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## Holocene fish remains from Saanich Inlet, British Columbia, Canada

Jacqueline M. O'Connell
Earth and Ocean Sciences - Oceanography Unit, University of British Columbia, Vancouver, B.C., Canada.

### Introduction

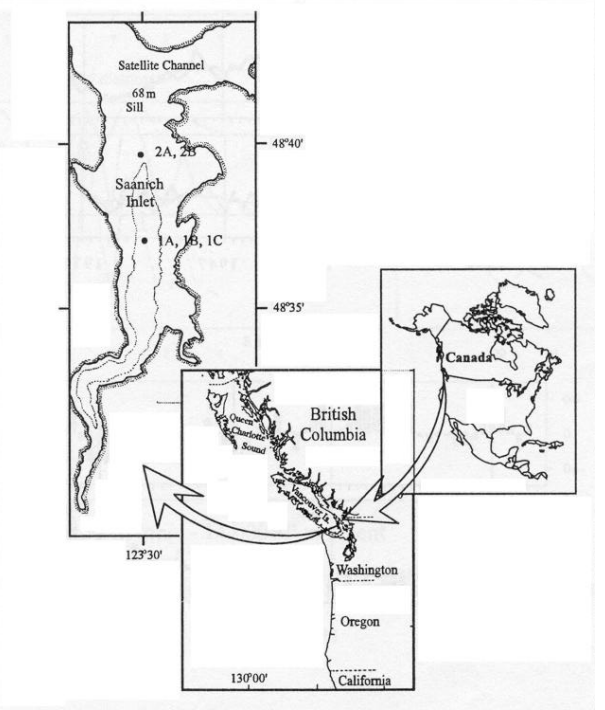
For most fish populations, available records are too short to resolve decade or century scale fluctuations. Here, the fine sedimentary fish remains record of Saanich Inlet is examined to infer fluctuations in fish population abundances – especially Pacific herring (*Clupea pallasi*) – through the Holocene.

### 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.

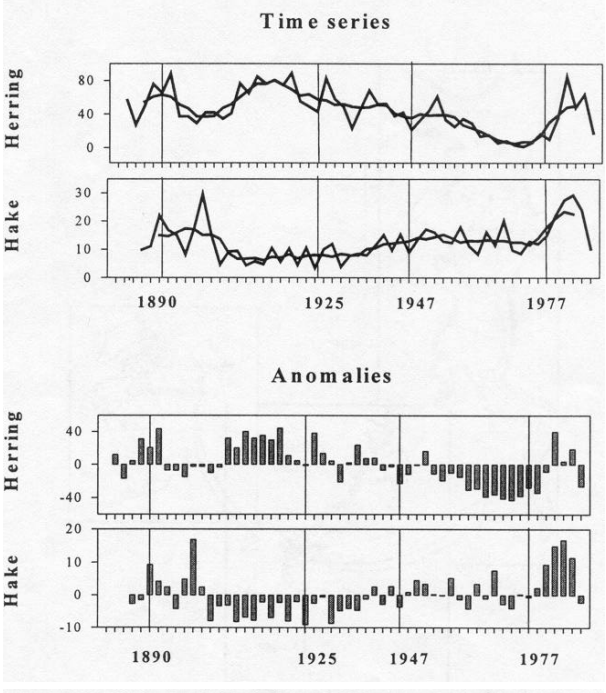


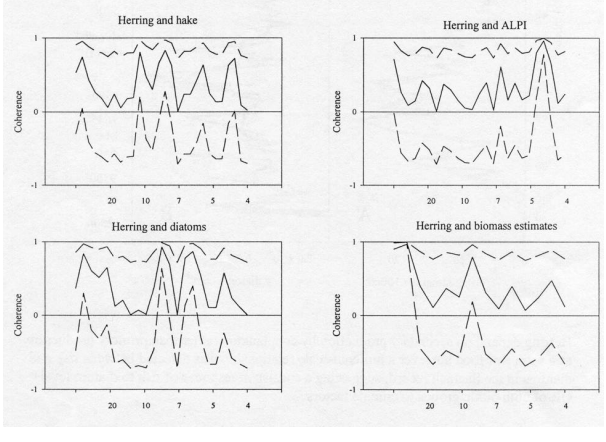

### BOX CORE TRENDS: The past 100 years

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

Anomalies: The herring scale record shows major transitions in keeping with the timing of regime shifts in the North Pacific Ocean.

Cross-spectral analyses: coincidental timing of scale deposition and physical/biological datasets and exploitation rates (4-10 year periodicity) does suggest correlation/common mechanisms. These timescales of variation warrant further investigation.



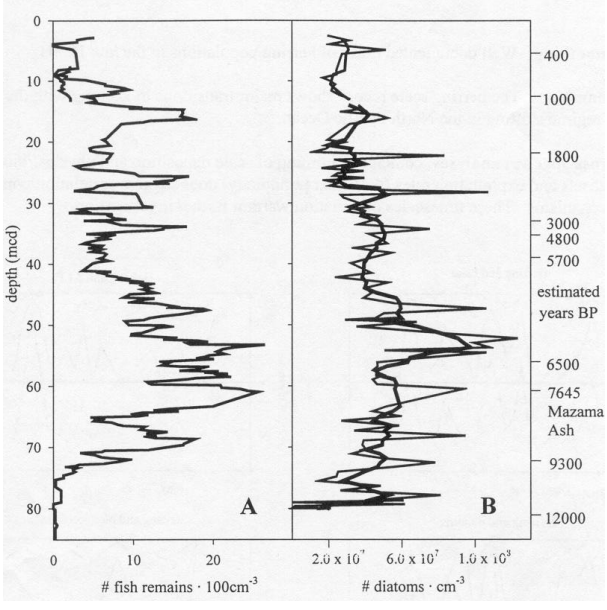




**ODP CORES: Holocene record**

ODP piston core

- 118m long – 14,000BP to recent
- 8.3cm$^2$ area, no replicates
- Generalized century to millennia-scale fish story, focussing on herring

Herring depend on secondary production by zooplankton rather than primary production as a source of food however a millennia-scale relationship was detected between fish and diatoms in the Saanich record, suggesting a consistent response of fish to diatom levels OR of both biotic groups to climate factors.




Taxonomic identification was only possible for 37% of the remains in the ODP core but over half of the bone fragments were herring. An interesting qualitative story of first appearances was inferred indicating that herring were early colonizers of the inlet after deglaciation (12,000yBP).

**Overall**

Detailed, large volume sedimentary records are useful to infer long-term dynamics of herring and their major hake predators.

From the high-resolution, large volume box core samples, some potential factors correlated to fish dynamics were explored. Response to

documented regime shifts and higher-frequency 4-10 year periodicities were detected in the herring data, and in biological (sedimentary hake scale record, diatoms) and physical factors (ALPI), as well as fishing intensity (historical landings).

From the ODP cores, a long-term relationship between primary and tertiary trophic levels does appear to be resolved in the Saanich record. Herring were among the first fish to colonize post-glacial Saanich Inlet.

Further research of this kind may help to provide testable hypotheses about patterns and causes of long-term variability. Data such as these may also prove invaluable to management of herring stocks as a better understanding of the timescales of change may assist in planning for major regulatory changes at periods of low abundance.

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## On relationship between crustacean zooplankton (Euphausiidae and Copepods) and Sakhalin-Hokkaido herring (Tatar Strait, Sea of Japan)

Elsa R. Ivshina and Irina Y. Bragina
Sakhalin Research Institute of Fisheries and Oceanography, 196 Komsomolskaya St., Yuzhno-Sakhalinsk, Russia. 693016, E-mail: elsa@tinro.sakhalin.ru

### Introduction

Sakhalin-Hokkaido herring is potentially the most abundant among all herring populations in the Far East. During the last several decades, the status of that population has been extremely low. A significant reduction in abundance began in 1940–50s and during the 1980–90s, the population appeared to be in a critical situation. The reasons for the decline were discussed widely (Svetovidov, 1952; Probatov, 1958; Hirano, 1961; Kondo, 1963; Motoda & Hirano, 1963; Birman, 1973; Pushnikova, 1981; 1996; Sokolovsky & Glebova, 1985). A majority of scientists considered that the main reason of this phenomenon was a change in ocean conditions such as the warming in the northern Sea of Japan and adjacent areas. Increasing commercial pressure on the Sakhalin-Hokkaido herring population is considered to be another important reason.

It is well known that the abundance of each generation depends on many factors, both biotic and abiotic. Prey abundance affects them to a considerable extent as well. In the Tatar Strait, the zooplankton community, feeding structure and other problems connected with herring feeding were studied actively. However, a question of the relationship between the biomass of the dominant zooplankton forms, the main components of herring feeding, and the number of Sakhalin-Hokkaido herring were not considered. The aim of our work was to determine the relationship between the biomass of one of the main components of feeding (crustacean zooplankton such as Euphausiidae), the number of Sakhalin-Hokkaido herring generations and the biomass of predatory zooplankton.