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**Stock and fishing of chub mackerel (*Scomber japonicus*)
by Russian vessels in 2020**

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Mackerel comes to waters of Russia during the period of feeding migrations and concentrates in the South Kuril area from June to November. Due to stocks decrease of mackerel since the second half of the 1980s its commercial schools in the EEZ of Russia and the adjacent open waters of the Pacific Ocean have not been observed. Russia did not fish mackerel in the northwestern Pacific Ocean until 2015. Only 420 tons of mackerel were caught in 2015.

18 vessels were fishing for Pacific squid, sardine and mackerel in the South Kuril area in 2016. The average catch of mackerel per day for vessel (CPUE) was 22 tons for the fishing season. The catch of mackerel in Russian waters reached its peak in October and remained at a high level in the first half of November until the main concentrations of mackerel went into the waters of Japan by mid-November. The catch of mackerel by Russian vessels amounted to 9 thousand tons during the fishing season in 2016. Most of the fishing vessels that fished for mackerel were medium-tonnage equipped with pelagic trawls, a small part of them worked as twin trawls.

In 2017 season 26 vessels of different tonnages mostly with pelagic trawls (only 2 of them were equipped with purse seines) took part in the mackerel fishery. The fishery was conducted in the Russian EEZ from July to the first part of November to south and east of Shikotan Island.

The concentration of mackerel in Russian waters increased significantly in the fall compared to 2016. CPUE in September was at the level of 40-50 tons, in October - 70-80 tons, and in the first ten days of November it increased to 100 tons. In the first half of November vessels flying the Russian flag began to cross to the zone of Japan where they continued to fish. The efficiency of fishing in Japanese waters remained high until the first decade of December. The catch of mackerel in mid-December 2017 amounted to 52 thousand tons.

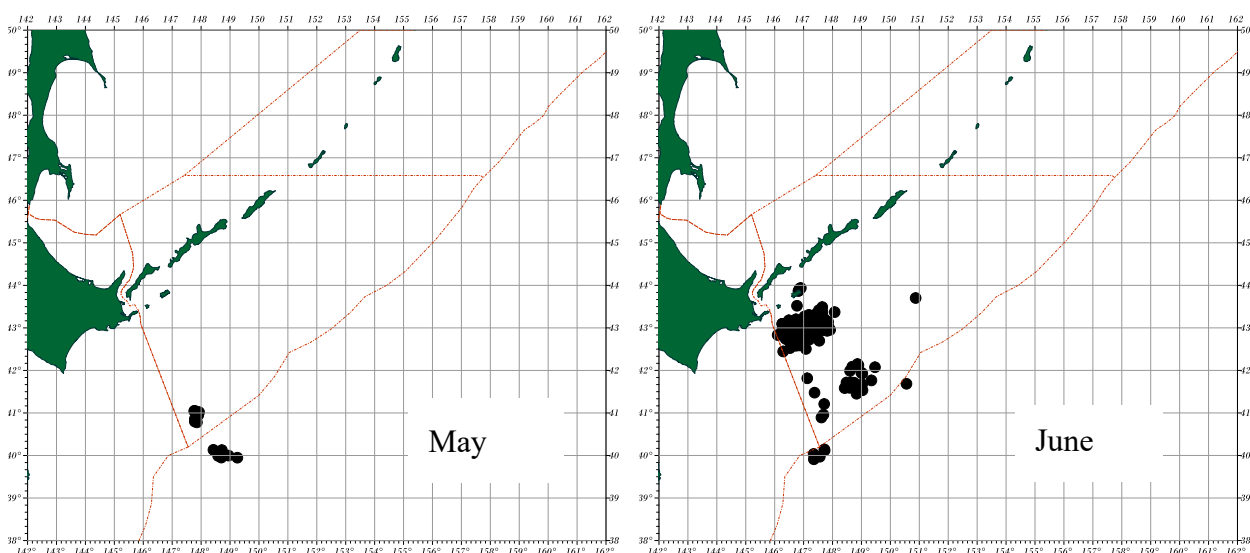
Schools of mackerel were found practically throughout the entire water area adjacent to the South Kuril Islands from the Pacific side, as well as near the middle Kuril Islands in 2018. Sardine and mackerel remained in the Russian EEZ for much longer due to the slower cooling of surface waters. The number of fishing days in the fishing season in 2018 was in 2 times higher than in the previous fishing season due to the larger number of vessels and a longer fishing period. The number of fishing days reached a maximum in November.

The transfer of fishing vessels flying the Russian flag to the Japanese zone for fishing pelagic fish according to quotas under intergovernmental agreements began in 2 weeks later than in 2017 - in

the second decade of November. This is mainly due to the significantly slow cooling rates of surface waters and the higher concentration of mackerel in Russian waters. The total catch of mackerel by vessels flying the Russian flag at the end of December 2018 amounted to 98 thousand tons.

Fishing for mackerel in 2019 by vessels flying the Russian flag began at the end of May outside the EEZ. However, in mid-June mackerel was fished in the economic zone of Russia to south of Shikotan Island. As the surface waters warmed up the fishing areas shifted to north in July. In August and September, the mackerel fishery was carried out in the zone of interaction between the Kuril Current and the warm waters of the Kuroshio off Iturup Island. In October with the autumn cooling of surface waters schools of mackerel began to move to southern areas off Kunashir and Shikotan Islands. Some of the fishing vessels moved to the Japanese EEZ to fish for mackerel according to exchange quotas under intergovernmental agreements between Russia and Japan in mid-November. The remaining vessels continued fishing within the Russian EEZ to south of Shikotan island. Russian-flagged vessels in December fished for mackerel within the Japanese EEZ off Hokkaido and northern Honshu Islands.

The situation in the Russian mackerel fishery was similar to the previous year in 2020. Fishing for mackerel began in May in open waters, in June fishing was carried out in the area off Shikotan island. In July, August and September as the surface water warmed up the mackerel schools shifted to northern and spread widely over the area of the Southern Kuril region. In October mackerel schools were found both in the southwestern regions and in the east, during this period migrations of mackerel begin to south as the ocean surface cools. In November, the main part of mackerel stocks are concentrated in the south along the Japanese EEZ border. In December, most part of the feeding mackerel goes to the economic zone of Japan (Fig. 1).



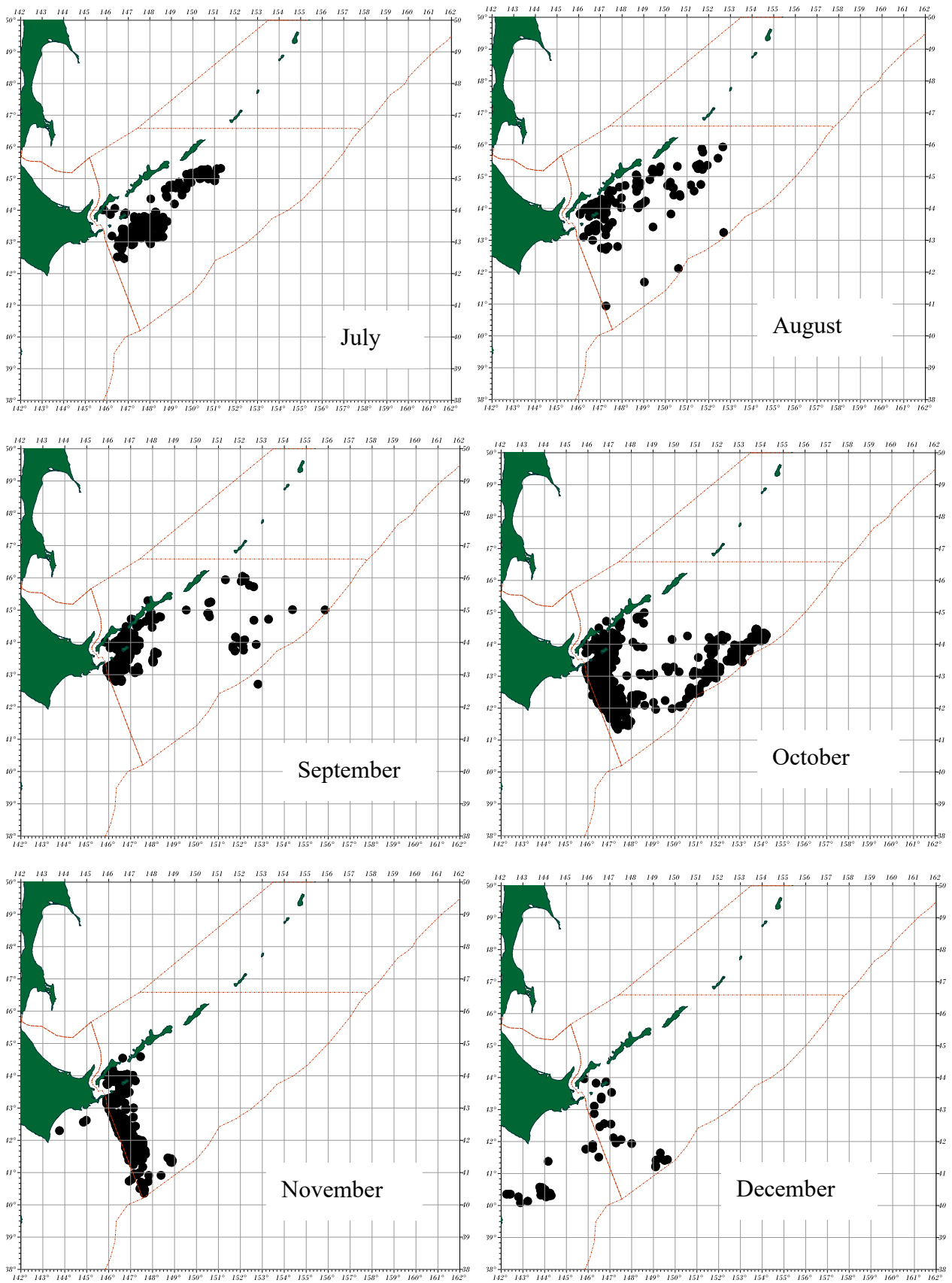


Figure 1 - Distribution of fishing grounds of Russian vessels fishing for chub mackerel in the northwestern Pacific Ocean monthly in 2020.

The number of fishing days during sardine and mackerel fishery season in the waters near the Kuril Islands has increased more than 5 times over the past 5 years (Fig. 2). This is primarily due to 2 factors - the increase in the number of fishing vessels and the lengthening of the fishing period. If in 2017 a large-scale fishery for sardine and mackerel began in mid-July and in the second half of November all vessels moved to the zone of Japan. In 2019 and 2020, sardine and mackerel fishery continued in Russian waters from the begin of June to the mid of December. The maximum number of large- and medium-tonnage fishing vessels in recent years - 76 units was put up for fishing pelagic species in 2020. However, the maximum number of vessels fishing for sardine and mackerel was 40 in the 1st decade of October.

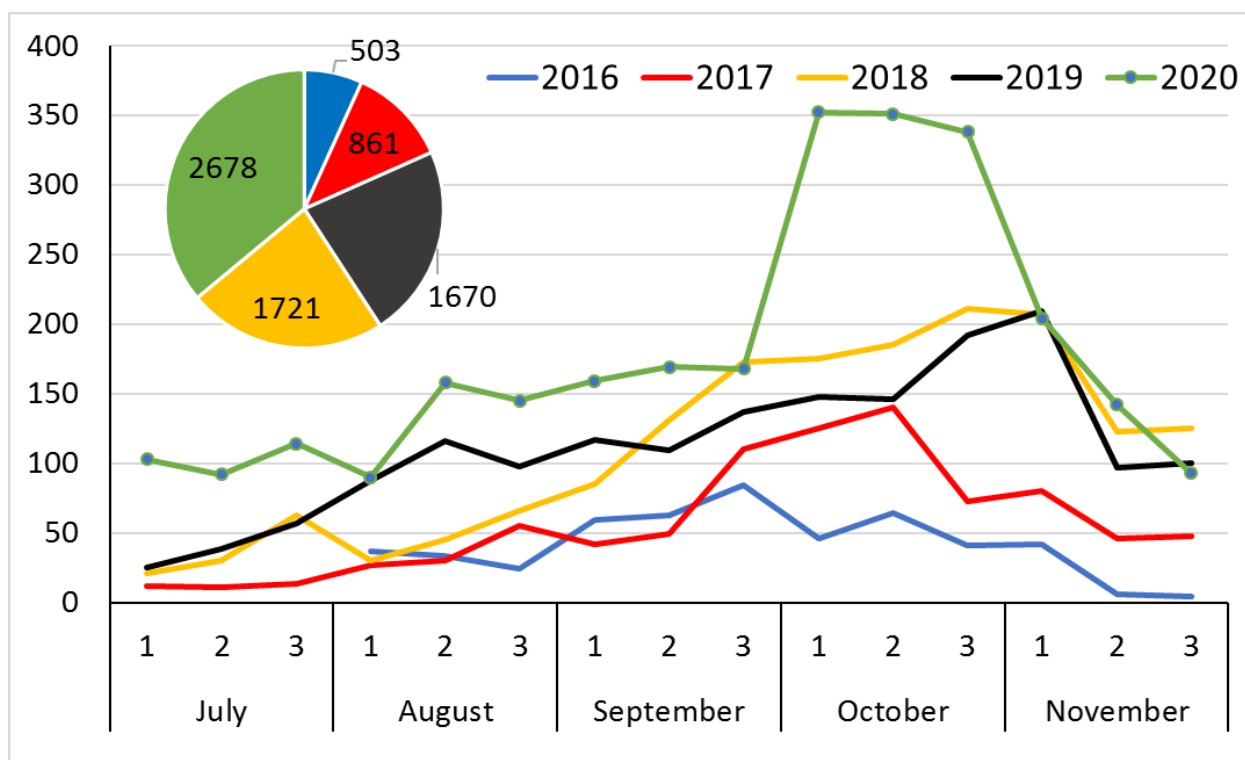


Figure 2 - The number of fishing days by decades during fishing seasons 2016-2020

A feature of the mackerel fishery in 2020, as in 2019, was that low catches persisted until the 2nd decade of October, and the maximum CPUE fell on the 3rd decade of November (Fig. 3). Over the fishing periods average CPUE was the highest in 2018 - 39.1 tones, in 2017 - 38.1 tones, in 2019 - 24.6 tones, and in 2020 - 11.9 tones. The low catch rate in 2020 is due to the peculiarities of the distribution of mackerel in summer and in the fall. The main stock of mackerel in 2020 was formed mainly by the harvest generation of 2018 and 2019, which have just begun to enter the commercial stock. The most part of mackerel stock fed in the east outside the Russian EEZ. Commercial concentrations of mackerel began to be observed in the fishing areas in the South Kuril region only in the second half of autumn. For the same reason, the total catch of mackerel increased markedly only in the 2nd decade of October (Fig. 4).

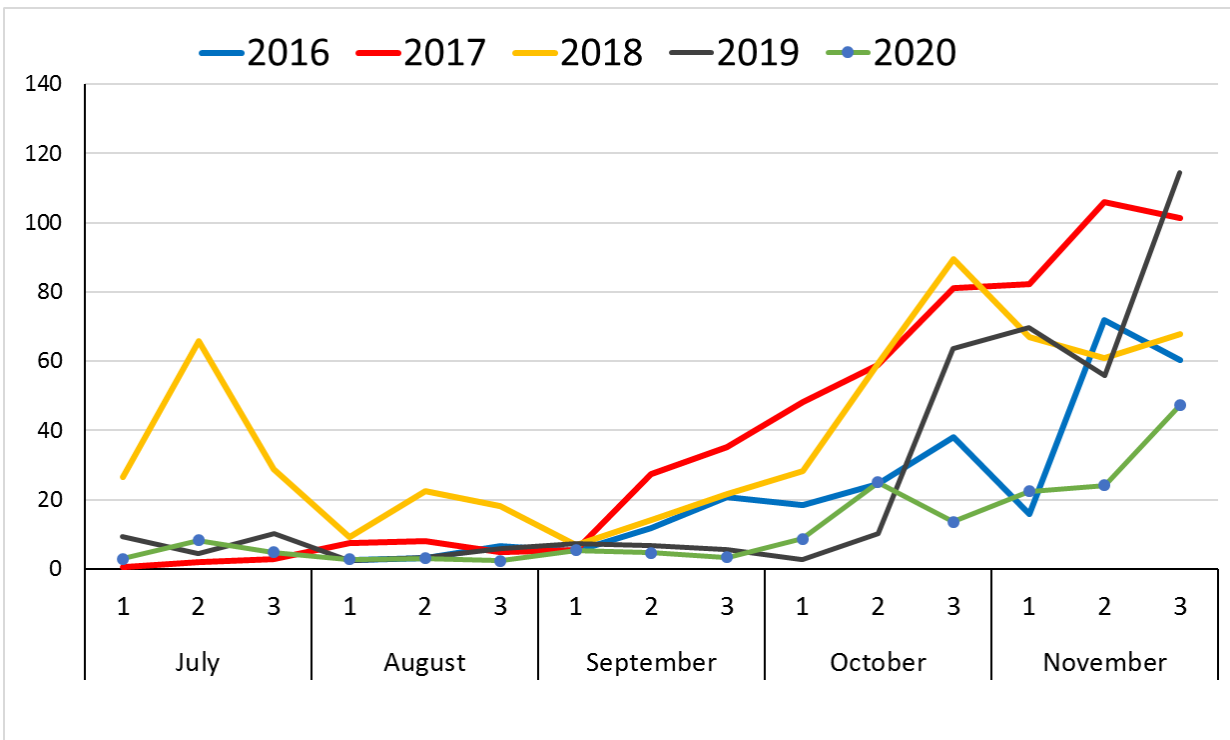


Figure 3 – CPUE of mackerel in fishing season 2016-2020 by decades, tons

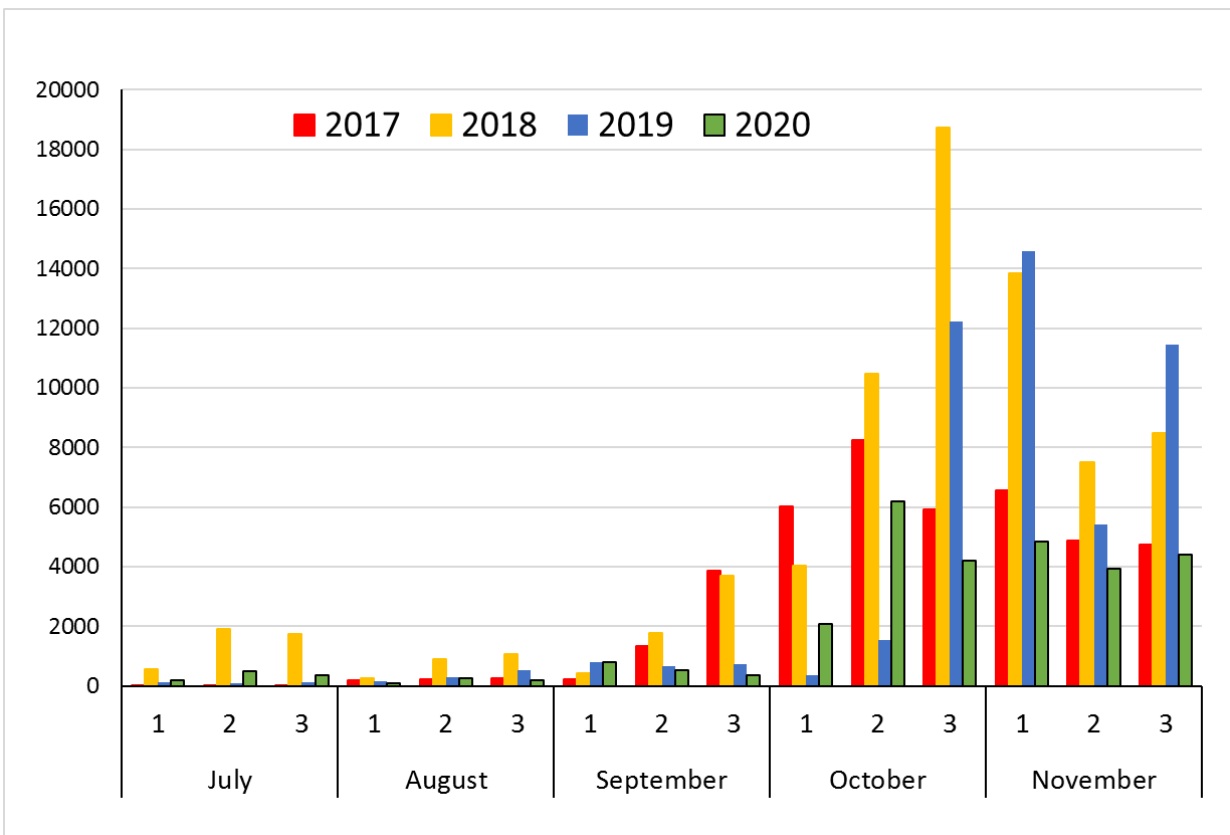


Figure 4 - catch of mackerel by decades in the fishing season 2017-2020

The catch of mackerel by Russian vessels reached a maximum in 2018 - 99 thousand tons, in 2020

they managed to catch 78 thousand tons (Fig. 5).

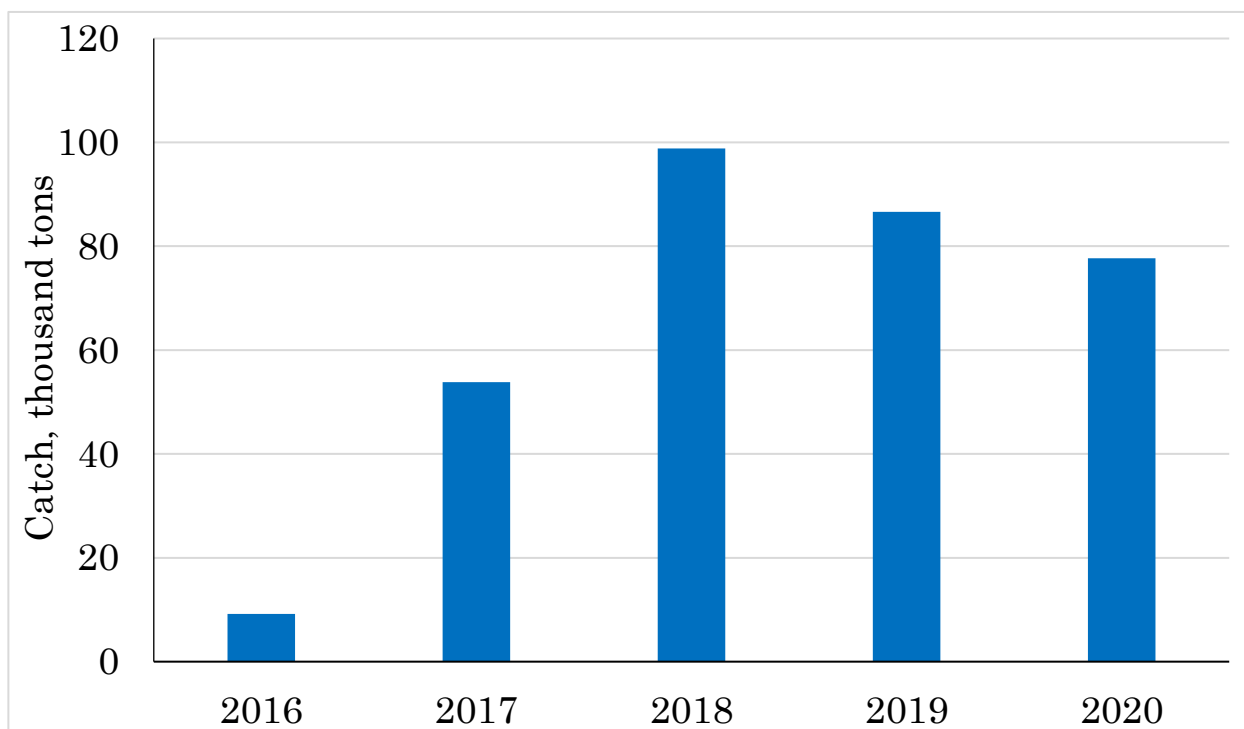


Figure 5 - catch of mackerel during the fishing periods 2016-2020

Survey trawl survey was carried out in the upper epipelagic zone of the South Kuril region which covered the water area within the Russian EEZ in August and early September 2020. Feeding mackerel was found practically throughout the entire South Kuril region with the exception of the Oisyashio stream off shore the Kuril Islands during the period of maximum warming of surface waters (Fig. 6). The maximum catches were noted in the northeast part of the area in the frontal zones of the Northern Subarctic Front where high-density concentration of zooplankton is noted. In the structure of pelagic communities of the Kuril waters in terms of recorded biomass, the first place was occupied by two species of subtropical-temperate boreal fauna - sardine and chub mackerel with an estimate of 2.023 million tons (48%) and 1.654 million tons (39%), respectively, or in the sum of two species - 87.2% of the biomass of all species of fish and squids (Fig. 7, 8),

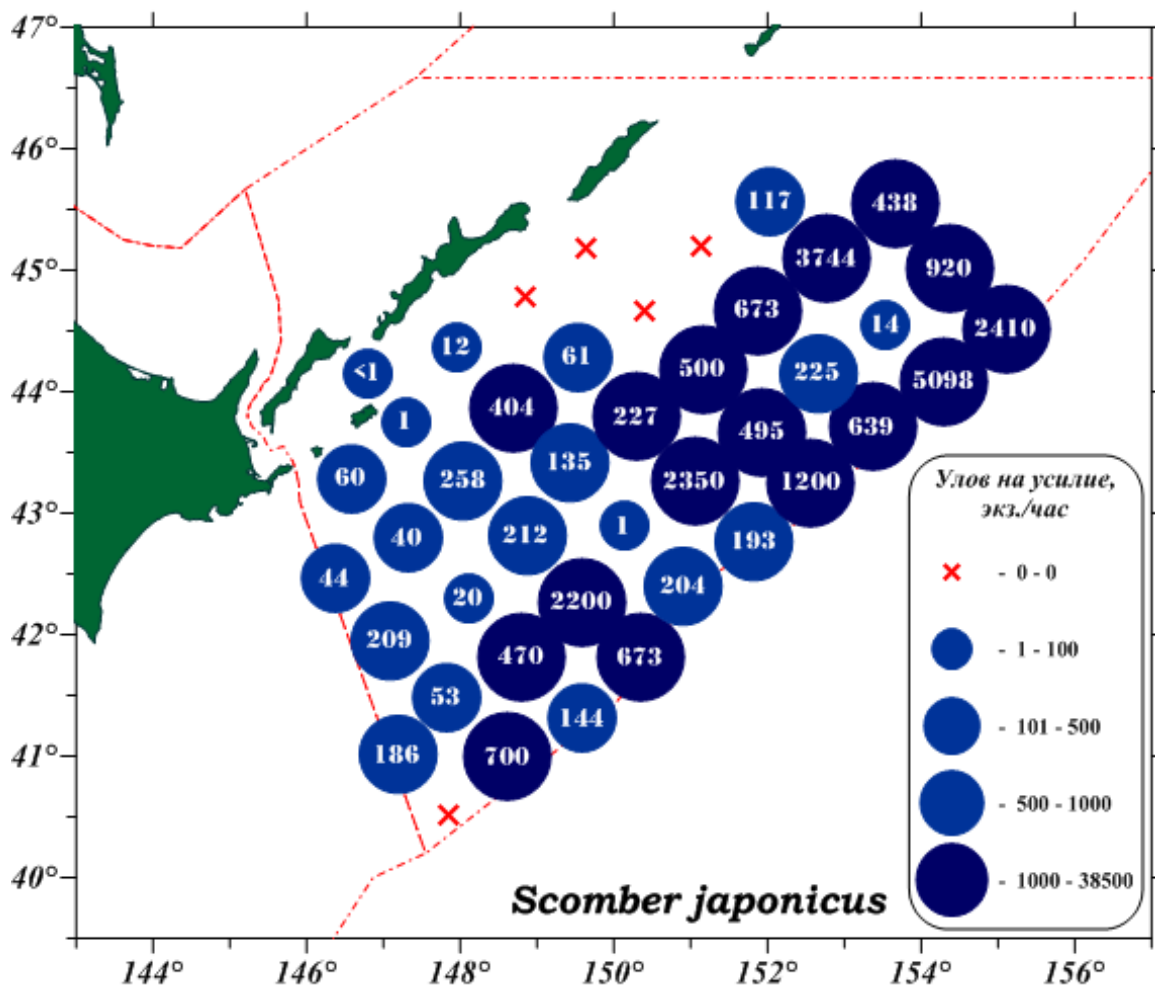


Figure 6 - Distribution of catches of chub mackerel (specimens per trawling hour) in the Kuril waters in August 2020 based on the results of a pelagic trawl survey. In the center of the circles - the catch in kg per hour of trawling.

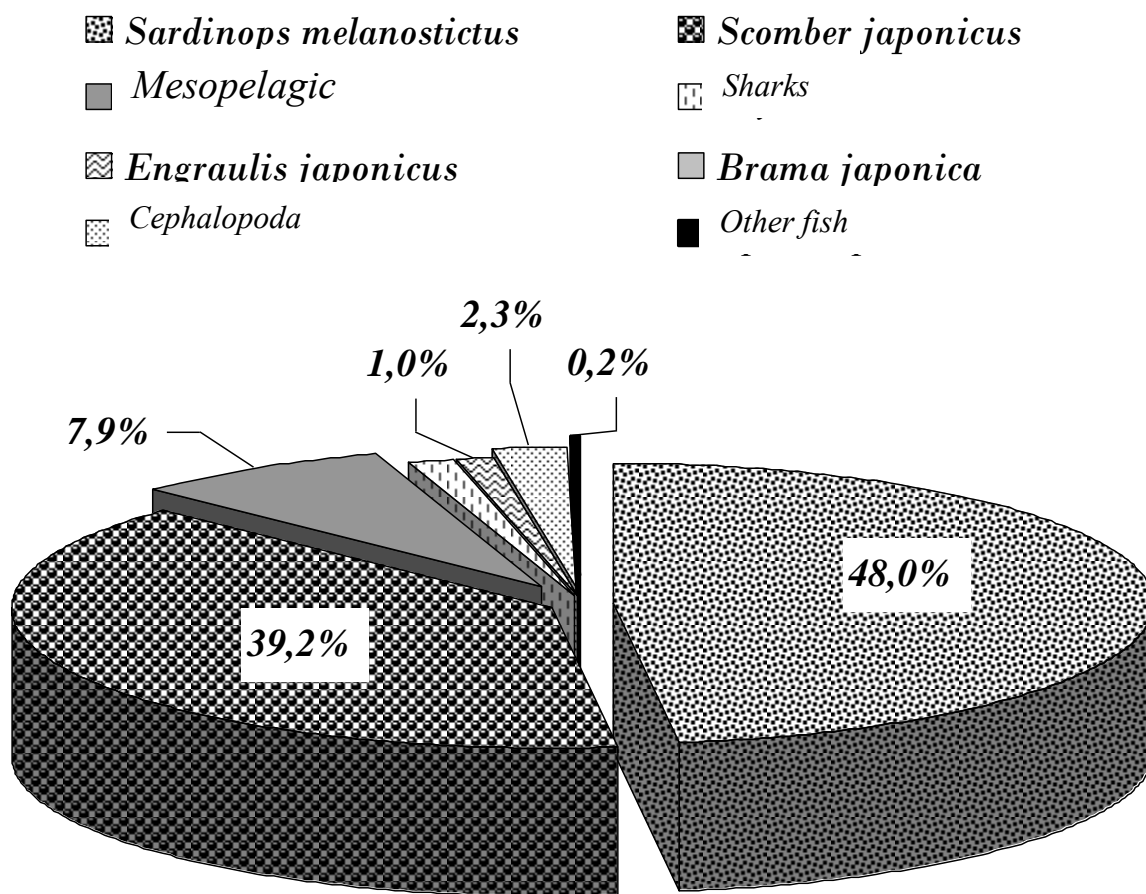


Figure 7 - Composition of nekton (fraction of biomass) in the upper epi-pelagic of the South Kuril region in August 2020

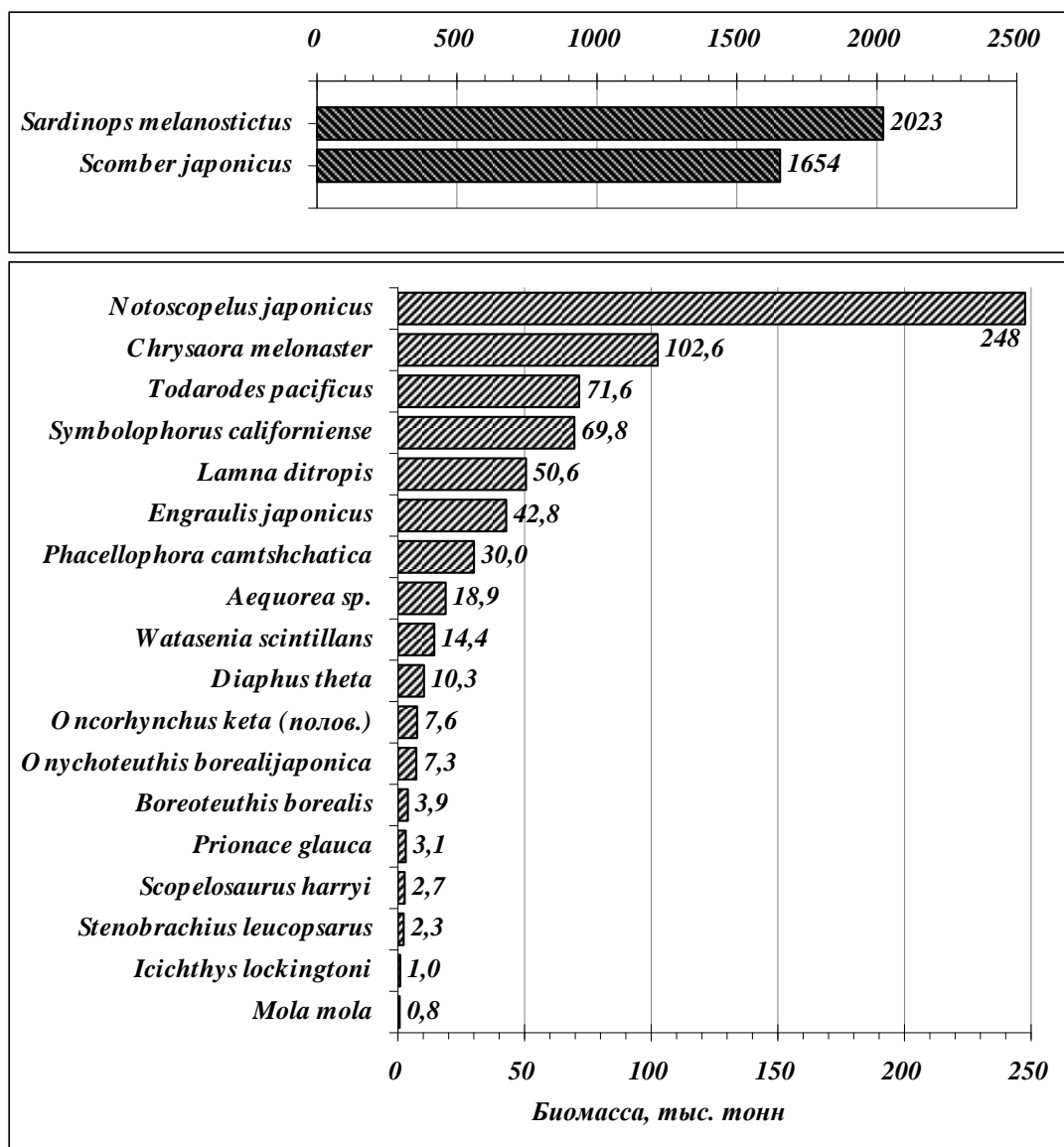


Figure 8 - Distribution of mass species of nekton by estimated biomass (thousand tons) in August 2020. The series is divided into two panels with a scale ratio of 1:10