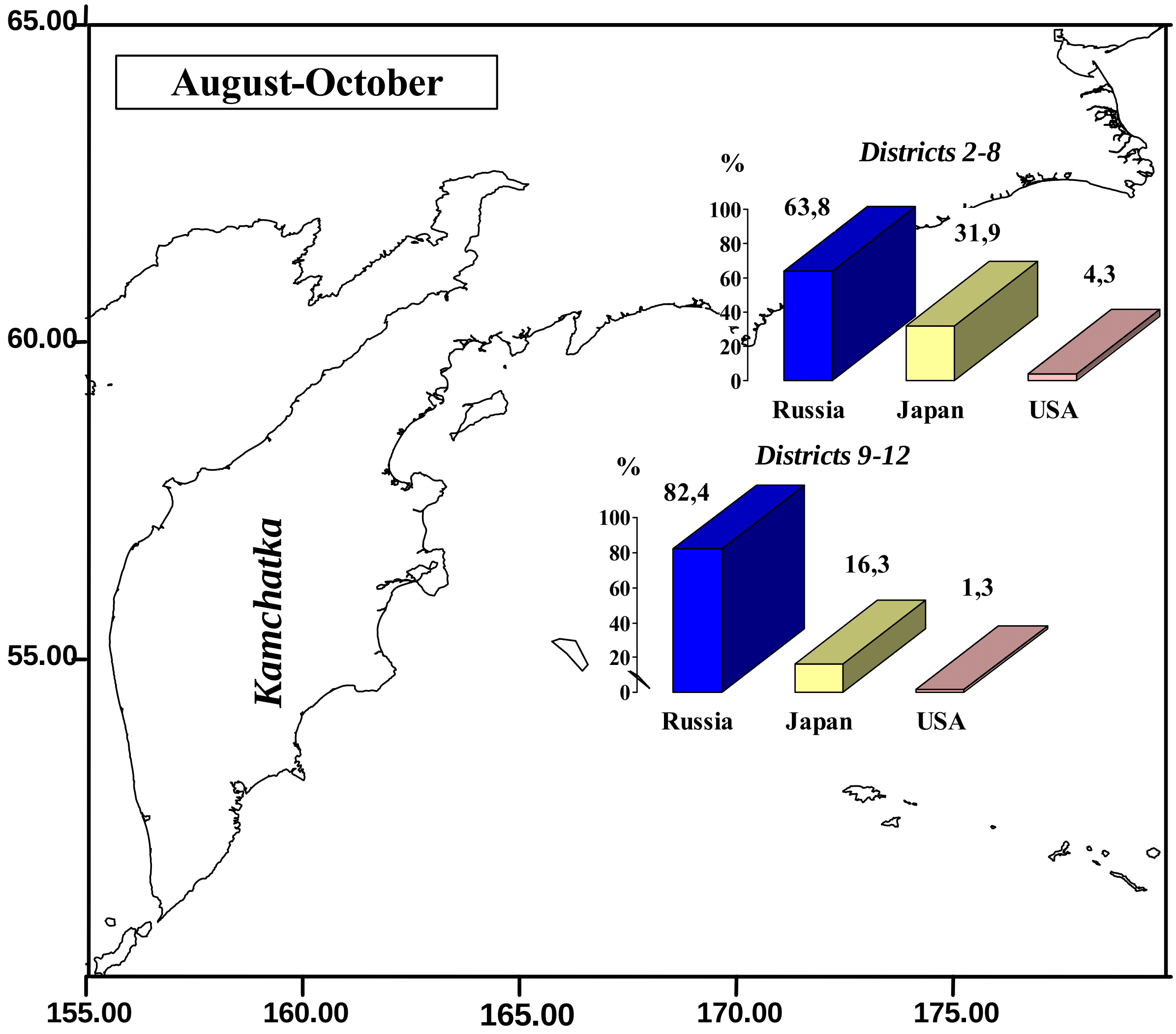

Fig. 8. The ratio between the complexes of stocks of immature chum salmon from the main countries of chum salmon production in the Western Bering Sea (the EEZ RF) on the data of the trawl surveys by R/V TINRO in 2006

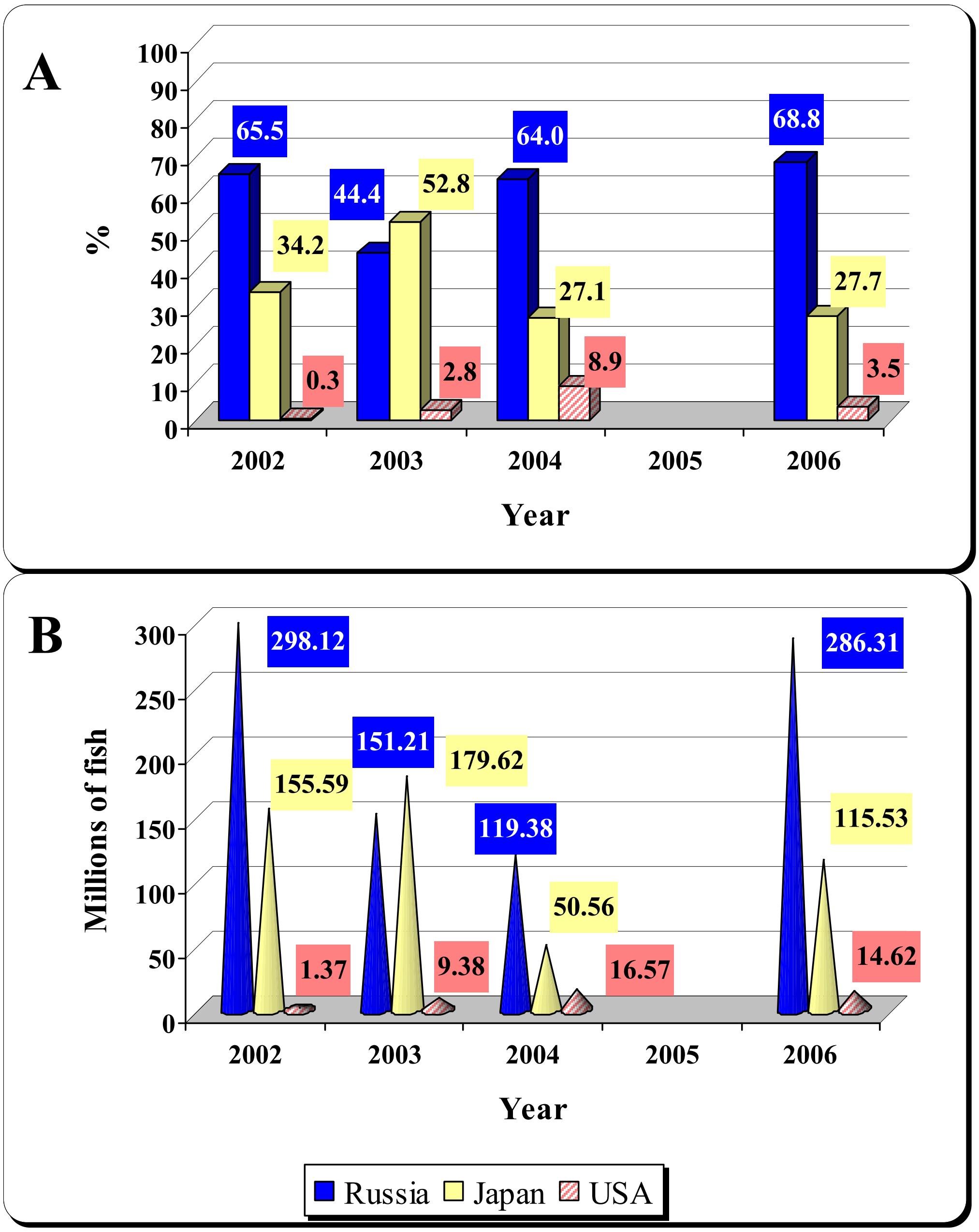

Fig. 9. The dynamics of frequency (A) and of estimated in fact abundance (B) of regional complexes (the countries of principle production of this species) of immature chum salmon on the data of fall surveys by R/V TINRO in the Western Bering Sea in 2002-2006