Current Stock Assessment of Pacific Salmon in the Far East of Russia

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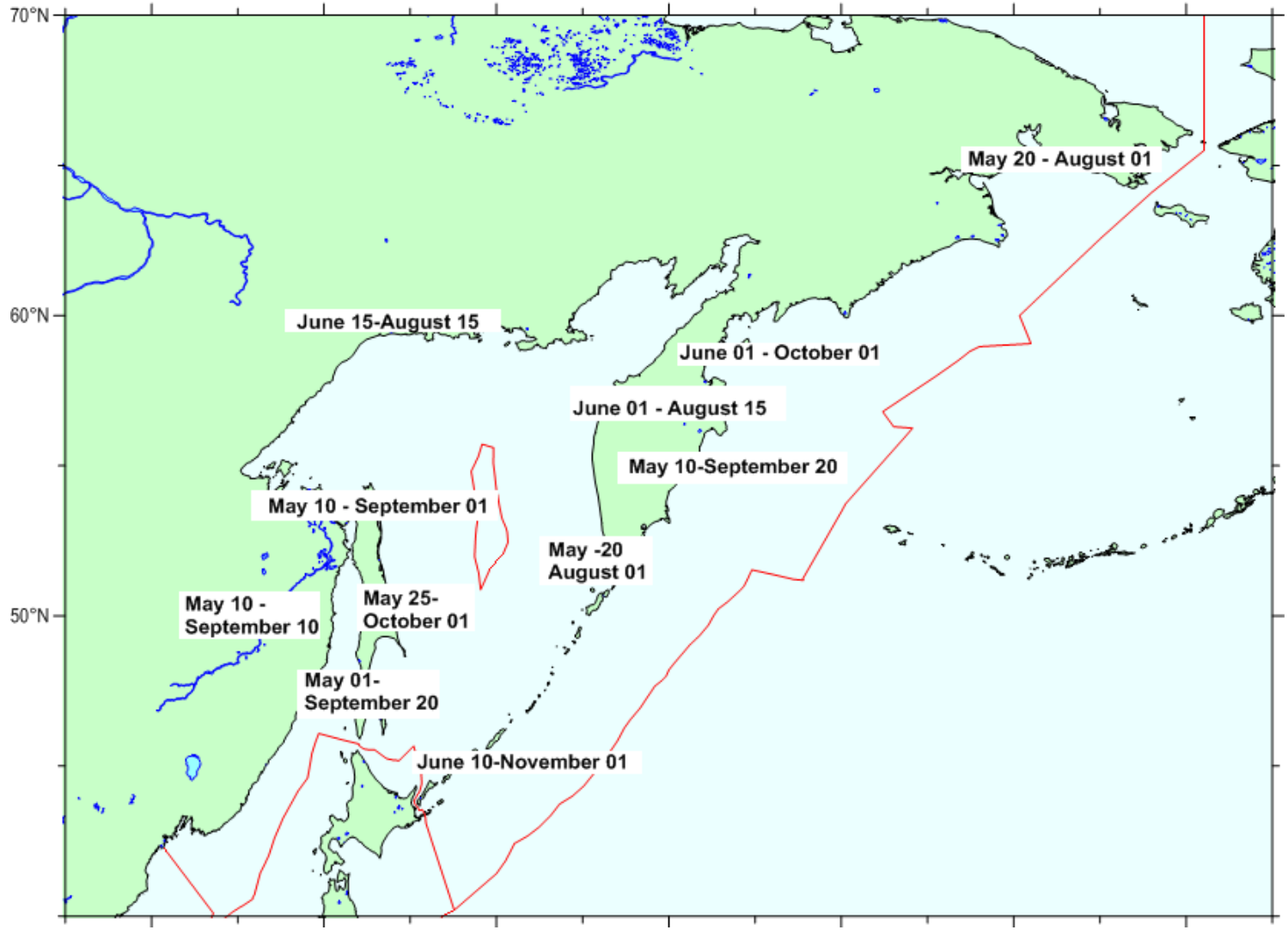
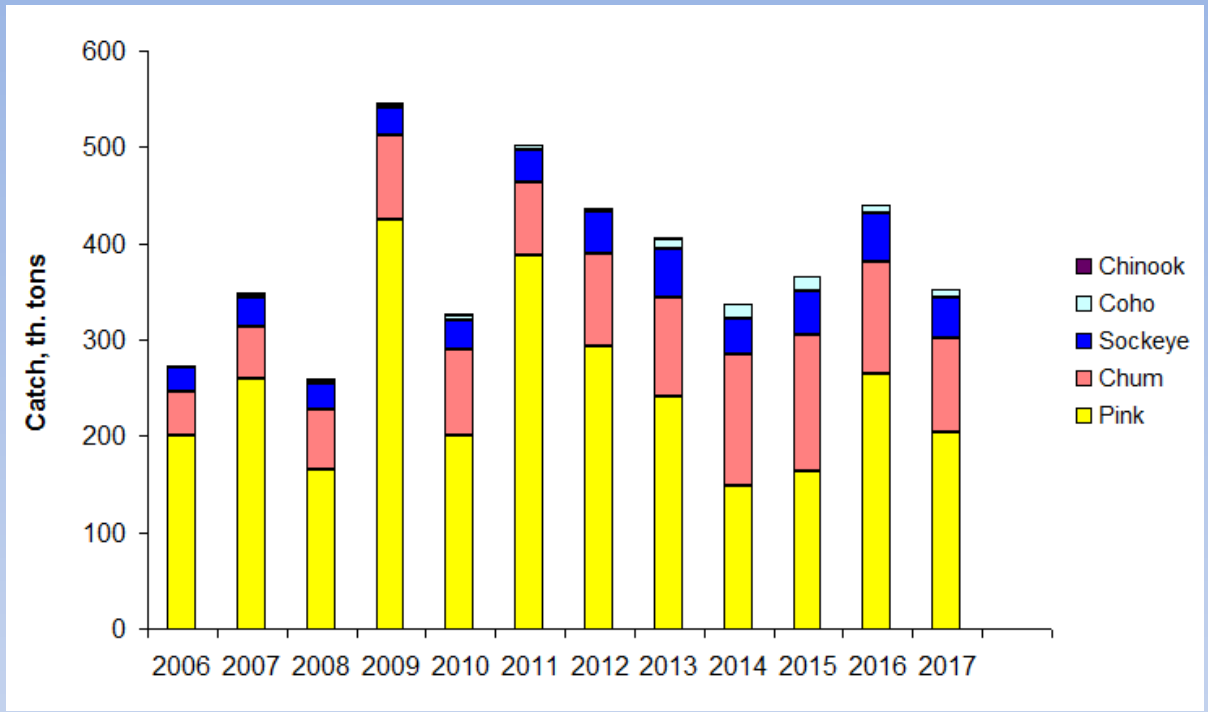
The areas of reproduction and terms of Pacific salmon spawning migration in the Far East of Russia



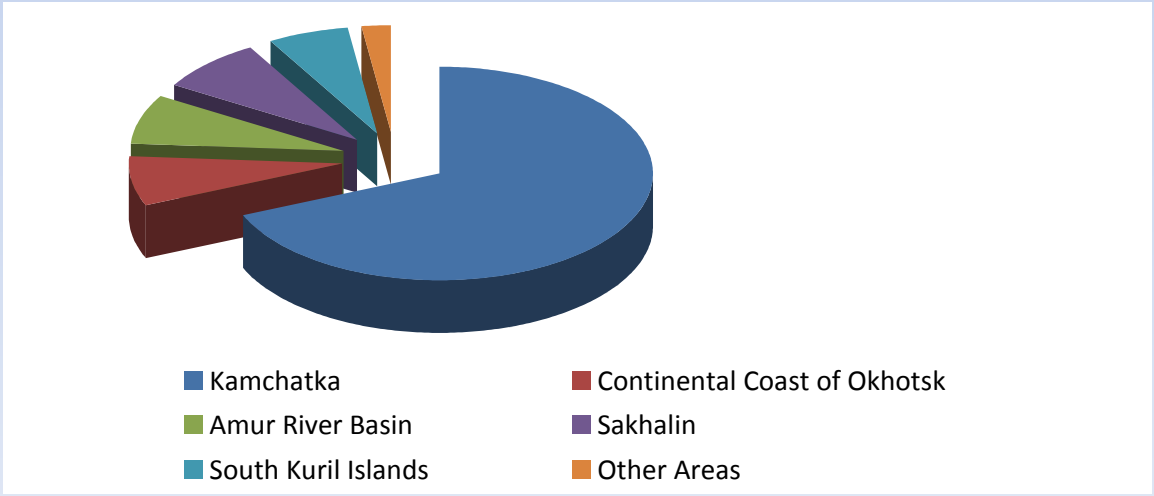
The huge length of the reproductive area of Pacific salmon in the Russian Far East, the different climatic conditions of reproduction and feeding, the various terms of spawning migration determine the different dynamics of stocks in the regions, both in general and particular salmon species

Salmon catch in the Far East in 2006-2017, thousand tons



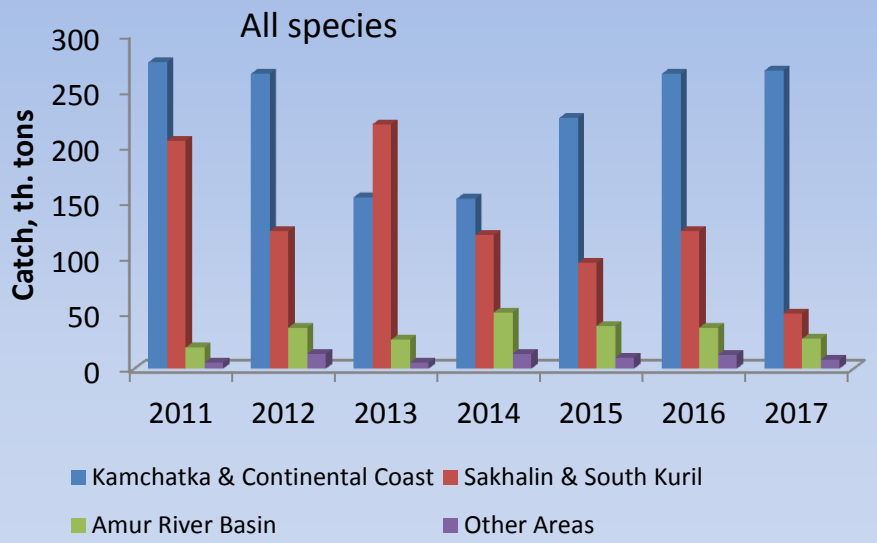
By 2017 Russian salmon stocks, remain in general at high level, but slightly below the level of recent years. The total catch of all Pacific salmon species by the coastal fishery in the Far East in 2017 was 353,000 tons, that is by 13,000 tons less than in 2015 and by 85,000 tons less than in 2016.

Salmon catch in various regions of Russian Far East in 2017

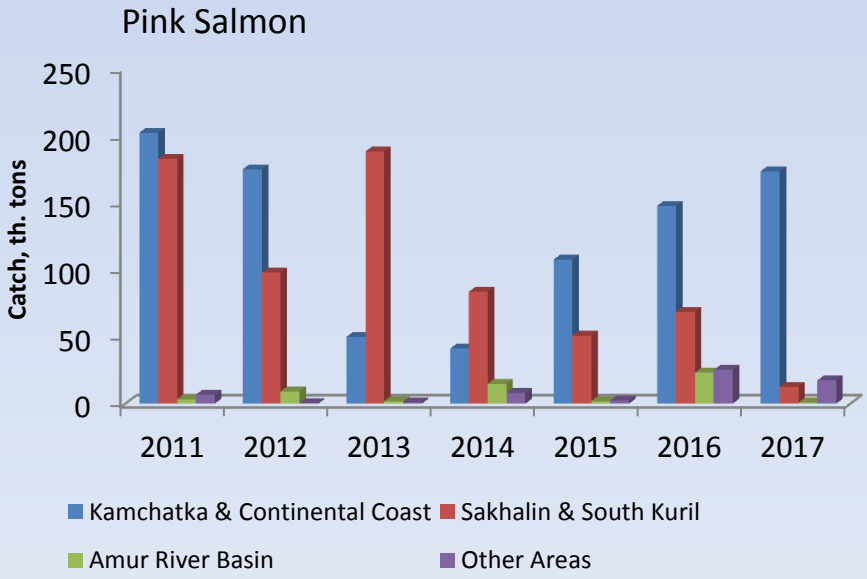


Out of these 353,000 tons, 241,000 tons were caught off Kamchatka with 163,000 tons captured in its northeastern part. The total catch in all other regions was only 112,000 tons. The salmon approaches to the Northeast Kamchatka in 2017 were on the third place and the catch - on the second place over the whole history of fishery in this region (Shevlyakov et al., 2017).

Salmon catch in the different regions of the Russian Far East in 2011-2017, thousand tons

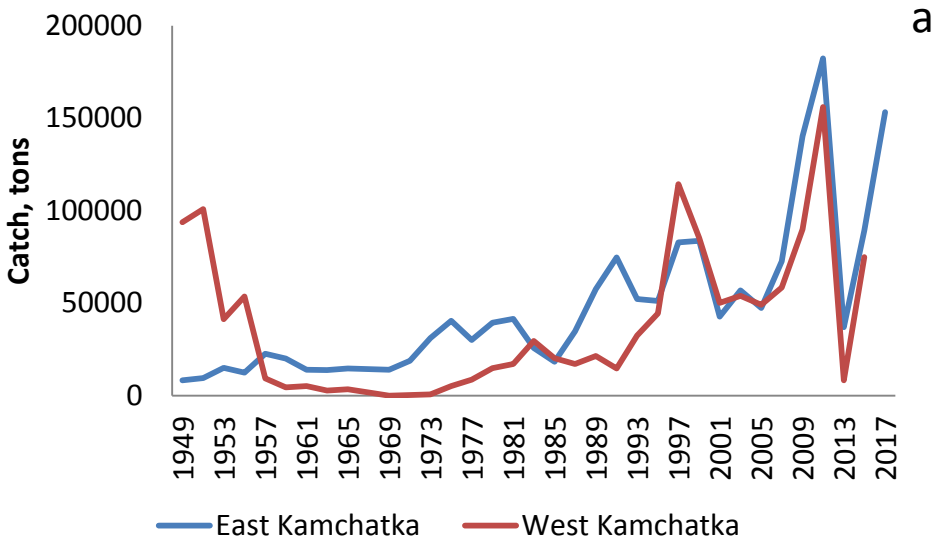


In recent years due to the warming of the ocean, the main areas of salmon reproduction shifted to the north. As a result, salmon abundance and catch increased in the northern regions (Kamchatka and Continental Coast of Okhotsk), while importance of southern reproduction areas (Sakhalin and South Kuril Islands) decreased.



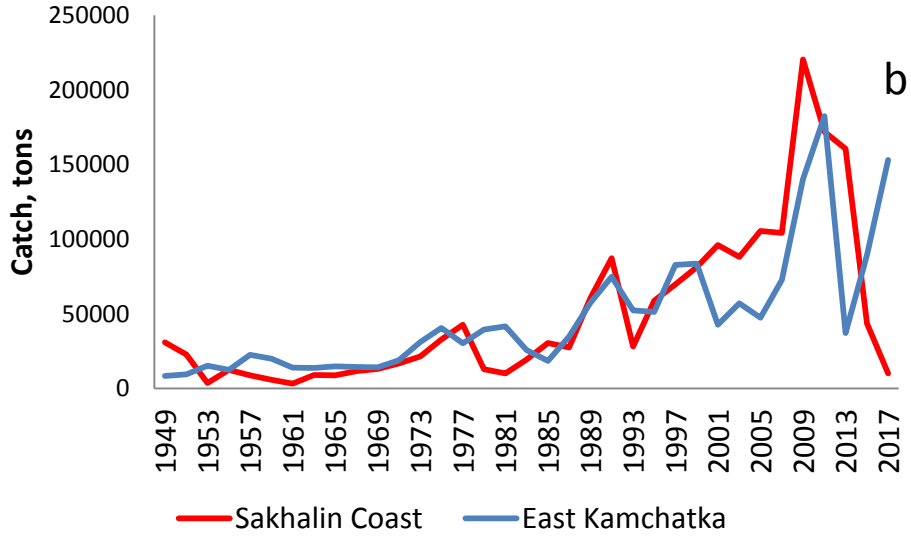
Pink salmon constitute about 55-70% of the total salmon catch in the Far East. Warming of 2014-2017 slowed down a decrease in Kamchatka pink salmon stocks started in 2013-2014. However, decline of the Sakhalin Coast stocks continued in 2012-2017 under the influence of both adverse environmental conditions at early life stages and poaching in the rivers.

Dynamics of pink salmon catch in Western and Eastern Kamchatka (a) and Eastern Kamchatka and Sakhalin Coast (b) in 1949-2017



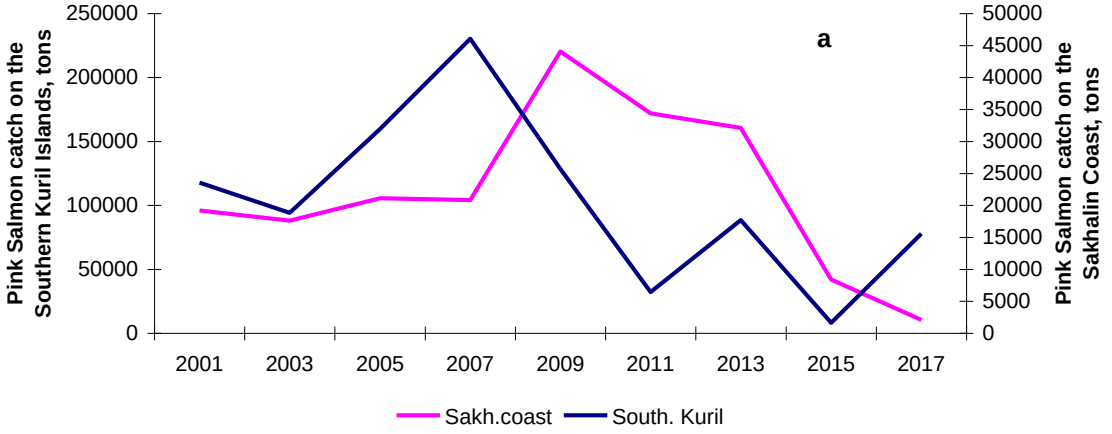
Rise of Kamchatka pink salmon stocks in 2015-2017 was associated with a very sharp warming of water in the Northeast Pacific in 2014-2016 and the subsequent advection of heat into the Bering and Okhotsk Seas observed in all seasons of the year (Krovnin et al., 2016).

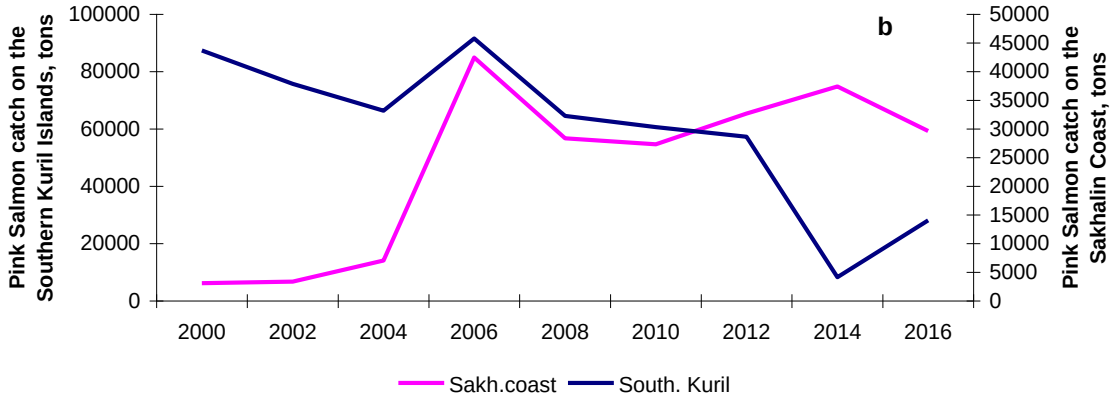
The pink salmon catches in the East and West Kamchatka are strongly correlated, when East Kamchatka catch leads West Kamchatka catch by 1 year.



The intensive growth of Sakhalin pink salmon stocks was noted in the early 2000s that resulted in the historical maximum of catches of both generative lines. This was associated mainly with an increase in survival during the marine life period. In 2015 - 2017 there was a sharp reduction in the number of pink salmon. After 2012 the tendency towards a decrease in SST in the southern Okhotsk Sea has appeared. Apparently, it resulted in decline in Sakhalin salmon stocks.

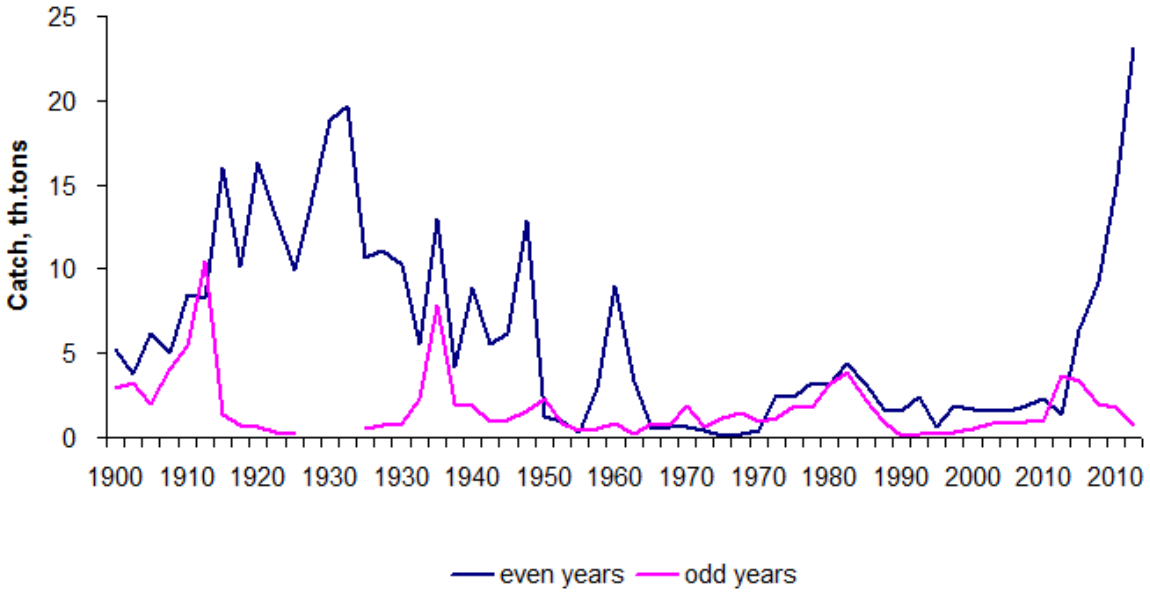
Pink salmon catch off the Sakhalin Coast and South Kurils in odd (a) and even years (b)





In addition, in the southern Okhotsk Sea in winter-spring seasons of 2014-2017 there was an increased intensity of cyclonic activity, frequent occurrence of typhoons with heavy rainfall. These factors also contribute to decrease in pink salmon stocks in Eastern Sakhalin and South Kurils. At the same time, in the South Kurils, in contrast to the Sakhalin Coast, decline in pink salmon catches in 2011-2015 was replaced by their rise in 2016 and 2017.

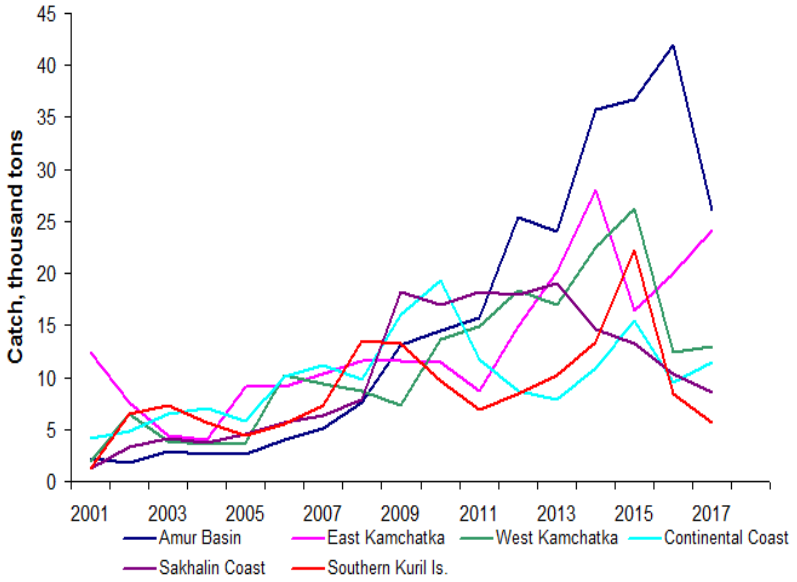
Catch Dynamic of Amur basin Pink Salmon in 1900-2017, thousand tons



At present, even-year generations of Amur and Primor'e pink salmon stocks and their catch exceed the level of the early 20th century (Ostrovsky, 2014). On of possible reasons may be associated with effects of continental hydrometeorological processes in winter on survival during embrionic drvelopment in nests.

Chum salmon catches in the Russian Far East in 2001-2017, thousand tons

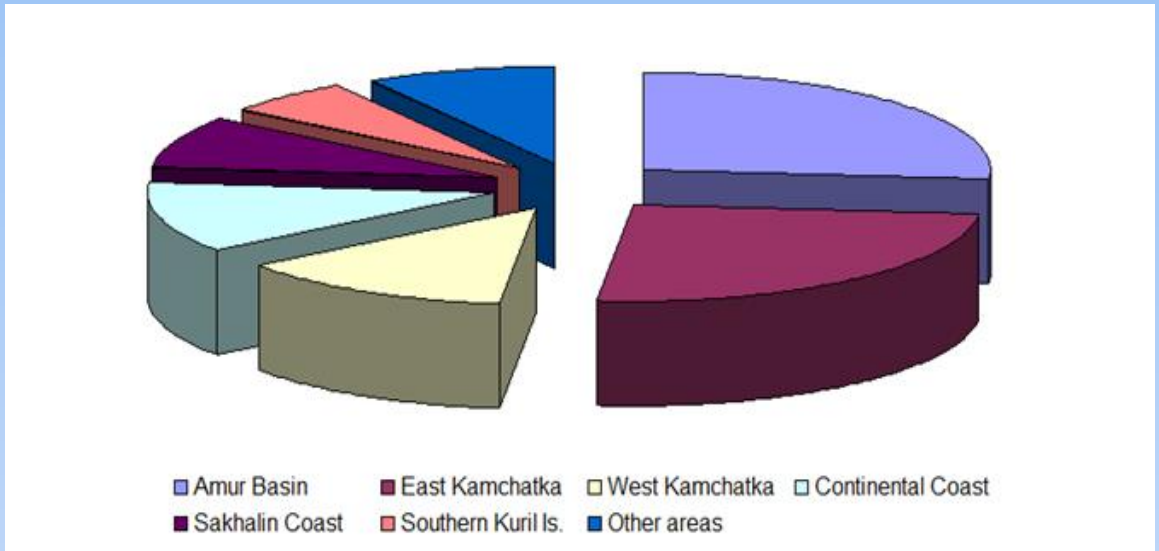
The chum salmon catch in various regions of the Far East in 1970-2017, thousand tons



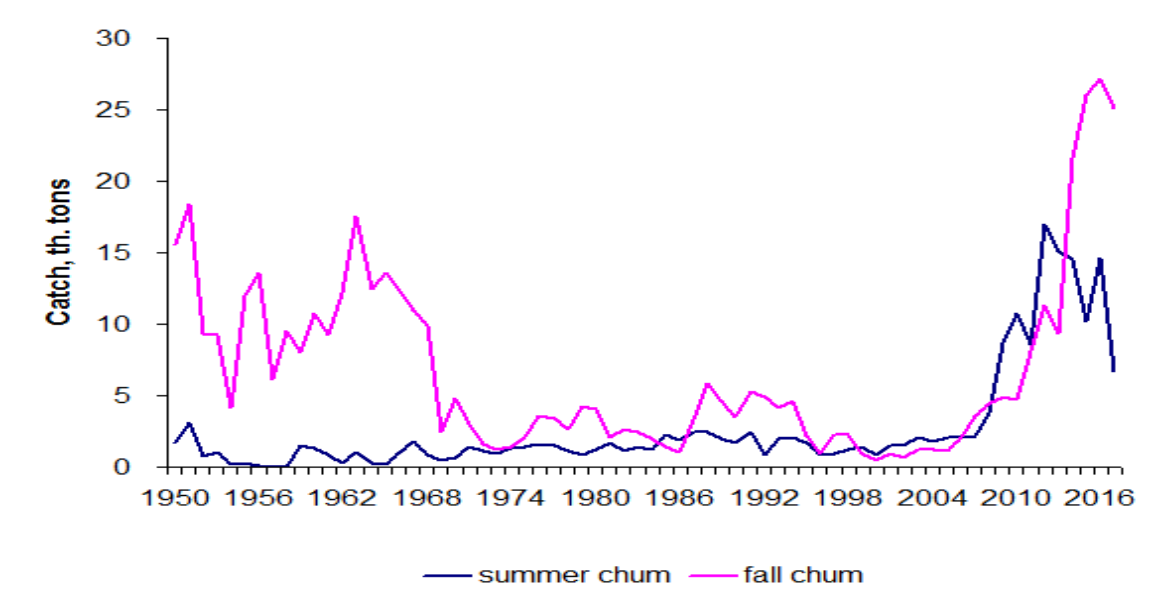
The chum salmon stocks are at a high level now. From 2001 to 2015, their catches in the Far East increased more than 5 times, from 28 to 142 thousand tons. Since 2016, decline in catch of chum salmon has been noted. In 2017 catch of chum was 98 thousand tons.

The contribution of the catch of chum salmon from different regions to the total salmon catch in the Far East varied with time. In recent years, the largest contribution of chum salmon to total catches was due to Amur basin stock. Its catches from 2001 to 2015 increased 17 times, from 2.14 to 36.7 thousand tons. In 2017, Amur chum salmon catch was 26.1 thousand tons.

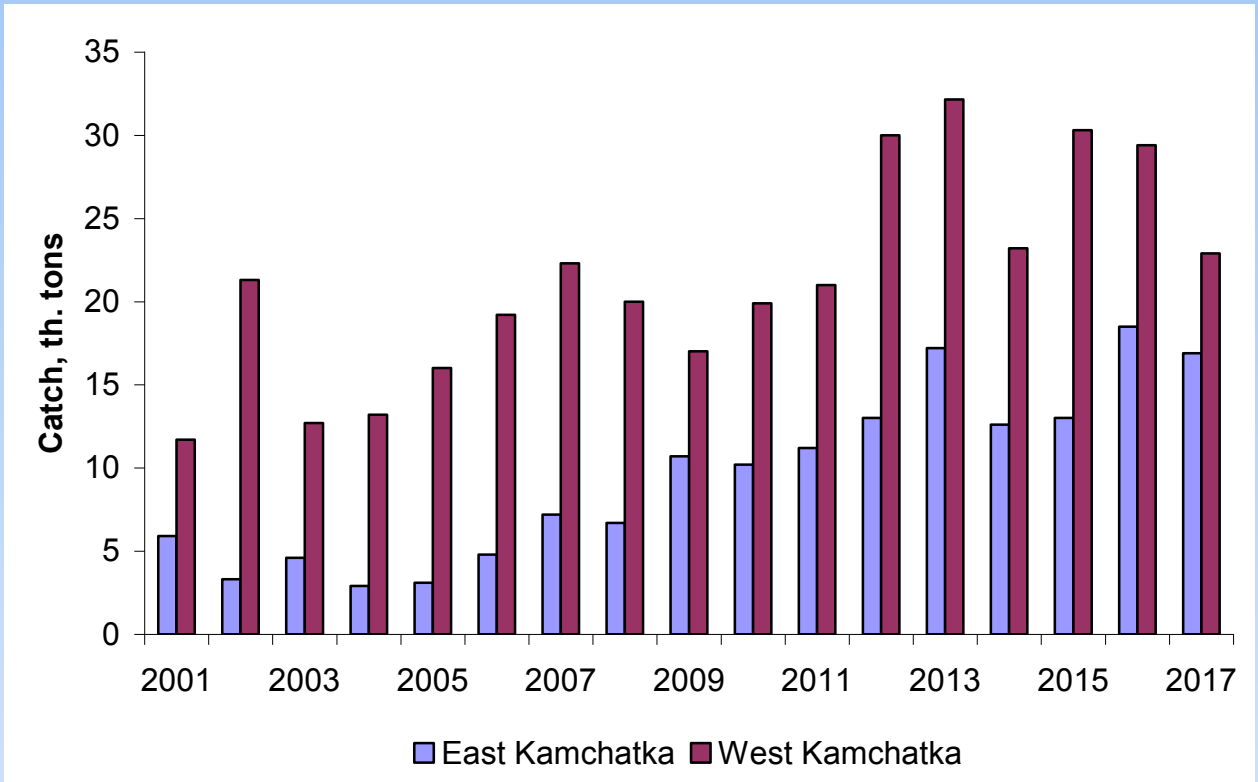
Chum catch in different reproduction areas of the Far East in 2017:



Dynamic of Amur summer and fall chum salmon catch in 1950-2017

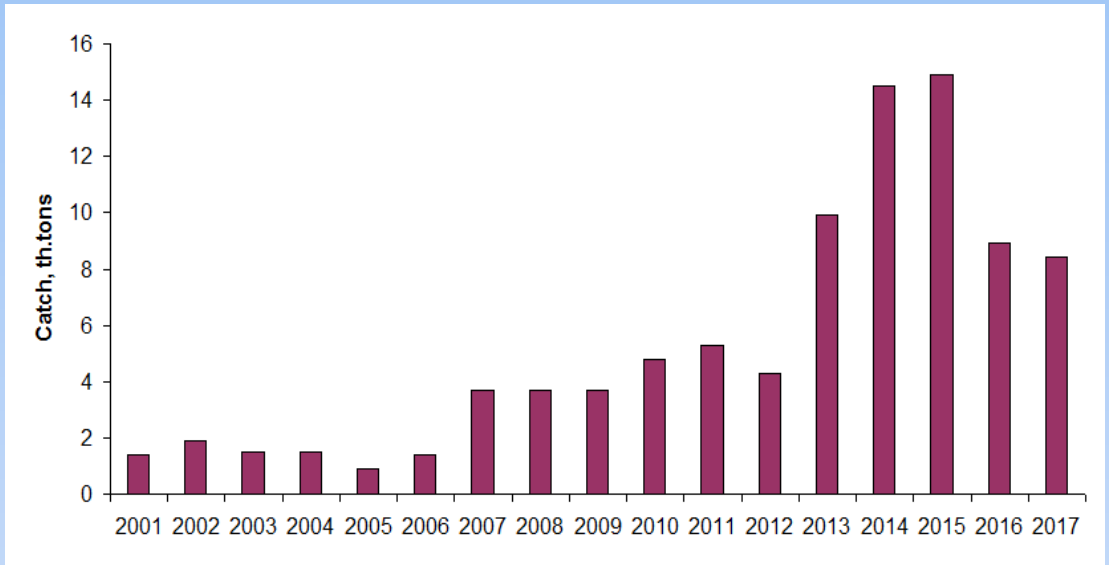


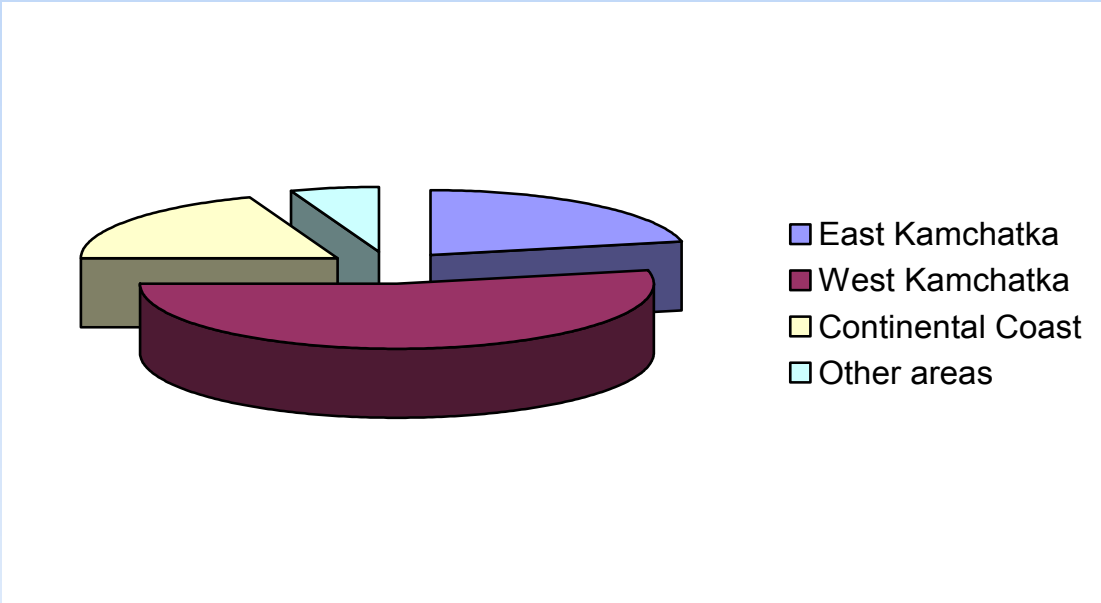
Sockeye salmon catches in the Eastern and Western Kamchatka in 2001-2017, thousand tons



Sockeye salmon, the third numerous species of Pacific salmons in the Russian Far East, are at a high level. Their catch of 42.1 thousand tons in 2017 was slightly lower compared to previous two years. This catch consists mainly of fish from two stocks - stock of Kurilskoe Lake in the West Kamchatka and stock of the Kamchatka river in the East Kamchatka. The abundance of both stocks is now at a high level. In Kamchatka. In 2017, 40 thousand tons of Sockeye salmon were caught in Kamchatka waters. In other areas, such as Chukotka, Continental Coast of Okhotsk and Kuril Islands, 2,100 tons in total, were caught.

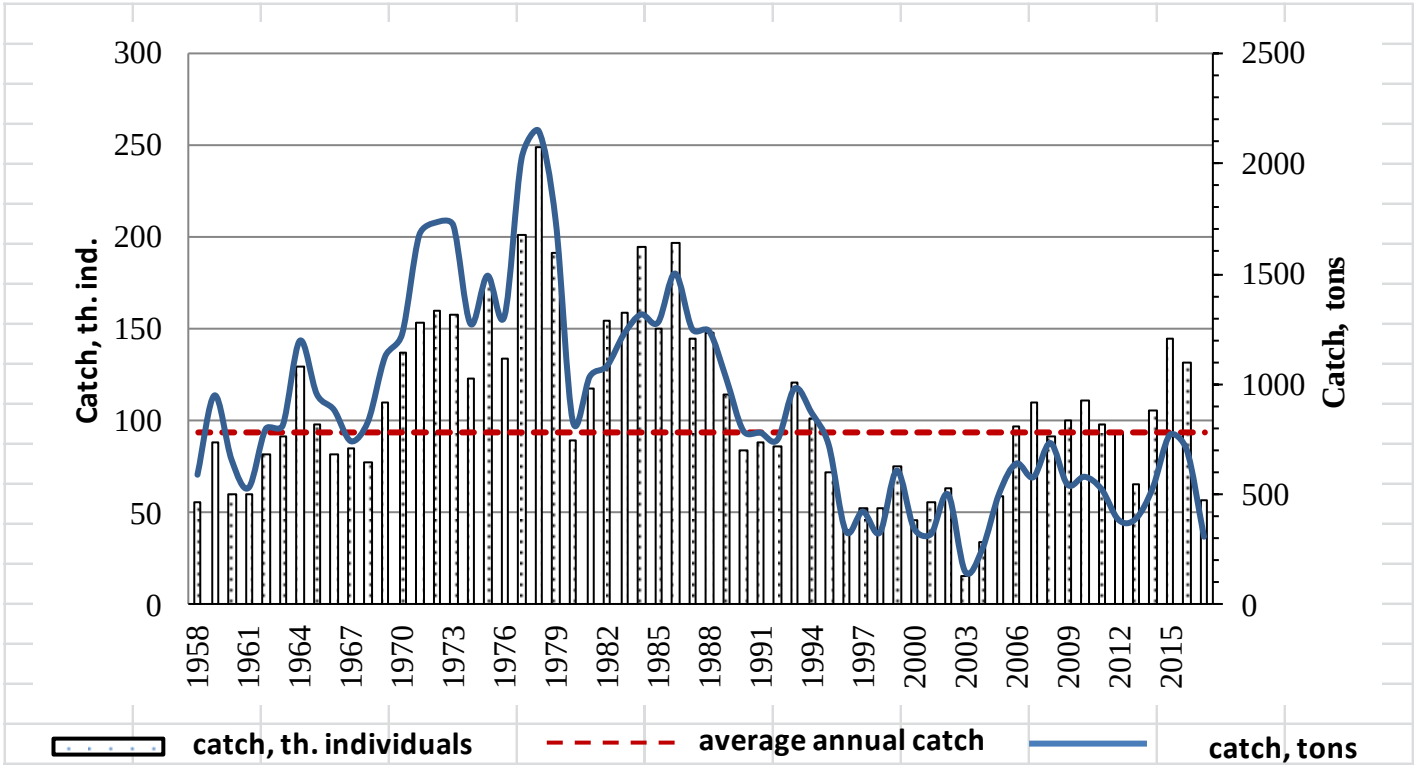
Catch Dynamic of coho salmon stocks in the Far East of Russia in 2001-2017





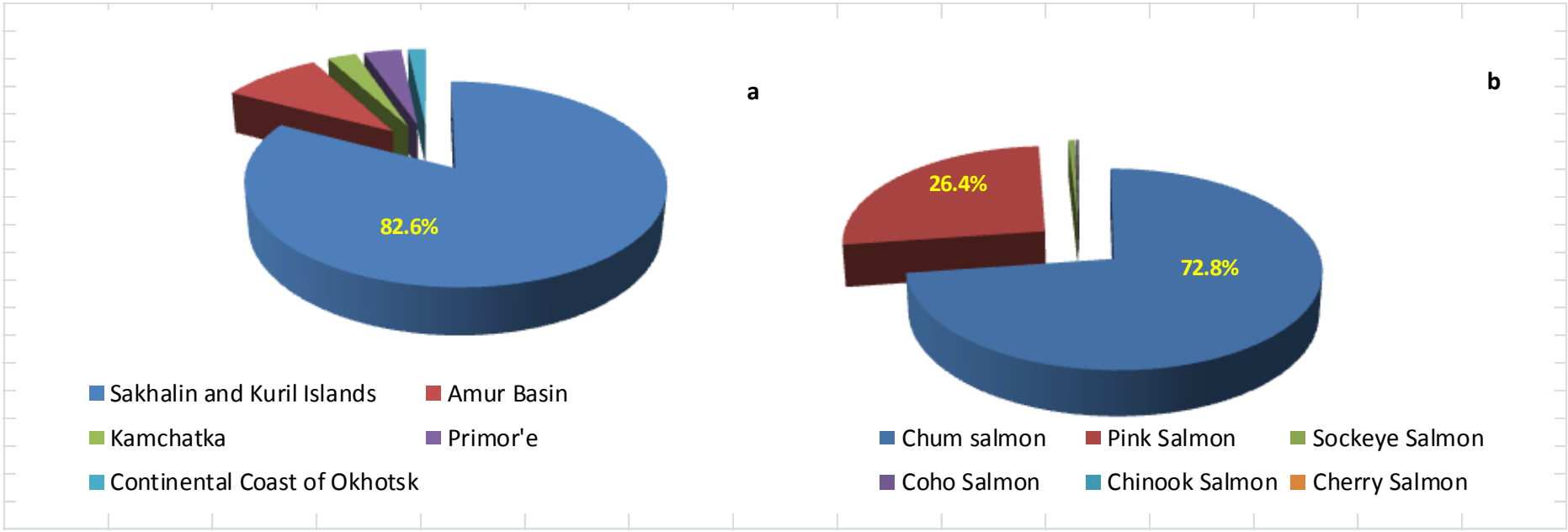
The coho salmon catch in 2017 was about 7 thousand tons. This is more than a half of the catch in 2015 and 2014 (14,5 th. tons). About the same amount was caught in 2016. Nevertheless, now Kamchatka coho salmon stocks are above mean long-term level. Also, there is an increase in Continental Coast coho salmon stocks (645 tons).

Chinook salmon Catch Dynamic in Kamchatka river (East Kamchatka) in 1958-2017



The catch of Far East chinook in 2017 was 388 tons that was more than two times lower than in 2016 (818 tons). The abundance of East Kamchatka stocks have stabilized at a average level. However, the catch-by-weight is lower than in the 1990s due to decrease in the proportion of females, their rejuvenation and reduction in body weight (Shevlyakov et al., 2017). The population of the Bolshaya River Chinook salmon (West Kamchatka) is in a depressed state now.

Share of salmon fry and smolts hatchery releases by area (a) and species (b) from the total production in the Far East in 2017 , %



There are 68 salmon hatcheries in the Far East. In 2017, they released 1043.5 million juveniles in total. 82.6% of juveniles were released from the Sakhalin and Iturup hatcheries. Among them chum and pink salmon constituted 99.2%

Conclusions

1. The anomalous surface warming started in autumn 2013, has spread into the western Bering Sea by spring 2014, and in 2015-2016 it reached the North Kuril area and northern Okhotsk Sea. This was accompanied by northward shift of reproduction areas of pink salmon. As a result, marine survival of the northern pink salmon stocks (West and East Kamchatka, Continental Coast of Okhotsk), their approaches to the coast and catches increased. At the same time, the Sakhalin and South Kuril pink salmon stocks decreased.

2. In 2017, all chum salmon stocks were at a high level but somewhat lower than during two previous years. All chum salmon stocks except for the South Kuril and Sakhalin stocks, were maintained by means of natural reproduction. The South Kuril and Sakhalin stocks were maintained by 90 % due to artificial reproduction.

3. The coho and sockeye stocks, originated mainly from Kamchatka, are in a good state now.

4. The further research is needed to explain the reasons of sharp increase in Amur and Primor'e pink salmon stocks in even years, as well as reasons of degradation and changes in biological features of Kamchatka chinook salmon.