body length among nearby age groups is similar (Fig. 58). For the period 1980-1997, the condition factor is related to linear growth of fish (Fig. 59). For the east Kamchatka stock, changes in growth of 5-6-year-old walleye pollock are inversely related to the total biomass of species (Fig. 60). For the periods of high and intermediate stocks the growth rate of the east Kamchatka walleye pollock depends inversely on cohort abundance (Fig. 61).

Effect of population abundance increase on herring distribution in the western Bering Sea

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The last two decades have been important for the development of the Korf-Karaginsky Pacific herring population. After a long period of low abundance in the 1980s, the population has been growing dynamically since 1990, reaching a maximum in 1997, and then started to decline again (Fig. 62).

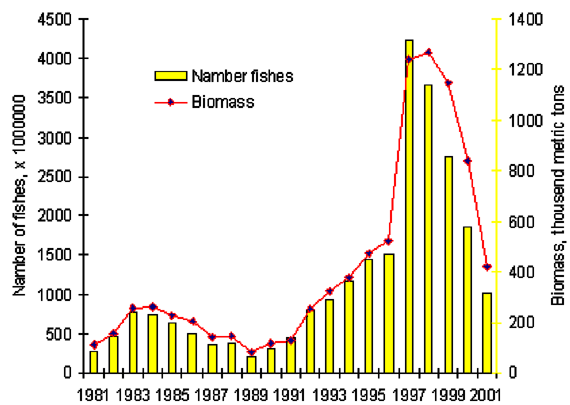

Fig. 62 The stock abundance dynamics of the Korf-Karaginsky herring in the western Bering Sea.

The annual distribution and migratory behavior of the Pacific herring during are determined by hydrology and the stock abundance fluctuations. The time period and the distance of the Pacific herring feeding migration are now significantly different from those when stock abundance was low.

During periods of low abundance, the feeding migration of the mature part of the stock occurred in Anastasiya and Dezhneva bays (Fig. 63A). Herring returned to Olytorsky Bay for winter before October 10th. This period was characterized by relatively stable conditions providing sufficient feeding for the Korf-Karaginsky herring. From the 1980s until the mid-1990s positive changes were observed in the Bering Sea. These included: 1) warming of the upper 200 m which resulted in an increase of the forage zooplankton abundance, and 2) decrease in the stock abundance of walleye pollock, the nearest competitor of herring for food. Thus during the 1980s and early 1990s, when the herring abundance was low, the feeding conditions for the Pacific herring became favorable. In 1993, conditions were optimal for the production of an abundant generation (Fig. 64). In 1997, the

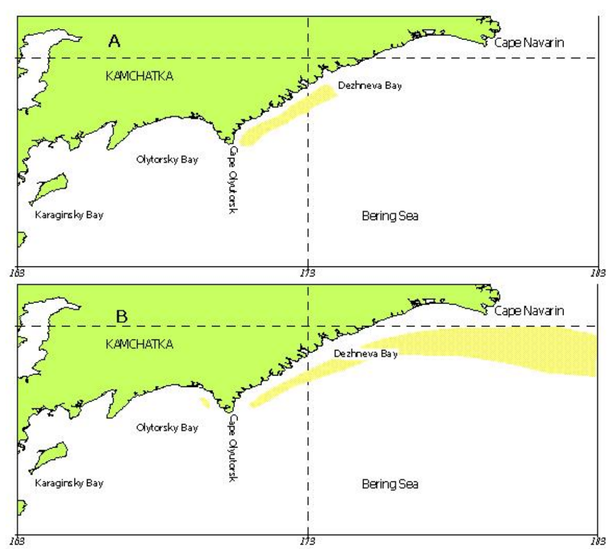

Fig. 63 The Korf-Kagarinsky herring distribution during the feeding migration: (A) low stock abundance and (B) high abundance.

4+ generation was the only one that recruited to the commercial fishery; in the last 40 years, it had the highest abundance and biomass, $4,230x10^6$ fishes or $1,240x10^3$ tons, respectively (Fig. 62).

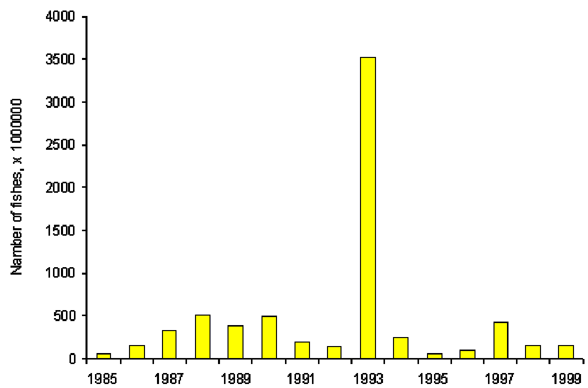

Fig. 64 Year-class abundance of age 4+ generations of the Korf-Kagarinsky herring in the western Bering Sea by brood year.

The increase in abundance of the fishery-size individuals in the Korf-Karaginsky herring population took place simultaneously with water cooling in the region. The indicators of that were: (1) a general decrease in the mixed water layer thermal capacity, and (2) extension of the ice cover in the Bering Sea since 1998. Cold water masses dominated on the shelf, providing poor conditions for the forage base. High abundance of the Korf-Karaginsky herring and poor food supply caused intensification of intra-specific competition for food. Unable to completely fulfil their food requirements, herring had to enlarge the area of feeding.

In 1998-2000, herring used marine bathypelagial in the Olytorsky-Navarinsky zone instead of the shelf zone for feeding until mid-October. In August and September, the echosounder tracks of herring shoals were discovered at the depth of 340-400 m. At the same time, local shoals of feeding herring were found in the eastern part of Olytorsky Bay (Fig. 63B). From the second half of October, fish shoals were distributed at depths of 80-150 m, on both sides of Olytorsky Cape (Fig. 65), however, these shoals were not stable. Herring migrated actively westward in small shoals, along the edge of the warmer and more saline Pacific waters, where trophic activity was high. During the daytime fish were distributed near the bottom, and at night they created thick shoals in the water column.

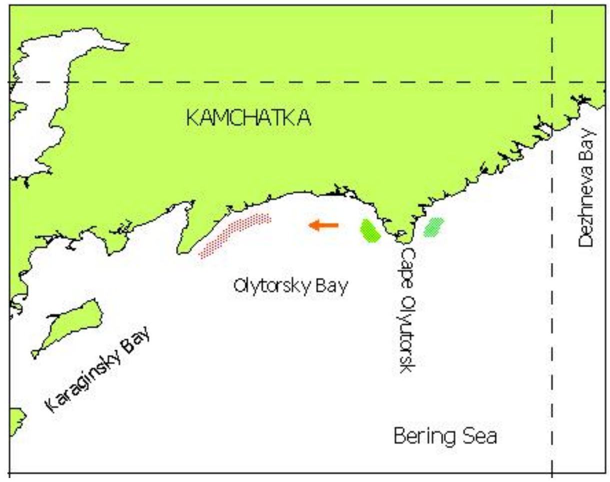

Fig. 65 Distribution of the Korf-Kagarinsky herring in the western Bering Sea, in October-November.

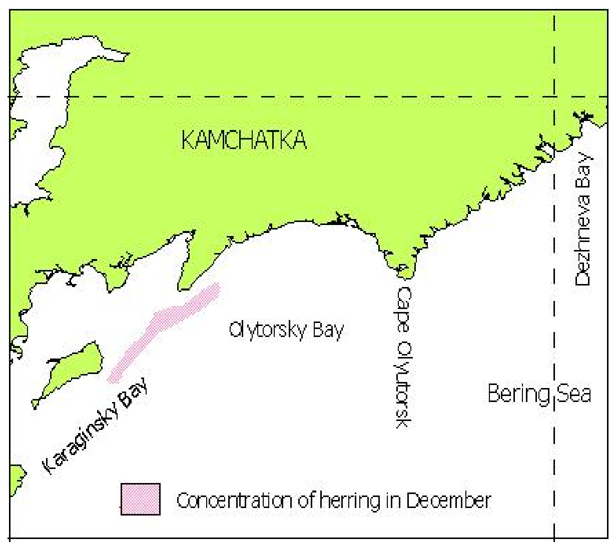

Fig. 66 The area of wintering of the the Korf-Kagarinsky herring in the western Bering Sea.

The transformation from summer to winter conditions in Olyorsky Bay has been normally completed in November. This transformation results in the quick cooling of the offshore waters. In 1998-2000, stable, favorable temperature conditions in November occurred at depths of 150-200 m, in the central and western parts of the bay. Therefore, the herring stocks formed at these depths. Their behavior at that time was similar to their behavior in October. Following the arrival of cold water, herring migrated westward, forming non-mobile stocks at the depth of 180-250 m between the Cape of Goven and the Cape of Golenischev in December (Fig. 66).

Since 1993, there has been no single abundant cohort produced by the population. Due to natural mortality, and fishing, the stock abundance of the Korf-Karaginsky herring has decreased. Moreover, at the present time, hydrological conditions can hardly provide the required biomass of forage zooplankton. This should prolong the feeding period until mid October and expand the feeding area.

Survival of yellowfin sole (*Limanda aspera* Pallas) in the northern part of the Tatar Strait (Sea of Japan) during the second half of the 20th century

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The northern part of the Tatar Strait is one of the traditional areas where yellowfin sole (*Limanda aspera* Pallas) dominate, averaging 60% of flounder abundance. The commercial fishery of flounder stocks began in 1943. In 1944, their catch reached the historical maximum – 10.1 thousand tons, but during the following year it reduced up to 7.4 thousand tons, and a catch per unit of effort (CPUE) decreased almost 2 times. Since 1945, the fishery ceased and until the beginning of the 1950s, the flounder catch did not exceed 0.1 – 1.0 thousand tons a year. Regular scientific research on this species was not conducted until 1956. Nevertheless, the data collected on the size composition of flounder catches during 1946, and some similar data since 1956, indicated overfishing in the mid-1940s (Tarasyuk, 1994A). After the 1950s, catch varied from 5.45 thousand tons in 1955 to 0.35 thousand tons in 1979. In the last ten years of the century, the catch constituted 0.4 – 2.0 thousand tons per year.

Age structure of the yellowfin sole population is characterized by an extended age distribution. Fish at age 4 to 18 occur in catches. Age-7 yellowfin sole are usually a modal age group, as their average long-term age value is 8.8. Body weights of yellowfin sole change according to the equation of allometric growth. A coefficient of allometry exponent in the equation is 3.1315, and the scale coefficient is 0.0073 when body weight is measured in grams and length (AC) in cm. Yellowfin sole from the shelf zone of western Sakhalin cease annual increments at age 8-9+. The instantaneous natural mortality rates vary by age decreasing from 0.22 to 0.12 beginning in age-4 to age-6-8 individuals, respectively, and then gradually increasing to 0.60 at age 15. The broods become fully available to the fishery beginning at age 8.

Methods

Data on the age structure of catches, annual catches, catch per unit of effort, natural mortality by age, rate of maturation, and average body weight by age during the period of 1956-2000 were processed using a method of virtual populations (VPA), with the help of program developed at the Fishery Laboratory Lowestoft (Darby and Flatman 1994). The Louric-Shepherd method was used for adjusting fishing mortality coefficients (Pope and Shepherd 1985).

Further processing of VPA results was done to reveal the causes determining brood year abundances. The abundance estimates of broods at age 4 were used as the index of recruitment. A cohort survival rate at age 4 was estimated as a quotient between the number of age 4 fish obtained from the VPA method, and the number at age 0. The spawning stock was calculated as the total number of the age groups taking into account the rate of maturation, less a year catch, since the fishery in this region is the most intensive before