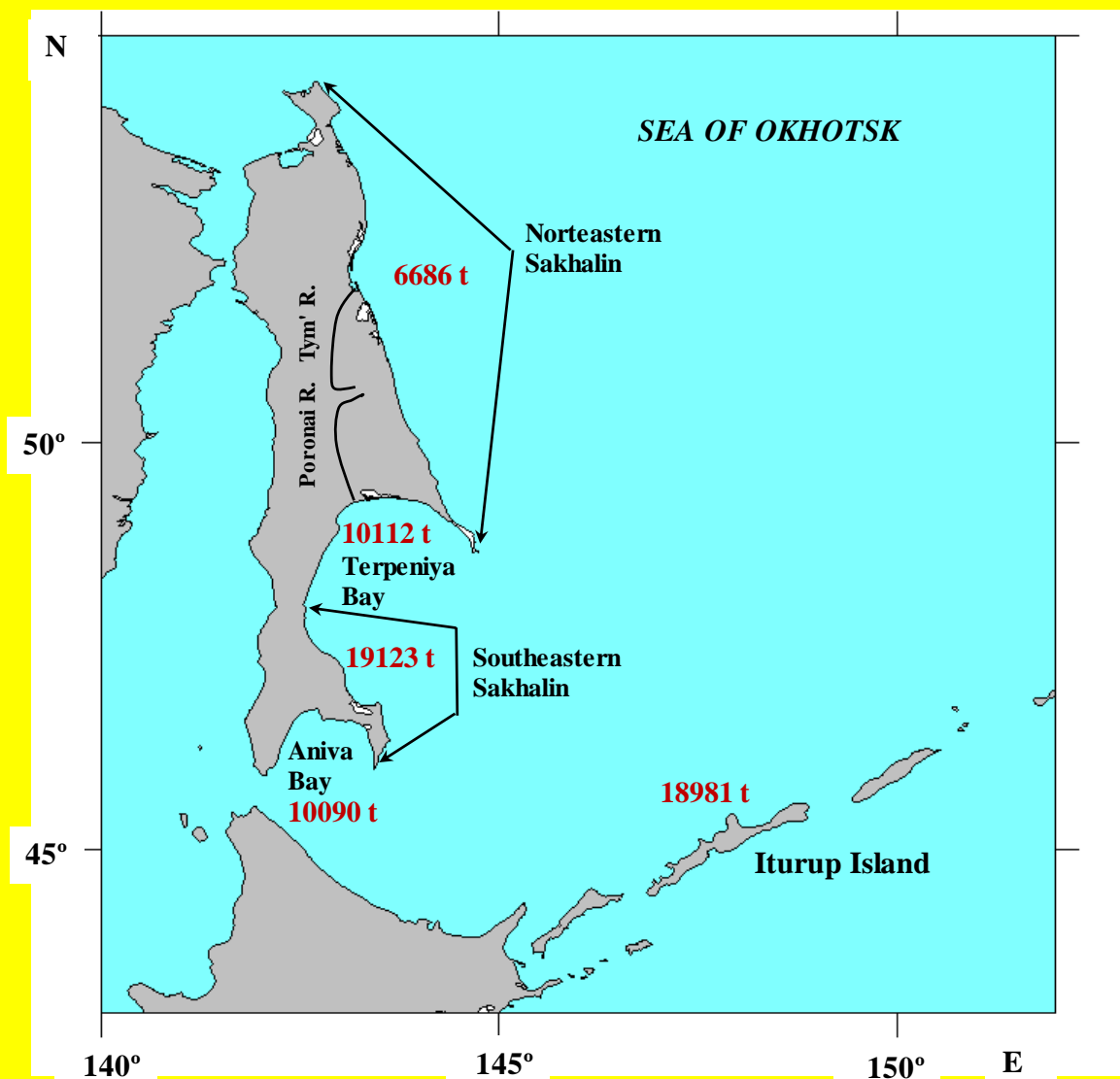


Alexander M. Kaev

**Ph.D., principal researcher of SakhNIRO,
head of laboratory of Sakhalin State University,
Yuzhno-Sakhalinsk, Russia**

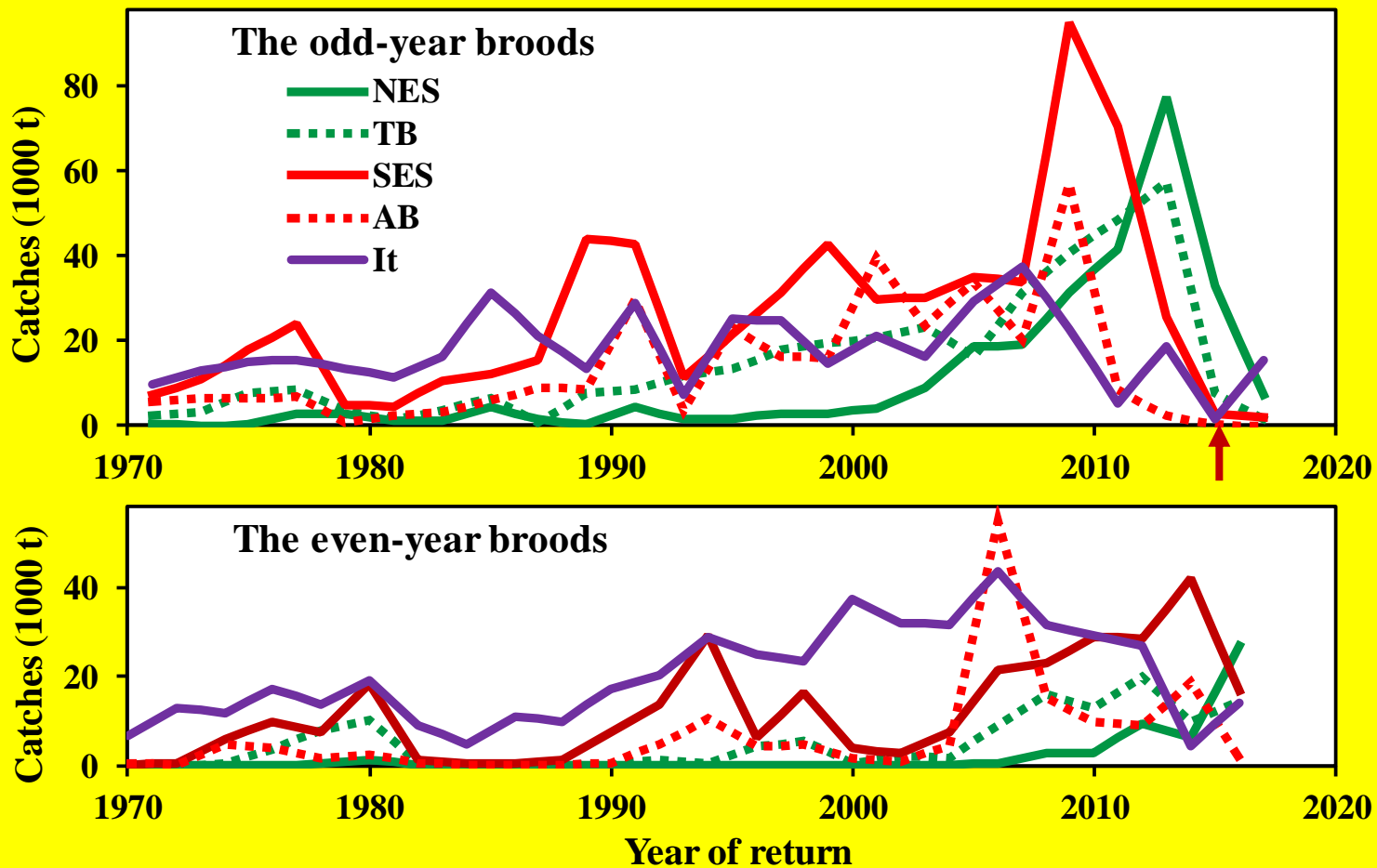
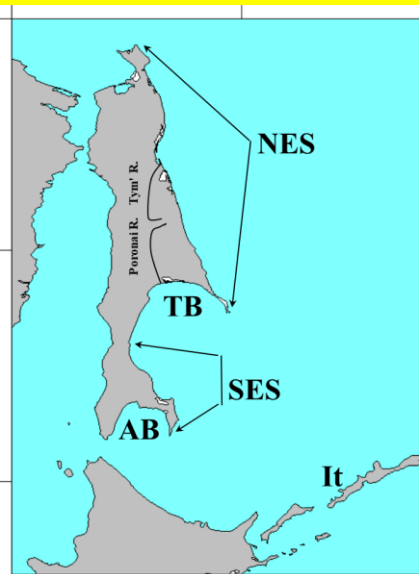
**ACTIVITY OF EXTREME
ENVIRONMENTAL FACTORS
AS A REASON FOR THE PINK SALMON
ABUNDANCE DECLINE
IN THE SAKHALIN-KURIL REGION**

The main areas of pink salmon fisheries in the Sakhalin-Kuril region



90 % of pink salmon are captured in the four areas of the eastern Sakhalin and Iturup Island. The Sakhalin-Kuril region possesses about a half of the Russian catches of pink salmon.

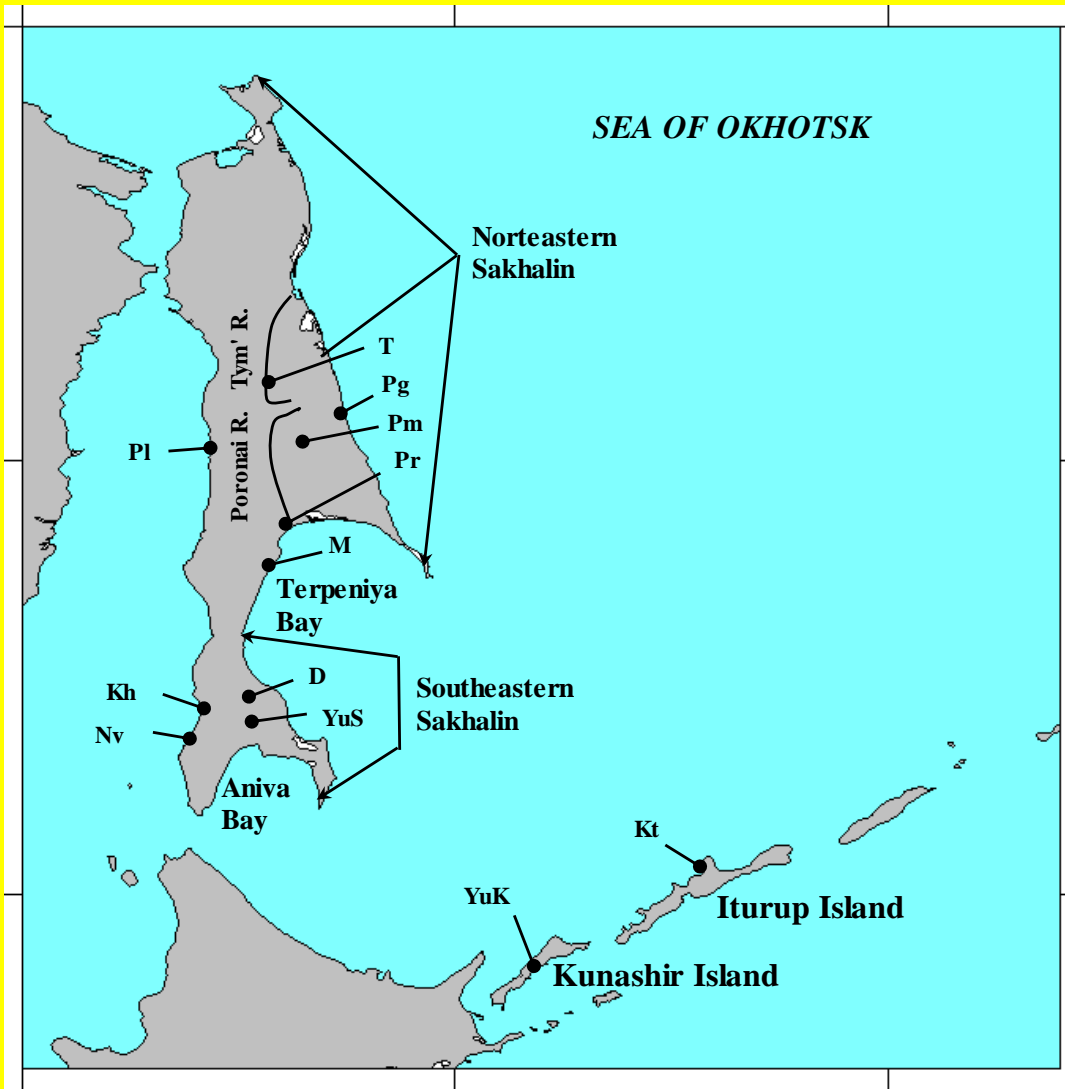
Dynamics of pink salmon catch in certain areas of the Sakhalin-Kuril region in 1970–2017



Both the abnormal high autumn floods that destroy grounds on the spawning areas, in May and a drought in about the year can significantly decline in catches in the Sakhalin-Kuril region. The decrease in catches in the Sakhalin-Kuril region is due to the destruction of spawning grounds by dominant broods selected in different years.

and that event had actually happened in 2015.

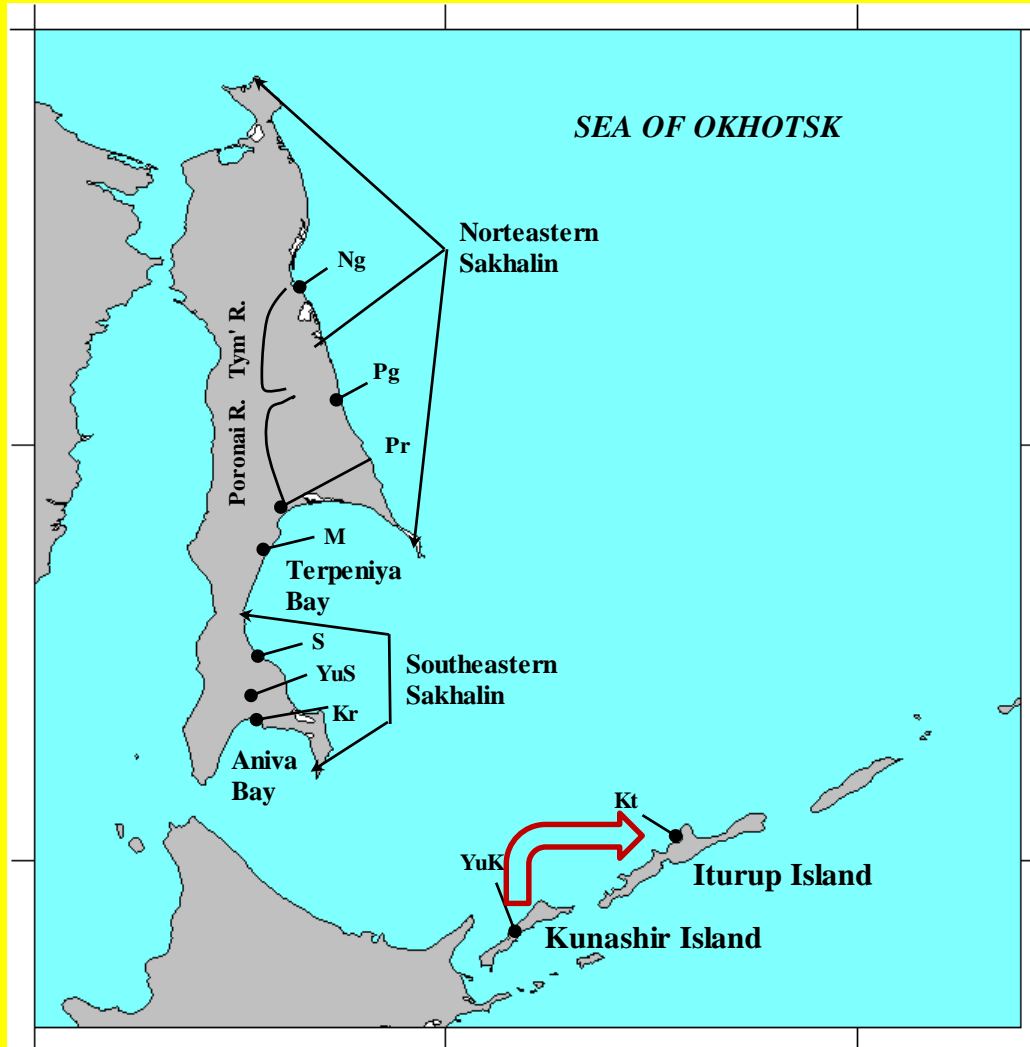
The main areas of pink salmon fisheries and sites of meteorological observations



- T Tymovskoye
- Pg Pogranichnoye
- Pm Pervomaysk
- Pr Poronaysk
- Pl Pilvo
- M Makarov
- Kh Kholmsk
- Nv Nevelsk
- D Dolinsk
- YuS Yuzhno-Sakhalinsk
- Kt Kitovoye
- YuK Yuzhno-Kurilsk

The principal size of the precipitation falling on each station is based on the mean of the mean precipitation during the last 10 years. The data of several meteorological stations.

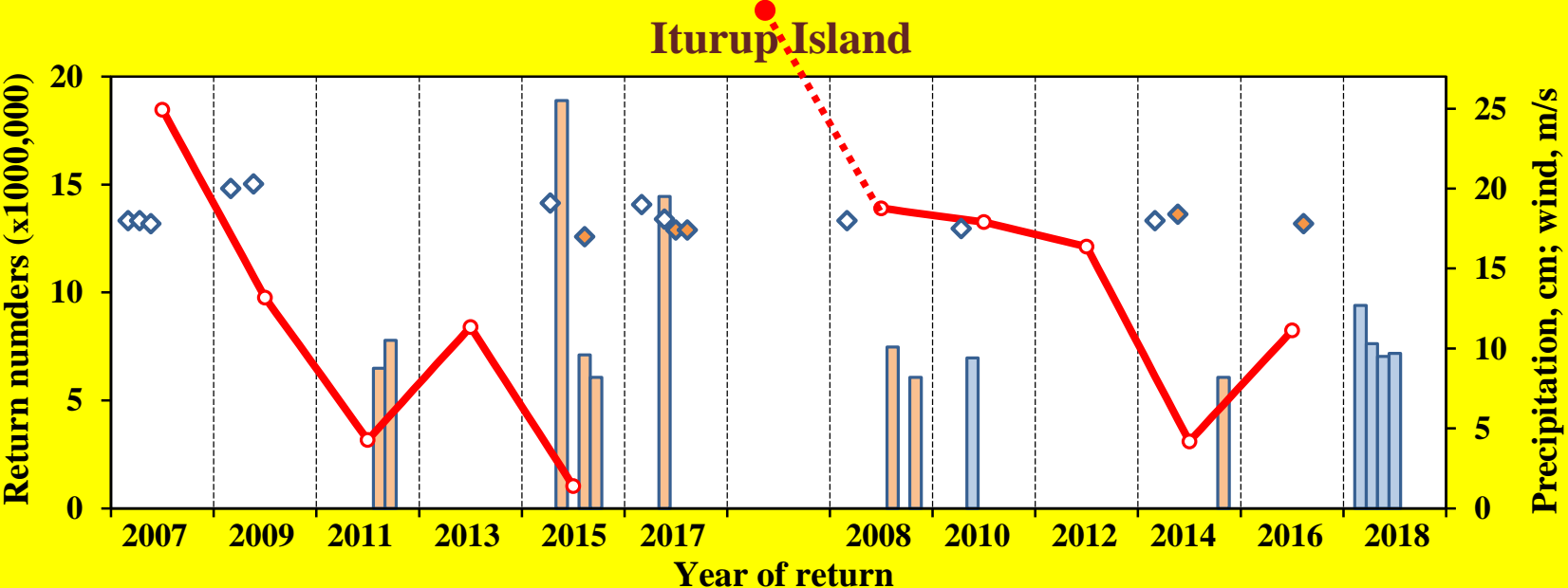
The main areas of pink salmon fisheries and sites of meteorological observations



- Ng Nogliki
- Pg Pogranichnoye
- Pr Poronaysk
- M Makarov
- S Starodubskoye
- YuS Yuzhno-Sakhalinsk
- Kr Korsakov
- Kt Kitovoye
- YuK Yuzhno-Kurilsk

A preliminary analysis of the observation conditions in the Sea of Okhotsk (2016) was stated based on the average value (20 of the period 2010) were used as the data for the daily measurements at these stations. Iturup Island were used for Iturup Island.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)



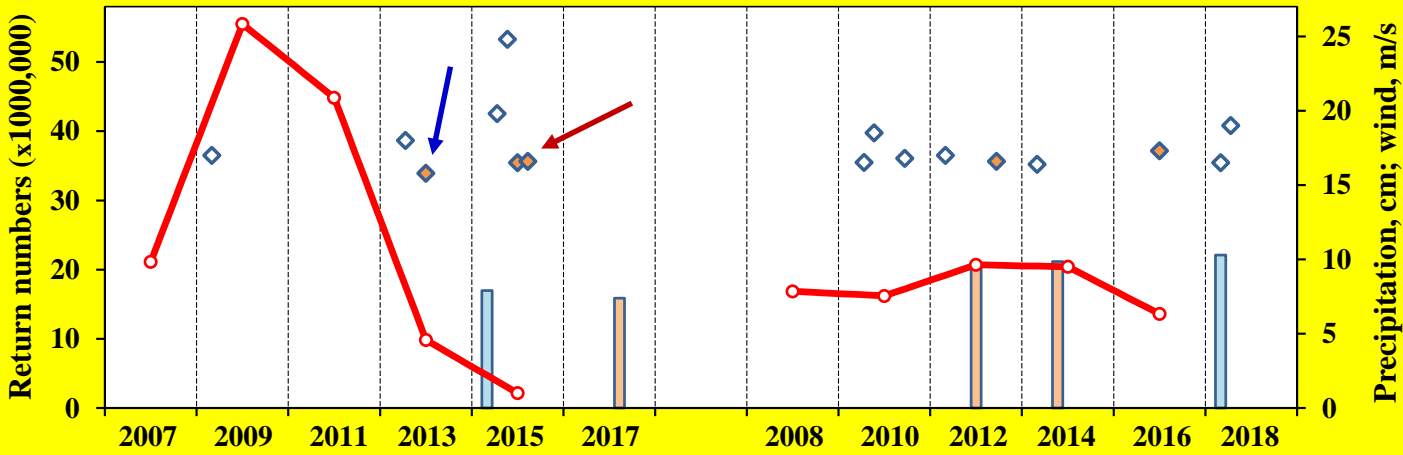
We took into account the timing of extreme factors when they could cause most damage to pink salmon reproduction. In the second half of the mass spawning period, the process of migration was affected by the extreme of precipitation, and storms — in the period of mass downstream migration from rivers.

The 2016, the minimum abundance of fish returned to Iturup Island was caused by floods in the spawning area. The process of migration was affected by the extreme of precipitation, and storms — in the period of mass downstream migration from rivers.

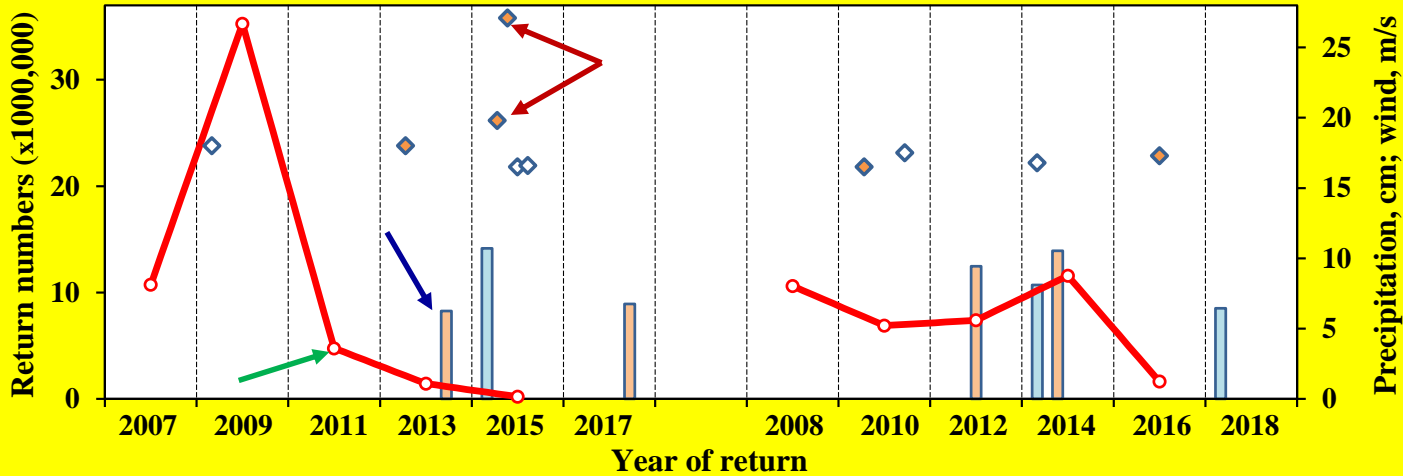
For the time being, we are considering the data to 2016 inclusive. The values of such factors are colored pink.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)

Southeastern Sakhalin



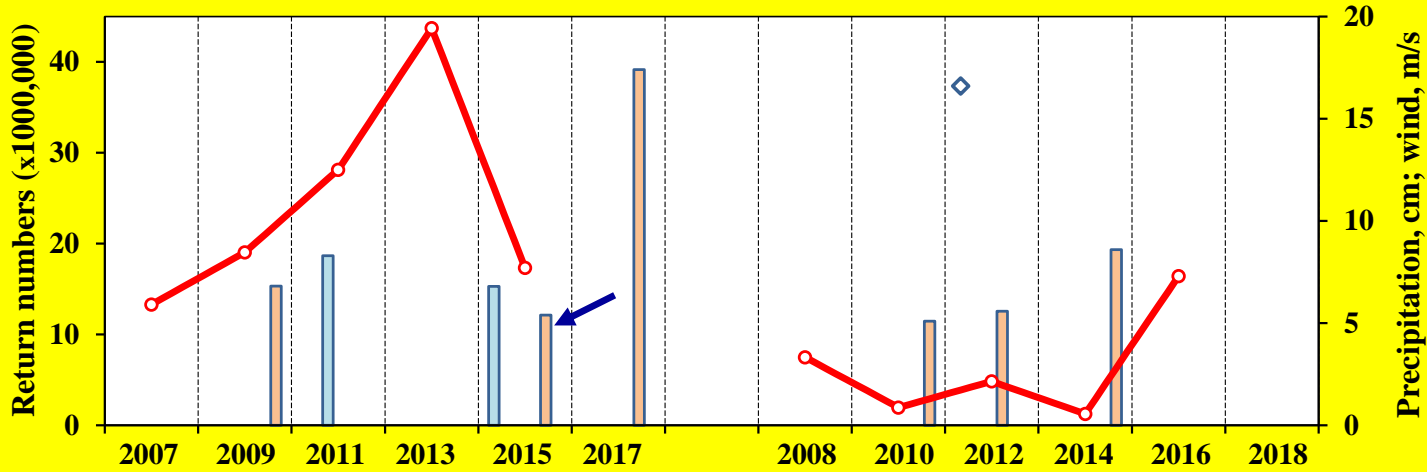
Aniva Bay



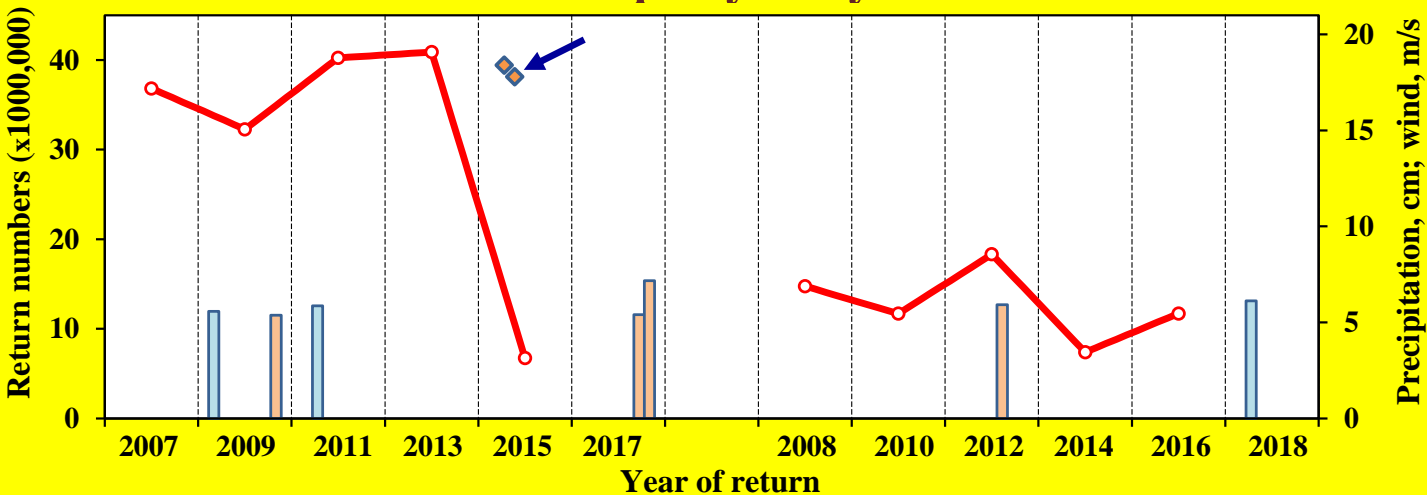
A decline in abundance in Aniva Bay was caused by the impact of the autumn river flood on spawning salmon abundance in the southern Aniva Bay also coincided with the autumn abnormally high precipitation. In 2015 in Aniva Bay is not exclusion part of pink salmon stock spawned in recent years.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)

Northeastern Sakhalin



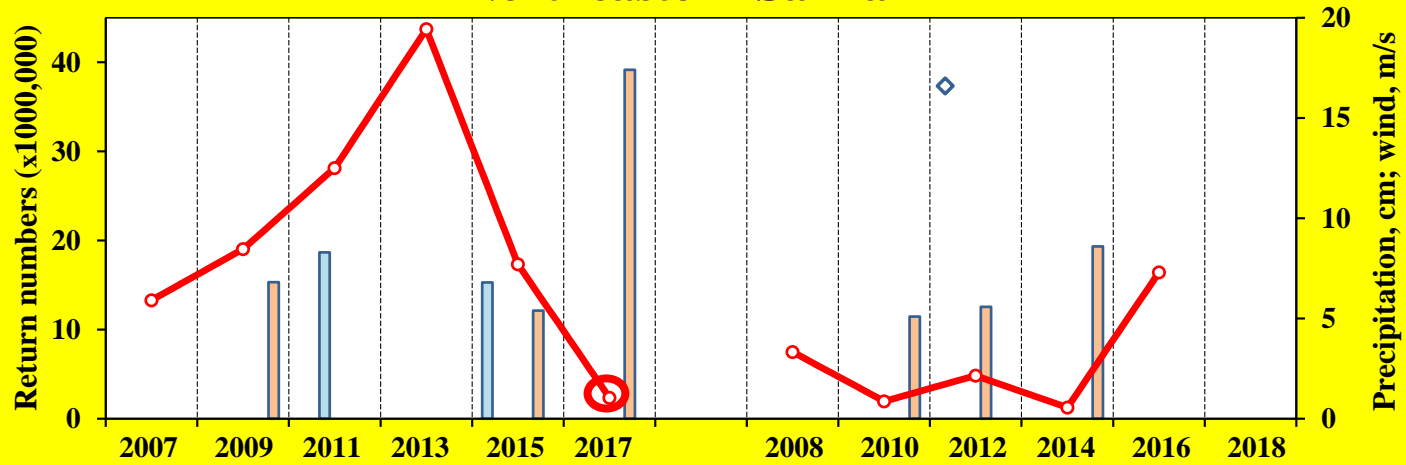
Terpeniya Bay



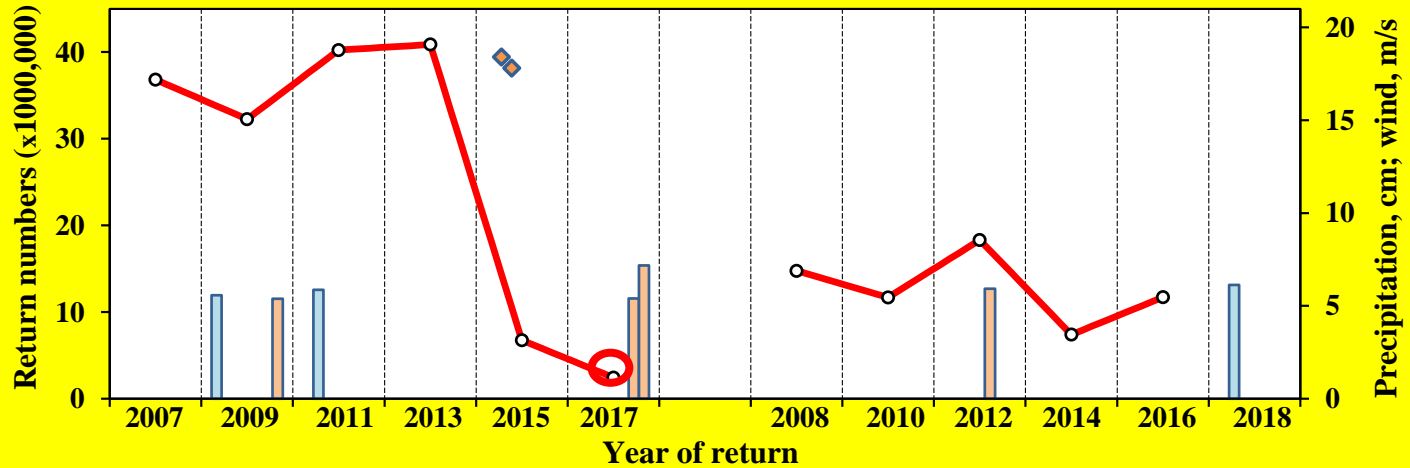
In Terpeniya Bay and northeastern Sakhalin a decline in pink salmon abundance in 2015 and in other years of these regions was not very large because storm winds in the first area affected only the early abundance in southern areas of the region would remain low... precipitation.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)

Northeastern Sakhalin



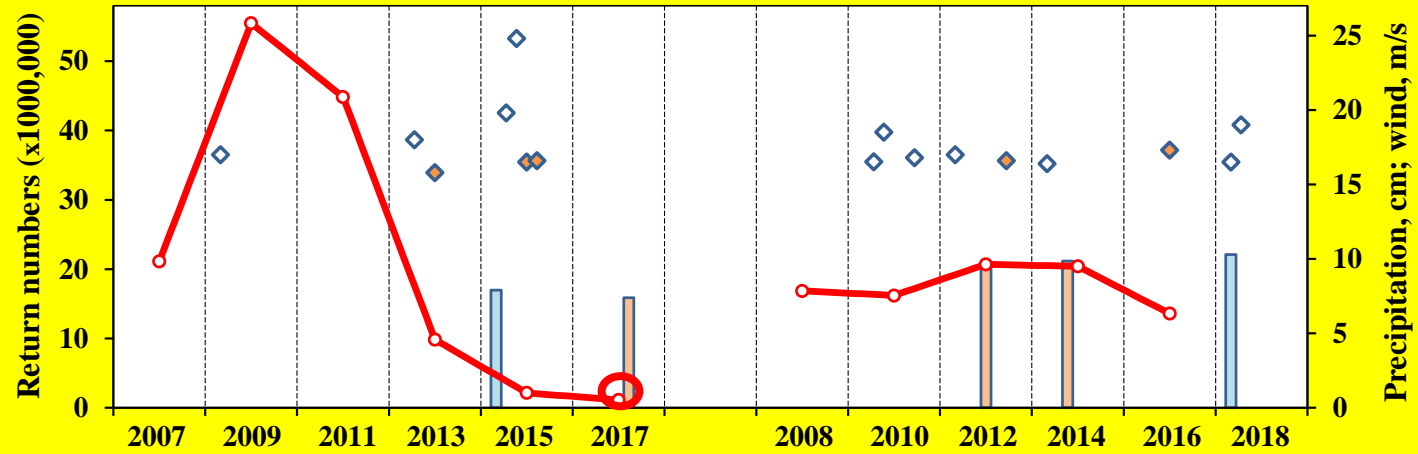
Terpeniya Bay



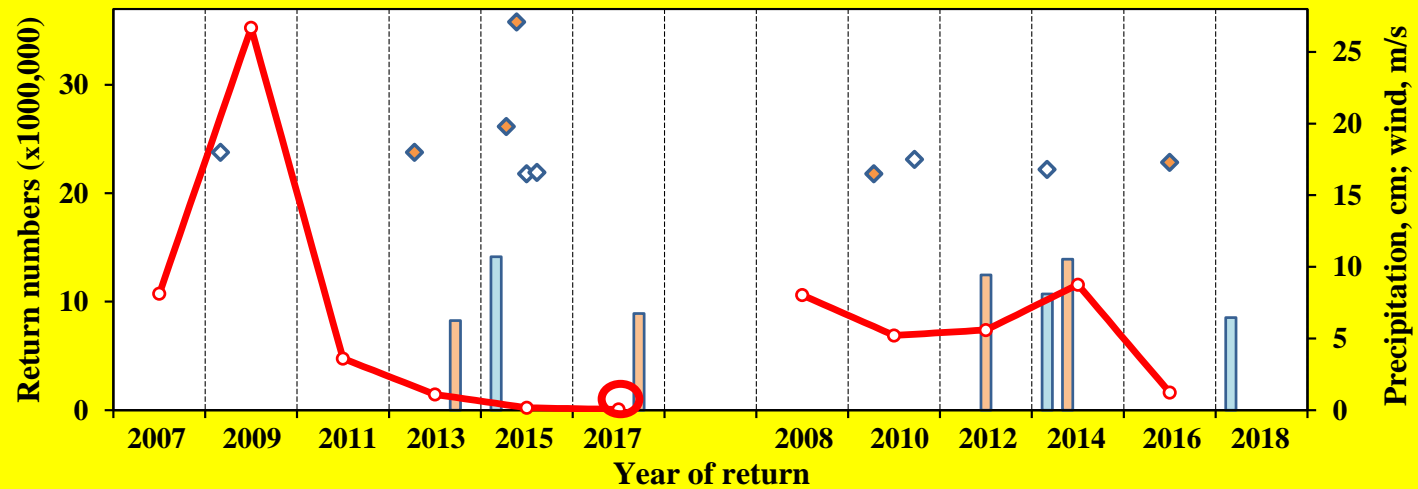
This scenario was fully realized in the northern part of eastern Sakhalin...

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)

Southeastern Sakhalin

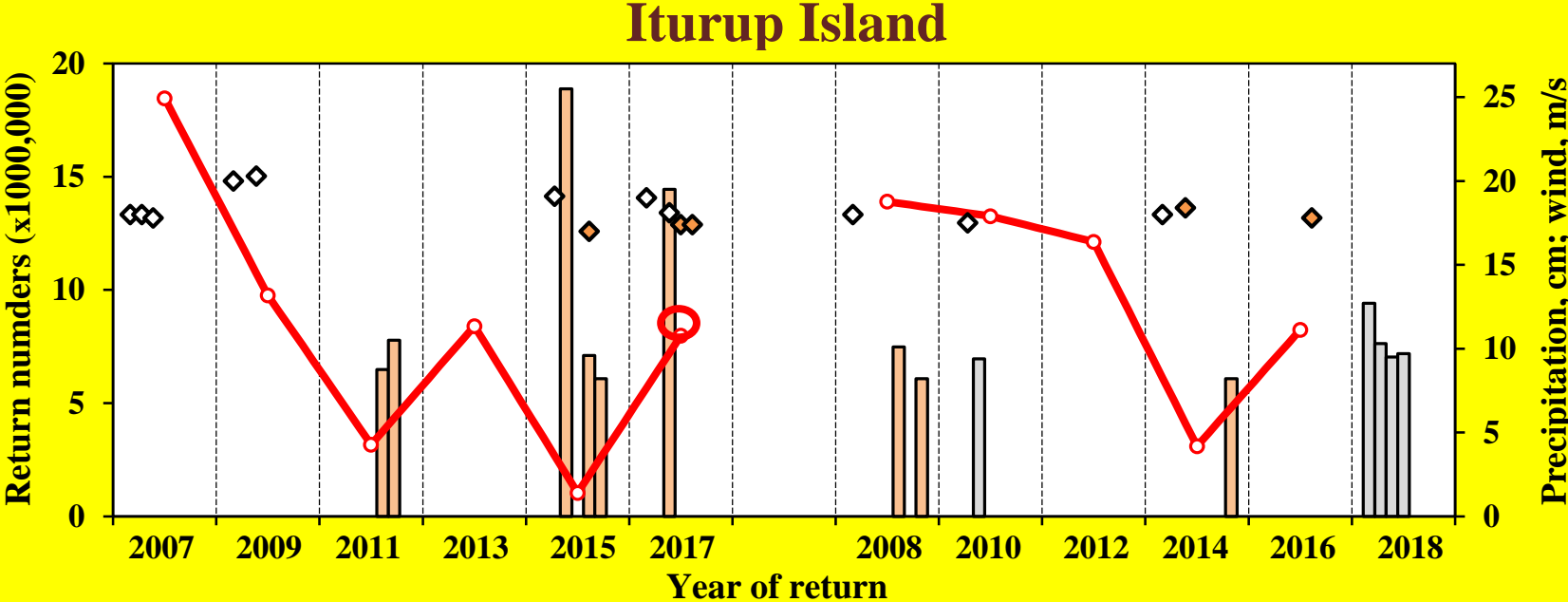


Aniva Bay



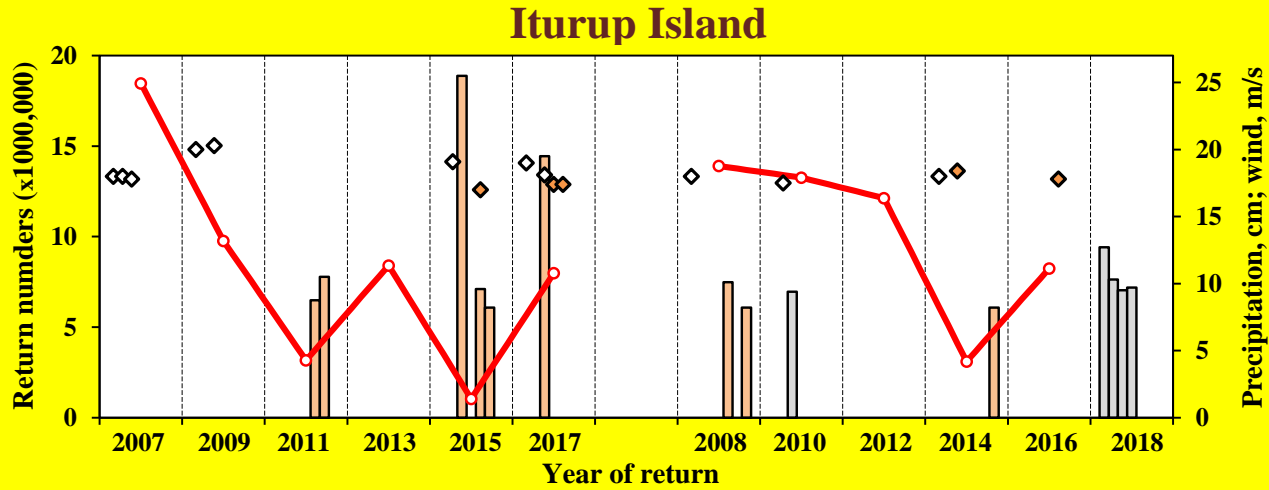
... and in the southern part of eastern Sakhalin.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)

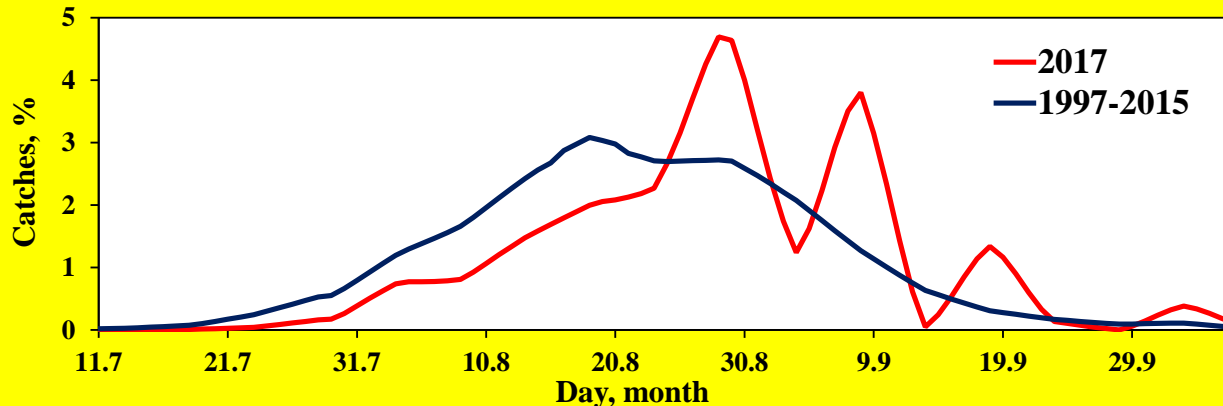


The impact of these factors on Iturup pink salmon could be not very significant since the meteorological data of Iturup Island, the one which is used to characterize spawning conditions for this brood line, because of the absence of the corresponding data on Iturup Island.

Dynamics of pink salmon abundance (lines), number of the days with extremely high precipitation (columns), and number of the days with strong wind (symbols)



Seasonal dynamics of pink salmon catch on Iturup Island in 2017 compared with the mean dynamics for preceding odd years



To date, the maximum number of the catches of pink salmon was recorded in 2017. For the first time, the number of days with extremely high precipitation (more than 19 cm) and the number of days with strong wind (more than 14 m/s) were recorded in 2015. The number of days with extremely high precipitation (more than 10 cm) and the number of days with strong wind (more than 13 m/s) were recorded in 2017. The number of days with extremely high precipitation (more than 7 cm) and the number of days with strong wind (more than 13 m/s) were recorded in 2008, 2010, 2011, 2014, and 2018. The number of days with extremely high precipitation (more than 6 cm) was recorded in 2009, 2012, 2013, 2015, and 2016. The number of days with strong wind (more than 15 m/s) was recorded in 2009. The number of days with strong wind (more than 13 m/s) was recorded in 2007, 2014, and 2016. The number of days with strong wind (more than 13 m/s) was recorded in 2017. The number of days with strong wind (more than 13 m/s) was recorded in 2018.

Correlation of changes in pink salmon abundance with the values of extreme factors

Area	R	p	n
Northeastern Sakhalin	-0.52	0.104	11
Terpeniya Bay	-0.47	0.148	11
Southeastern Sakhalin	-0.51	0.106	11
Aniva Bay	-0.52	0.102	11
Iturup Island	-0.70	0.015	11

Thank you for your patience!

Perhaps, a change of these epochs is accompanied by the shift of trajectories and dates of appearance of pink salmon abundance anomalies, observed under the influence of an increase in the number of extreme events. The fact that only 20% of the years are characterized by a constant increase in the number of extreme events, which has been observed in the study area, is a significant indicator of the low frequency of such events. In the rest of the years, the number of extreme events is low, which is characteristic of the rest of the epochs. This is evident from the low values of the correlation coefficients of the abundance formation of this species.