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Long-term fluctuation of the catch of Pacific herring in Northern Japan

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Several spawning grounds of Pacific herring have been observed in the waters of Northern Japan. These spawners are genetically isolated from each other and these populations are classified into the following four types: (I): lagoon-small migration type, (II): oceanic-wide migration type, (III): oceanic-small migration type and (IV): intermediate type between I and II. The Hokkaido-Sakhalin population is one of the oceanic-wide migration type (II) and Mangoku-ura population belongs to type III (Kobayashi, 1993).

Hokkaido-Sakhalin population

Catch and catch at age data for the Hokkaido-Sakhalin population are available since 1878. The annual catch was over 400,000 t from the late 19th century to early in the 20th century, with a historical peak of 970,000 t in 1897 (Fig. 1). However, the population has steadily declined thereafter with continual fluctuation, accompanied with the disappearance of spawning grounds from south to north in the west coast of Hokkaido. In 1955 the spawning ground completely disappeared from the coast of Hokkaido.

Studies of year-class strength, spawner-recruit relationship and observations of oceanographic events led to a hypothesis that the factors controlling the year-class abundance of Hokkaido-Sakhalin population relate to the variations in the spring-summer oceanographic environmental condition. This hypothesis has been tested by examining the data incorporated into a spawner-recruit pattern, for example, sea water temperature and food organism, obtained from spawning-nursery ground. Oceanographic data for the west coast of Hokkaido area is limited, with data from some locations available. Water temperature data for the west coast of

Hokkaido (Fig. 2) were obtained form Kamui, Yoichi, Takashima and Wakkanai and those data were analysed to examine the relationship between year-class strength and sea-water temperature.

As with sea surface temperature there is a large interannual variation. The annual mean seawater temperatures recorded at Takashima showed that an apparent rise in five year running mean after 1910. This tendency was generally seen in all locations off the west coast of Hokkaido. The northerly shift of the spawning area of this population was much accelerated after 1910, though there still remained large extensions of the spawning grounds on the west coast, sufficient to yield a large catch as whole. The records of seawater temperature at Kutsugata rose about 1932 and the amount of catch in Hokkaido and South Sakhalin greatly declined after 1935. There was a remarkable decline in sea surface temperature from 1939-1945 and the temperature rose again after 1946. The catch of herring was maintained to some extent up to 1953, but it declined greatly after 1955. Drastic changes in the marine environment which occurred in about 1955 would have accelerated the decrease in stock size and at the same time caused the changes in biology of the herring (Motoda and Hirano, 1963).

In 1985, there was a sudden appearance of two year old herring (Fig. 3) on the west coast of Hokkaido (1983 year-class). It is assumed that the spawning stock in 1983 was very small so that no information on spawning was obtained from the fishermen in 1983. In 1987 and 1988 eggs spawned on the sea grasses were observed. Thereafter a 1988 year-class also appeared on the west coast but the size of the 1988 year-class was smaller than the 1983 year-class. The decline of the seawater temperature was observed at Wakkanai in spring and early summer season in 1983. The recover of spawning by 1983 year-class of Hokkaido-Sakhalin population was the event after thirty-three years' absence. Interestingly, strong recruitment of the 1983 year-class also appeared in George's Bank herring and Norwegian spring herring. Were these events the result of a coincidental conjunction or a teleconnection? Unfortunately in recent years spawning of Hokkaido-Sakhalin population has not been observed along the coast of Hokkaido.

Mangoku-ura population

Only catch records from recent years are available for Mangoku-ura herring. The catch gradually increased from 1975 and reached >500 t in 1984, declining thereafter to <20 t by 1996. Strong year-classes have appeared every three years since 1975. A significant relationship between the abundance of age 1 fish and the total number of eggs spawned by adult fish was not detected. However it was reported that high survival rates were observed only when the sea temperature near the spawning ground (while herring were in the larval to juvenile stages) was <6°C (Fig. 4. Kodama, 1997).

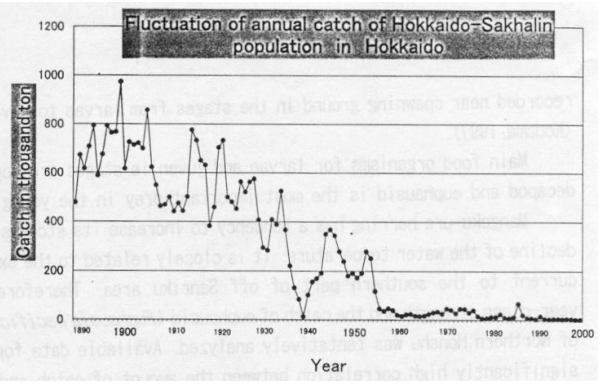

Fig. 1 Hokkaido-Sakhalin herring catch in Hokkaido.

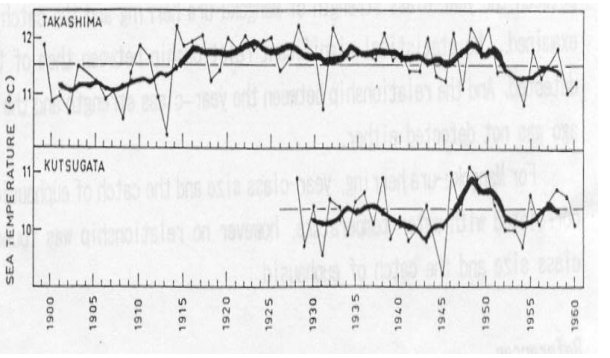

Fig. 2 Secular trends in annual sea temperature and the 5-year sliding means at Takashima and Kutsugata (Yamazaki, 1960).

The diet for larvae and juvenile stages is made up of copepods while the larvae of decapods and euphausiids are the most important prey in the young and adult stages.

The stock size of Mangoku-ura herring tends to increase with the decline of the water temperature (Fig. 5). It is closely related to the extension of Oyashio Cold Current to the southern part of off Sanriku area. Therefore, the relationship between year-class strength and the catch of euphausid (*Euphausia pacificus*) in the Pacific coast of northern Honshu was tentatively analysed. Available data for 1970 to 1977 showed a significantly high correlation between the amount of catch and the extension of cold waters, (<5°C at 100 m) in the area off northeastern Honshu during February through May (Odate, 1979). The abundance of euphausid may affect the survival of juveniles and young herring and the nutritional condition of adult herring. The relationship between the year-class strength of Mangoku-ura herring and the catch of euphausiids was examined and no statistically significant relationship was detected for observations taken during the same year. There was also no significant relationship between year-class strength and the catch of age one herring. For Mangoku-ura herring, year-class size and the catch of euphausiids was positively correlated with water temperature, however no relationship was found between year-class size and the catch of euphausiids.

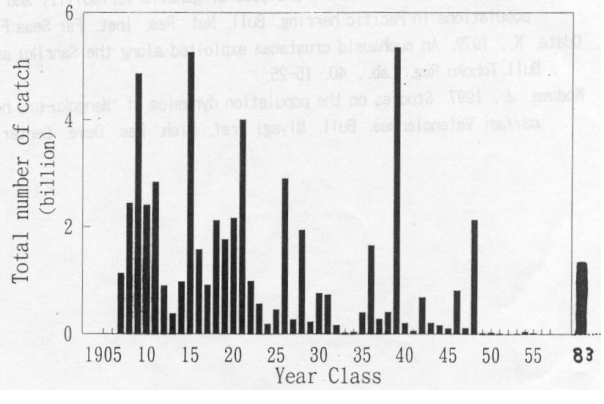

Fig. 3 Year-class strength of Hokkaido-Sakhalin population.

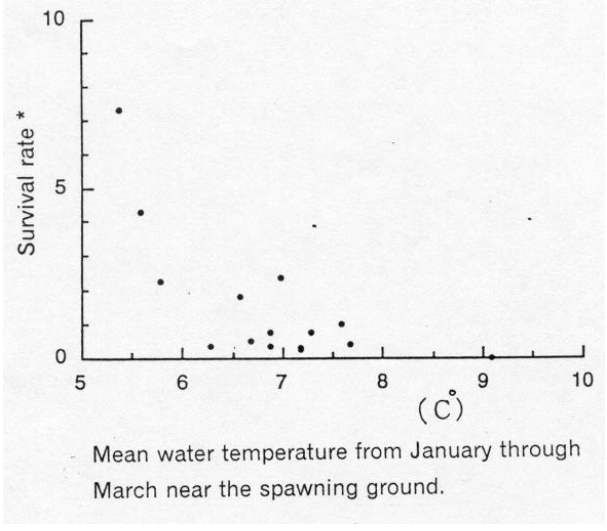

Fig. 4 Relationship between mean water temperature and survival rate (Kodama, 1997).

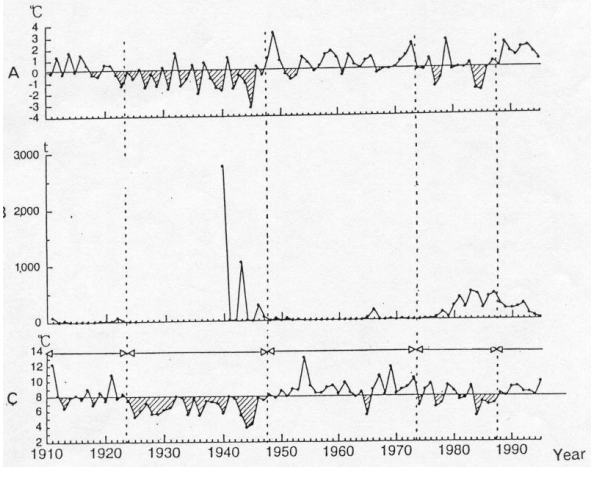

Fig. 5 Long-term fluctuation of catch of Mangoku-ura herring and air and water temperature observed on the coast of Miyagi Prefecture (Kodama, 1997).

A. Mean air tenperarure from Jan. through Feb. at Ishinomaki.

B. Landing of herring in ton.

C. Water temperature in April at Enoshima.

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Holocene fish remains from Saanich Inlet, British Columbia, Canada

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Introduction

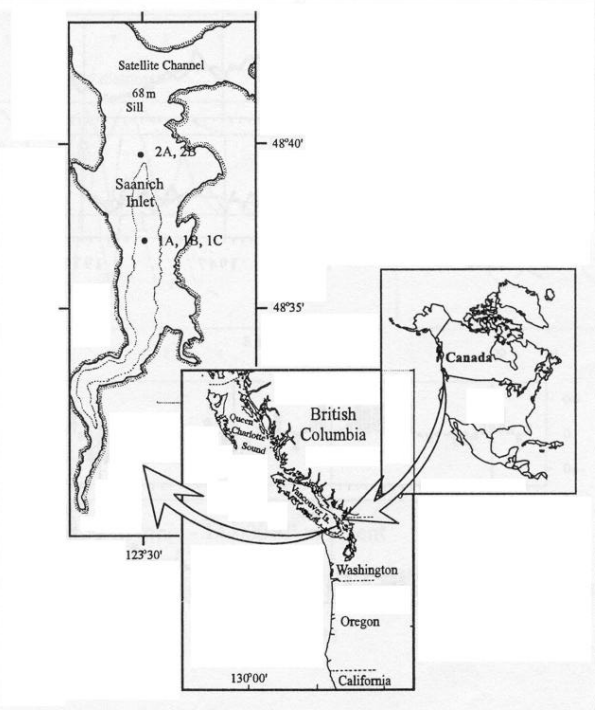
For most fish populations, available records are too short to resolve decade or century scale fluctuations. Here, the fine sedimentary fish remains record of Saanich Inlet is examined to infer fluctuations in fish population abundances – especially Pacific herring (*Clupea pallasi*) – through the Holocene.

Saanich Inlet

Saanich Inlet is a temperate marine fjord on Vancouver Island, British Columbia, Canada. The deep water in the inlet is anoxic for most of the year and therefore Saanich Inlet sediments accumulate undisturbed through time.

Methods

1. 5 high-resolution, large volume box cores (1A, 1B, 1C, 2A, 2B):
   - ~1.5 m long, recent sediments = 1883-1991
   - 400cm^2 area, 2-year sampling resolution
   - Detailed Pacific herring and hake population fluctuations are inferred
2. Bone and scales were sieved from sediments, identified and enumerated – the majority of remains are from Pacific herring and hake.
3. Data smoothing (low-frequency robust trends), anomalies (periods of high and low abundance) and spectral analyses (high-frequency) and comparison to physical (ALPI- Aleutian Low Pressure Index), biological (diatoms, hake) and human (herring landings) time series.



BOX CORE TRENDS: The past 100 years

Smoothing: Well documented crash of herring populations in the late 1960s.