Long-term dynamics of the greenland halibut population in the Okhotsk Sea

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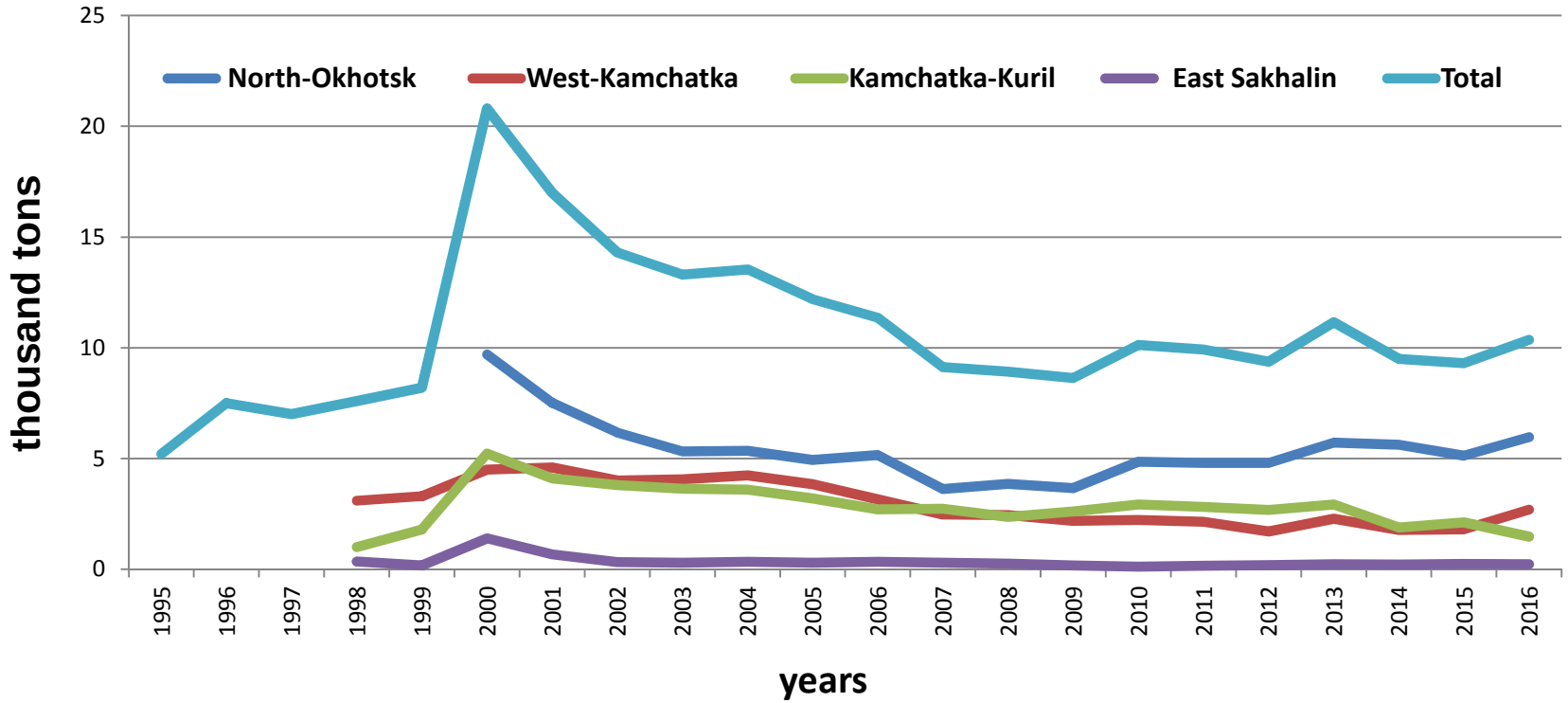
Stock dynamics

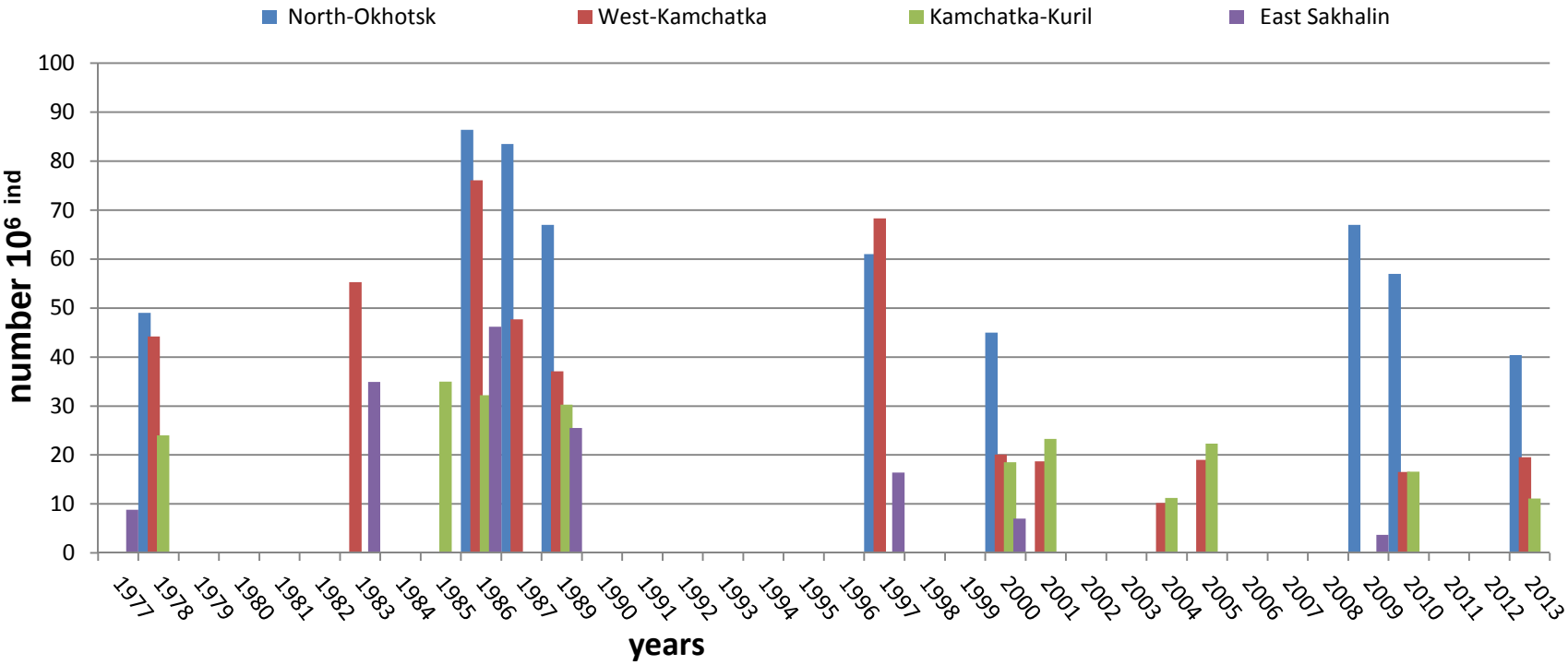
Stock decreased from 15-20 thousand tons in the late 1990-s to 9-11 thousand recently. What is the reason of the decline?



Annual catch of greenland halibut in certain fishing districts of the Okhotsk Sea

Stock dynamics

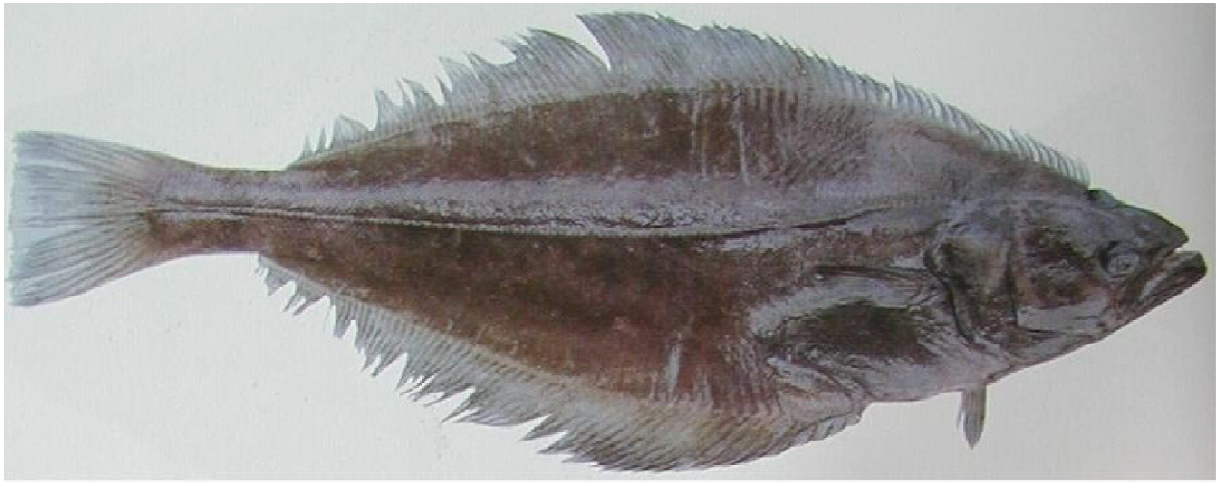
Abundance of greenland halibut in the Okhotsk Sea has prominent fluctuations, too, in particular in the West-Kamchatka zone (from 76 to 19 $\cdot 10^6$ ind.) and East-Sakhalin zone (from 46 to 4.5 $\cdot 10^6$ ind.). In the North-Okhotsk zone it is more stable and changed from 86 to 41 $\cdot 10^6$ ind.



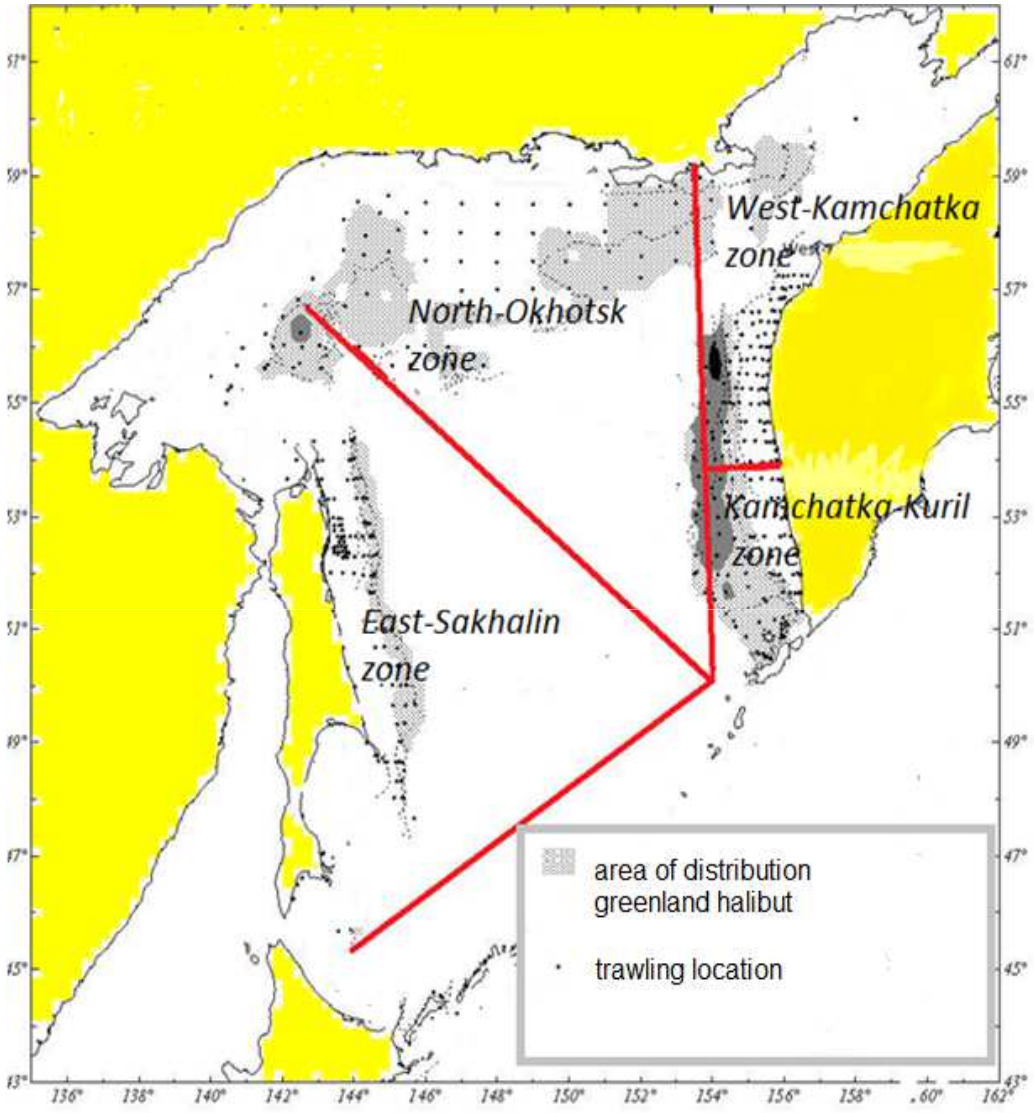
Change in the abundance of greenland halibut in fishery districts according to bottom trawl surveys

Goals:

In this study I tried to understand: what environmental factors are responsible for fluctuations of the greenland halibut stock in the Okhotsk Sea?



Materials



Scheme of commercial fishing districts in the Okhotsk Sea

More than 30 bottom trawl surveys and reports of observers aboard fishery vessels in the period from 1963 to 2015 are analyzed separately for 4 fishery districts:

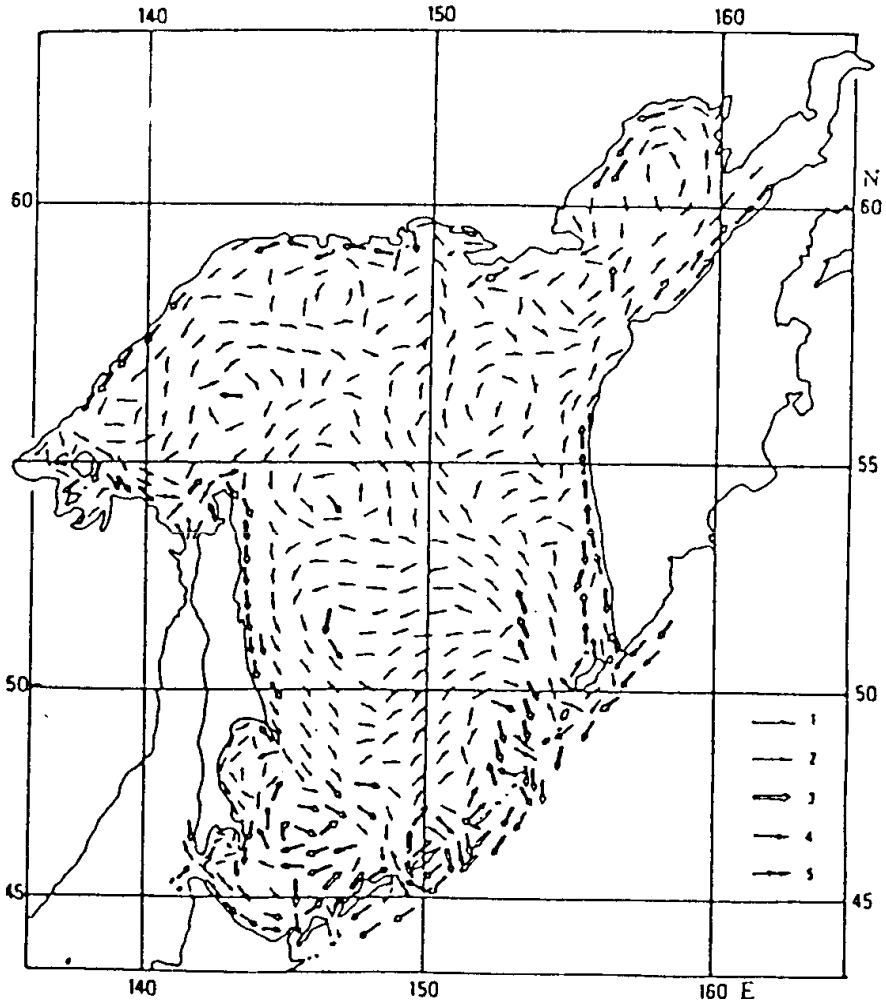
-West-Kamchatka,

--Kamchatka-Kuril,

- North-Okhotsk,

- East-Sakhalin.

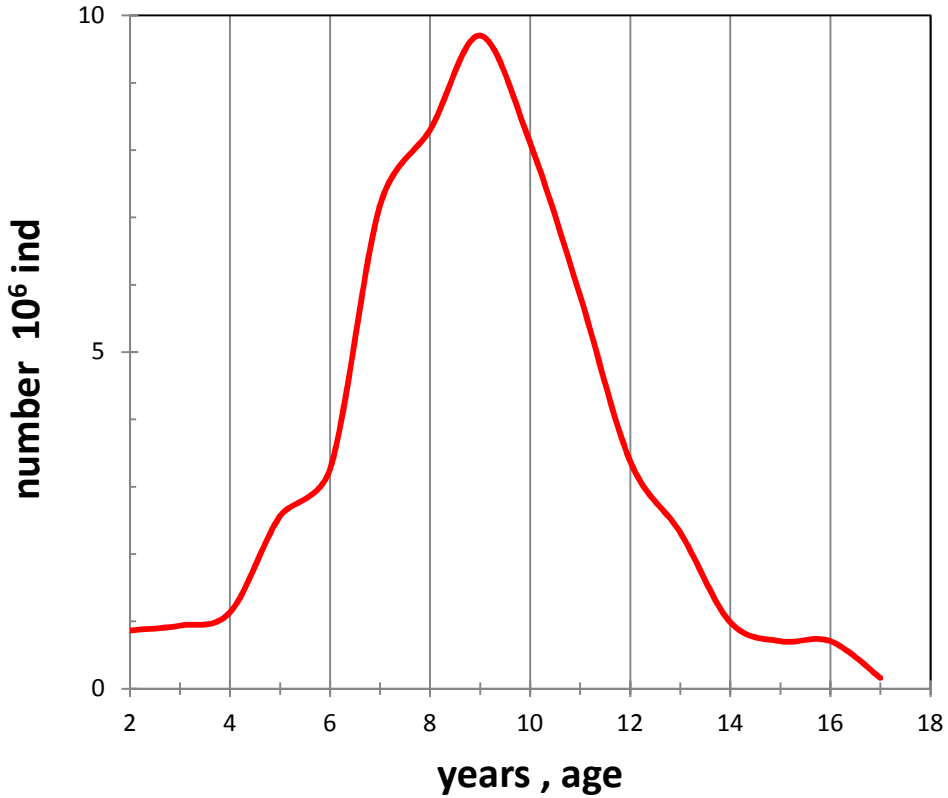
Materials



Scheme of water circulation in the Okhotsk Sea

Water circulation in the Okhotsk Sea is determined mostly by density currents (i.e. by temperature and salinity). This geostrophic component of currents is calculated from the data on temperature and salinity. The currents are calculated ***by Alex Figurkin from TINRO.***

Methods



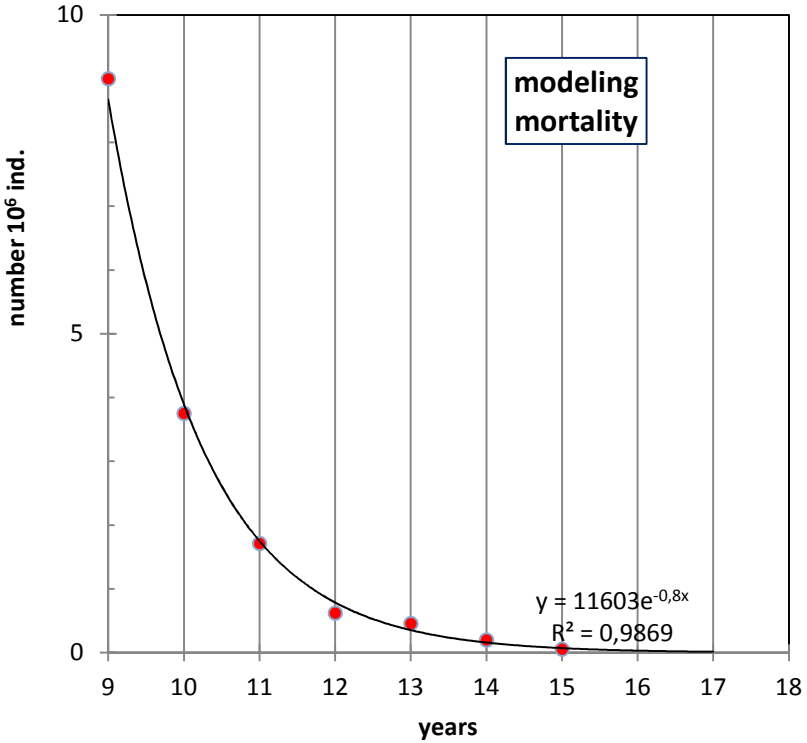
The age group 9+ is the most common in trawl catches.

Younger fish are not numerous in trawl catches because of lower catchability. Older fish are less numerous because of natural and fishery mortality.

Therefore the number 9-years old fish is taken as an index of year-class strength.

Mean for 1984-2004 number of greenland halibut in trawl catches, by age groups

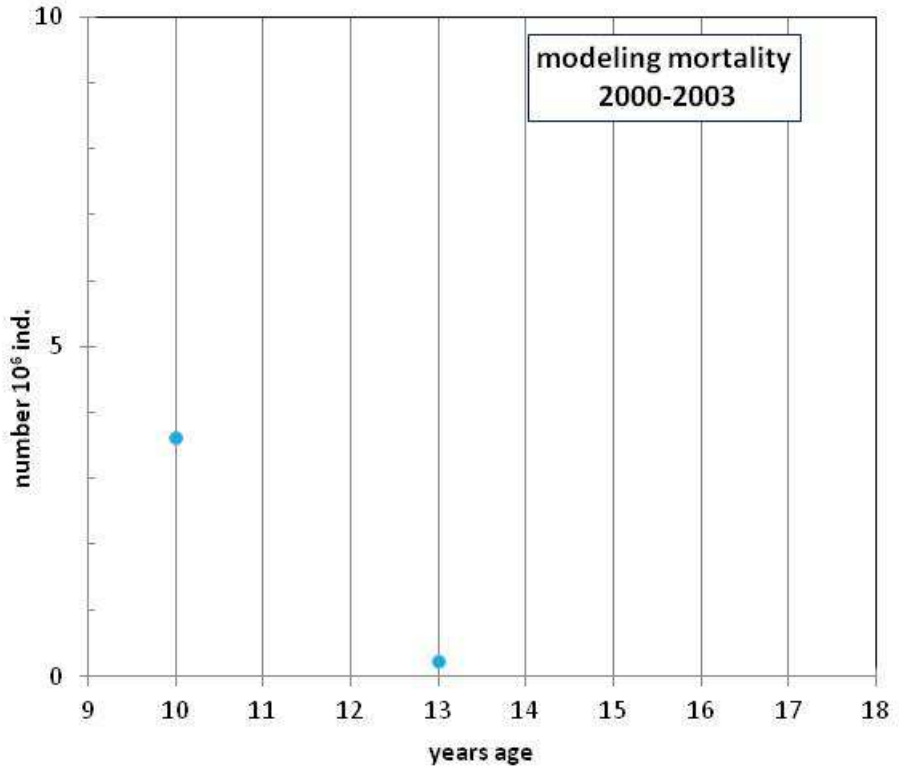
Methods



Declining the number of older fish with age is well approximated by exponential function

Mean for 1984-2004 number of greenland halibut in trawl catches, by age groups, approximated by exponential function

Methods

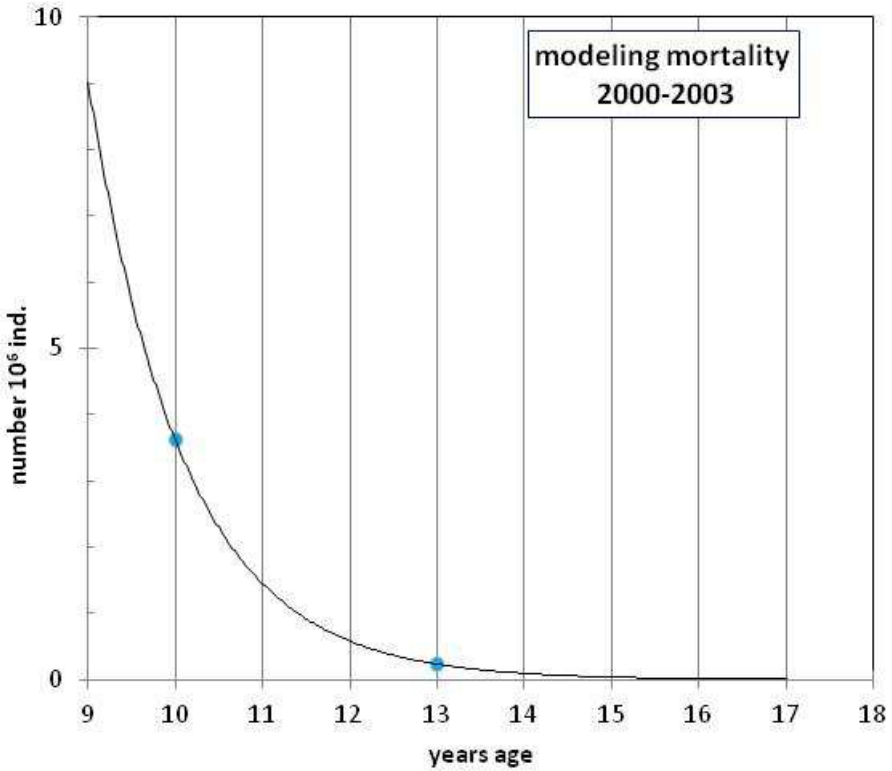


Using the exponential model, there is possible to restore the number of 9-years old fish for each year-class from the data on elder age groups.

For example, the number of 9-year fish of the year-class hatched in 1990 could be restored from the data on 10-year fish number in 2000 and 13-year fish number in 2003 .

Number of greenland halibut of the year-class hatched in 1990 according to the bottom trawl surveys of 2000 and 2003 in the Kamchatka-Kuril district

Methods



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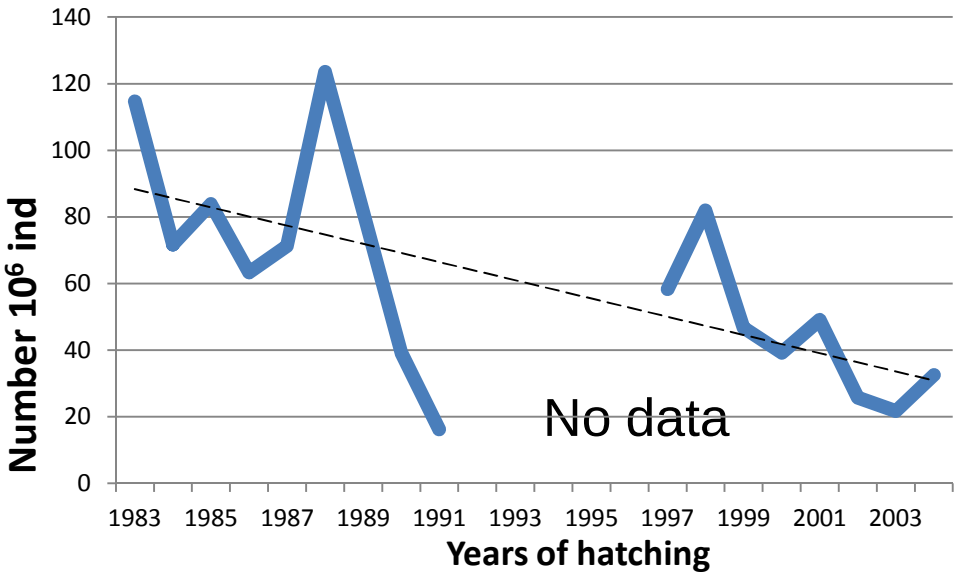
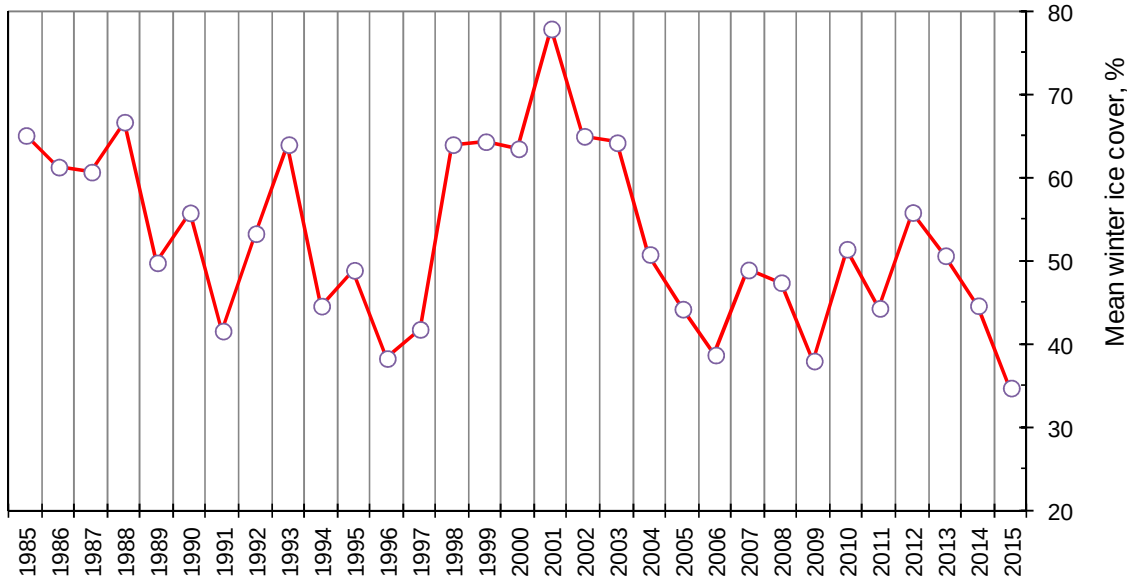
Number of greenland halibut of the year-class hatched in 1990 according to the bottom trawl surveys of 2000 and 2003 in the Kamchatka-Kuril district

Recruitment dynamics



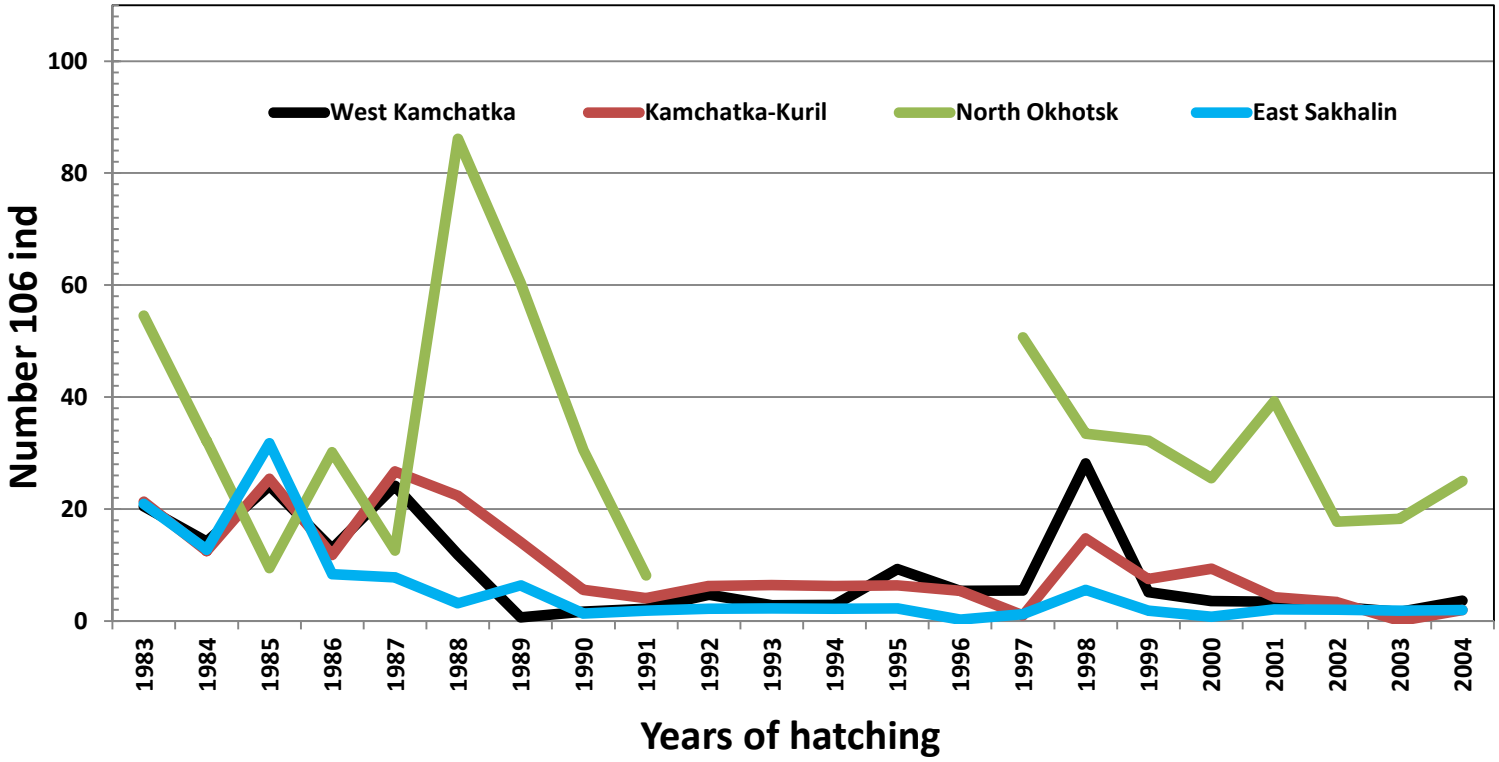
During the study period, the year-class strength of greenland halibut in the Okhotsk Sea has a tendency to decrease, and the decreasing is 40 % in two decades.

This tendency coincides with a prominent warming of the Okhotsk Sea waters in all layers and decreasing if its ice cover in winter, but mechanisms of these factors influence on the halibut reproduction are not investigated yet.



Recruitment dynamics

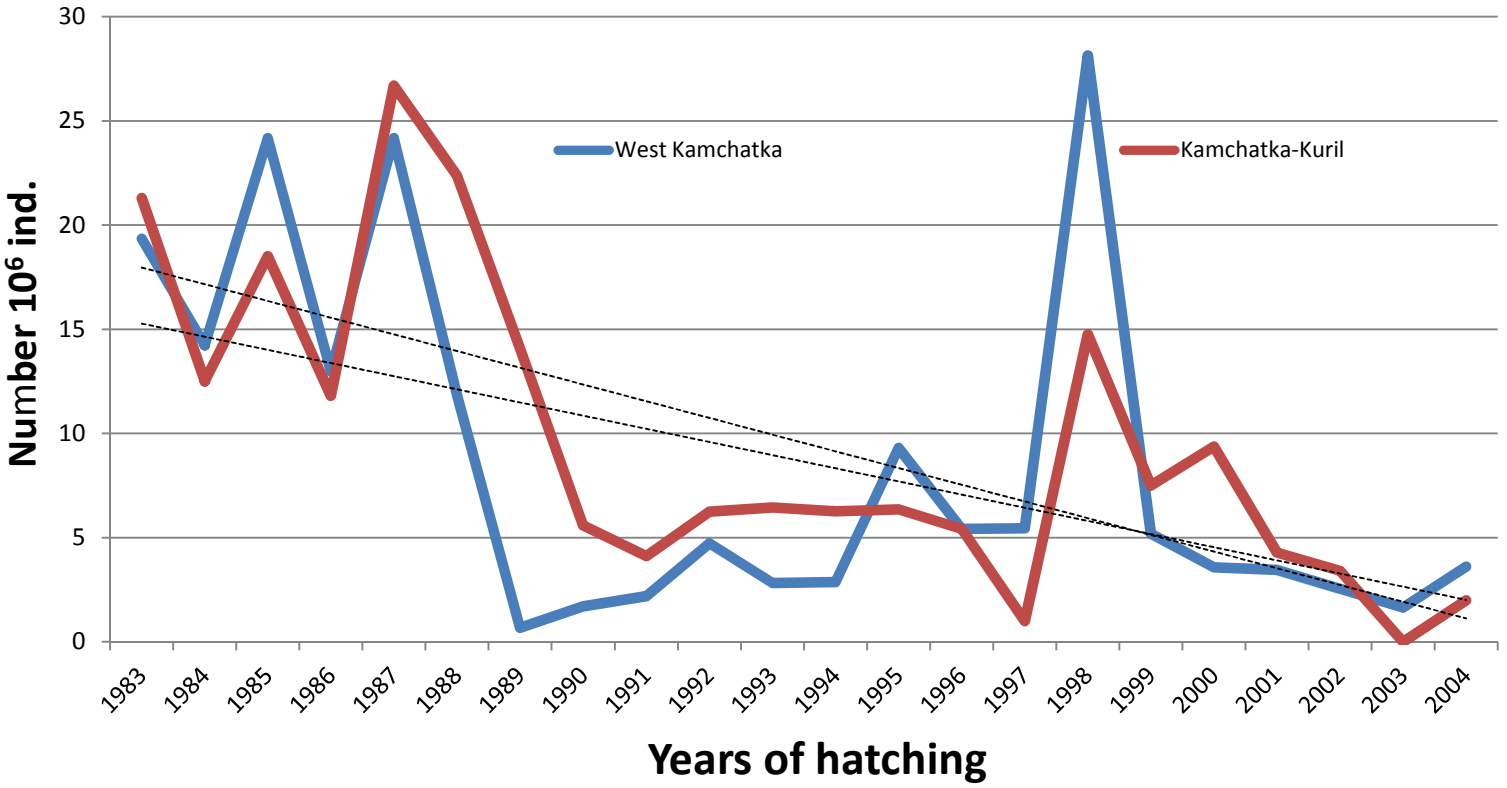
However, the year-class strength has different dynamics in 4 districts. The West-Kamchatka, Kamchatka-Kuril, and East-Sakhalin districts have approximately the same changes, with prominent negative trend of the year-class strength, but their strength in the North-Okhotsk districts is more stable.



Year-class strength in certain fishery districts

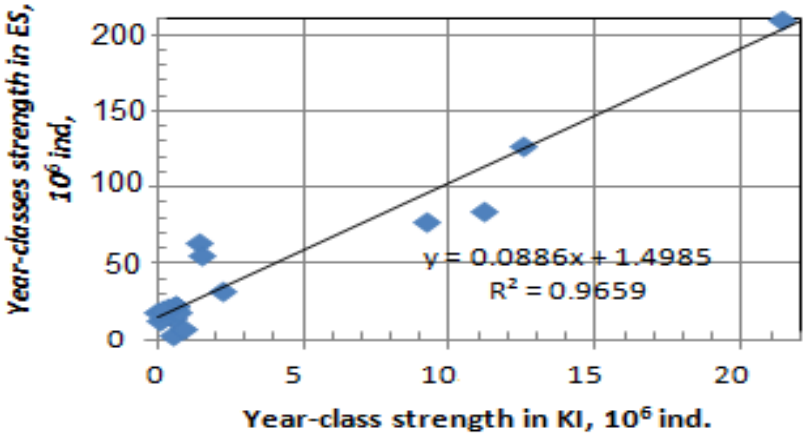
Recruitment dynamics

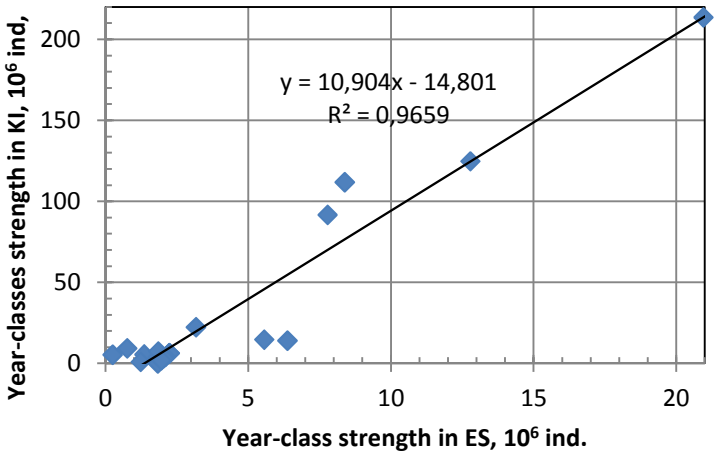
Changes in the year-class strength of greenland halibut in the West Kamchatka and Kamchatka-Kuril fishery districts are similar

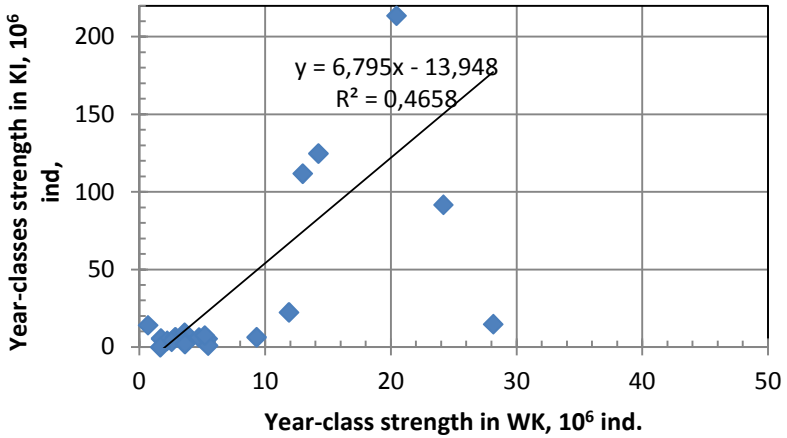


Year-class strength of greenland halibut in the West-Kamchatka and Kamchatka-Kuril fishery districts

Recruitment dynamics





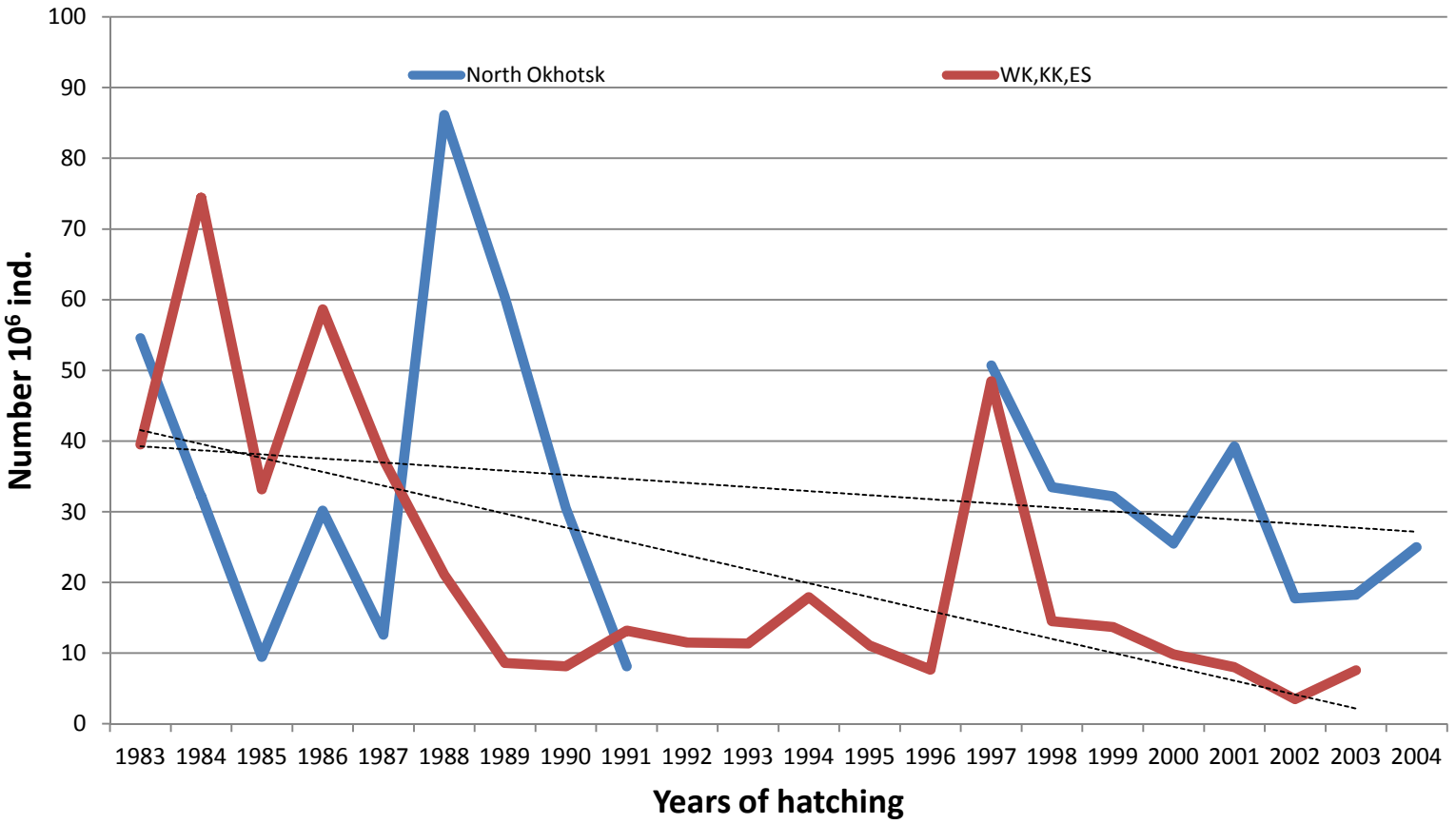


Year-class variations in the West-Kamchatka, *East Sakhalin, and Kamchatka-Kuril districts are very similar, but its variations in the North-Okhotsk districts are different*

Relationship between variations of year-class strength between districts

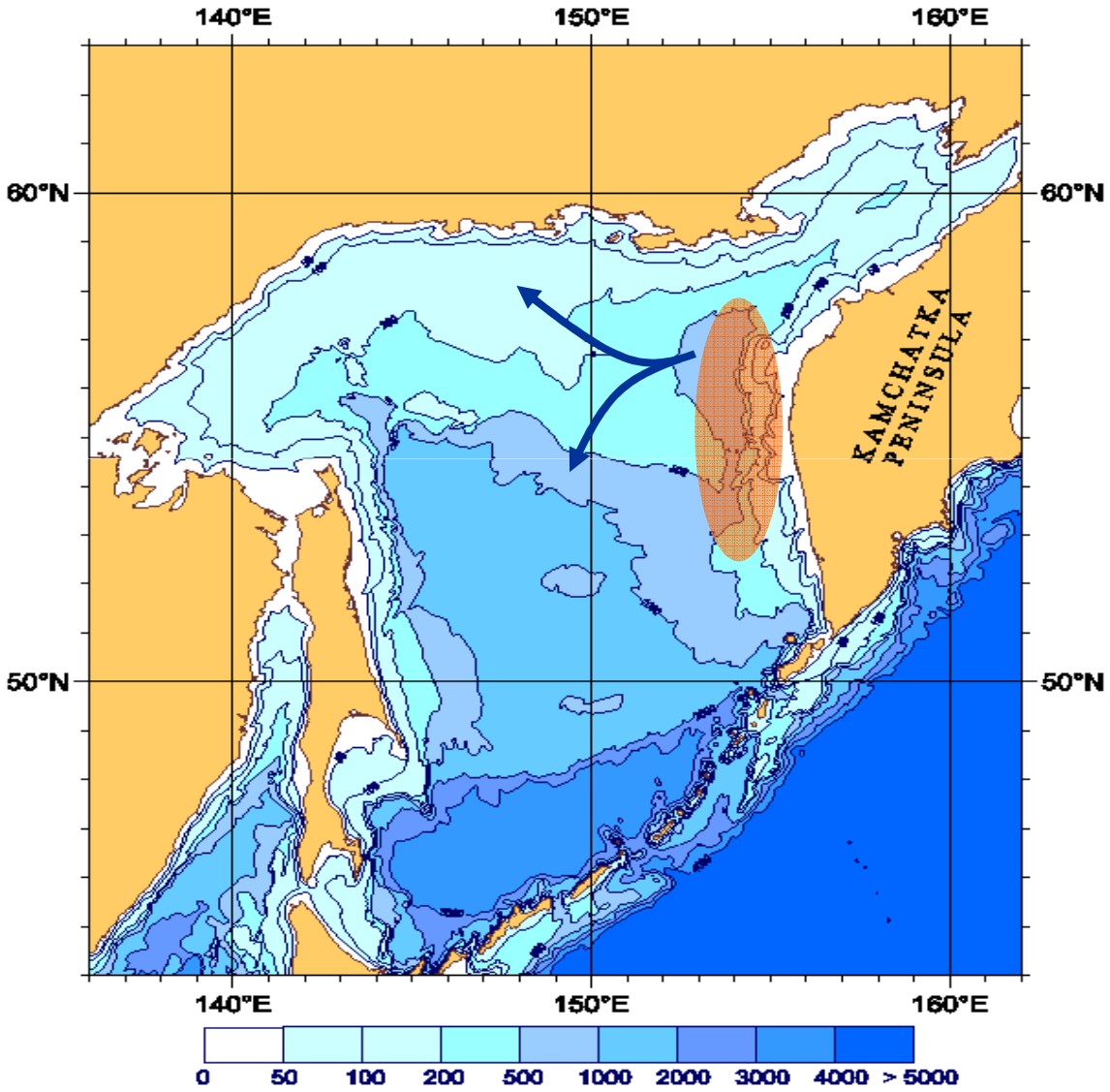
Recruitment dynamics

The decreasing in the North Okhotsk district is less significant (20 %).



Year-class strength of greenland halibut in the North-Okhotsk fishery districts and summary in other fishery districts

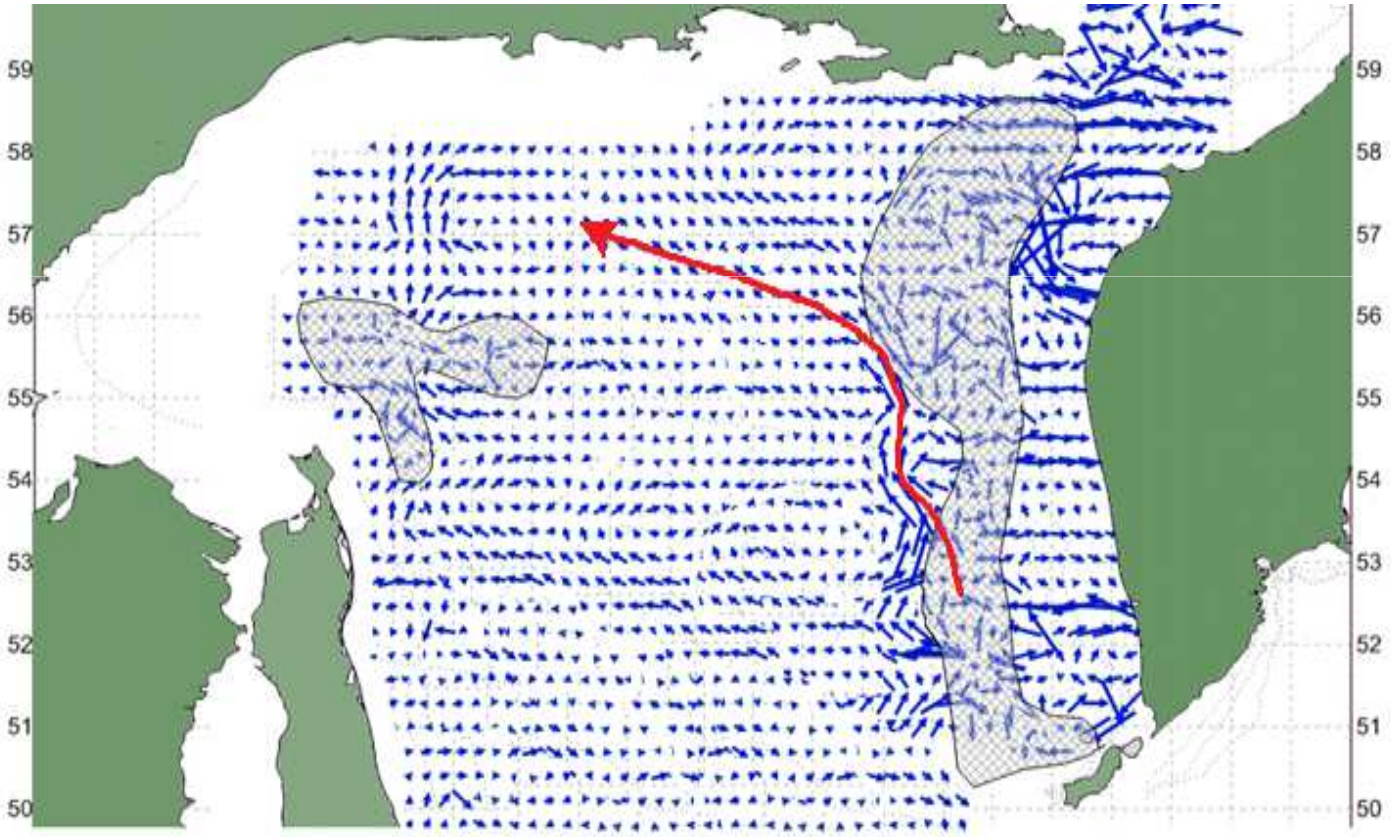
Eggs and larvae transport from the spawning grounds



The halibut stocks in all 4 districts of the Okhotsk Sea have the same source, because all of them are reproduced in one spawning ground that is located on the continental slope of West Kamchatka. From this spawning ground, the eggs and larvae of greenland halibut are distributed over the whole Sea, including the North-Okhotsk zone and East-Sakhalin zone, by surface currents.

Eggs and larvae transport from the spawning grounds

Geostrophic circulation in the Okhotsk Sea provided transportation of halibut eggs and larvae from the spawning grounds toward the North Okhotsk district in the late 1980s, tn the late 1990s , in 2001, 2004, and in 2014 and 2015.



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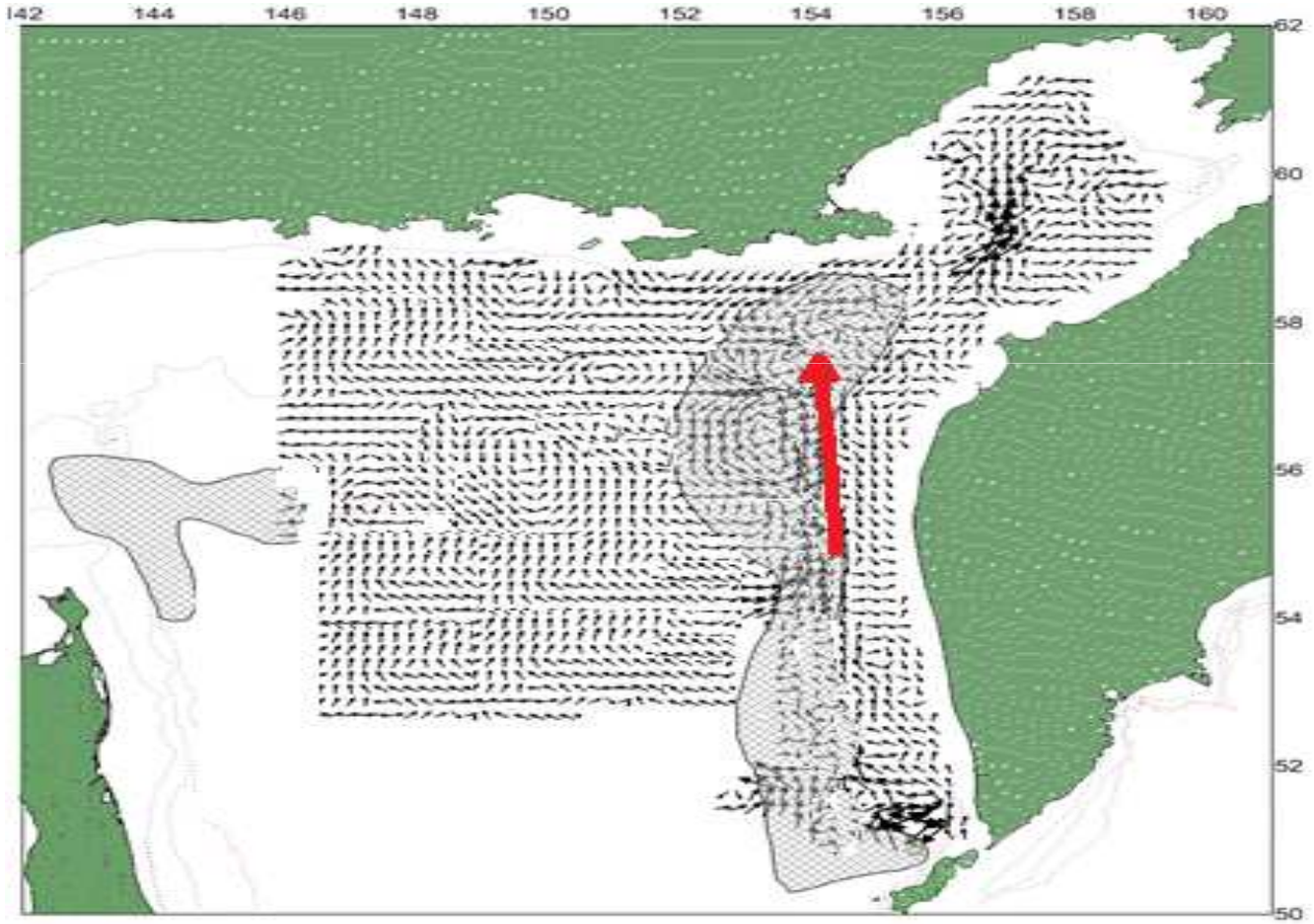
Averaged geostrophic currents in 1989, 1996, 2001, 2004, 2014, 2015.

Eggs and larvae transport from the spawning grounds

However, there is no obvious flow toward the North Okhotsk district in 1986, late 1998s, 2002, 2003, 2011, and 2012



Averaged geostrophic currents in 1986, 1999, 2002, 2011, 2012.

Conclusions

Abundance of greenland halibut in the Okhotsk Sea tends to decrease in all fishing areas. It had decreased in 40 % in the last two decades.

This trend coincides with a marked warming of the Okhotsk Sea waters and the ice cover decrease, but the mechanisms of these factor influence on the halibut reproduction are not investigated yet.

Redistribution of the halibut stock is noted due to changes in water circulation: when the flow is directed from the spawning area toward the North Okhotsk district – strong year-classes of halibut form there, and when there is no apparent northward flow – weak year-classes form in the North Okhotsk district

The water circulation in 2014 and 2015 promotes strong year-classes of greenland halibut in the North Okhotsk district in the middle 2020s.