Multifrequency acoustic observation of arctic cod biomass at the head of Franklin Bay in relation with environmental conditions over winter 2003-2004

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Introduction

Arctic cod (*Boreogadus saida*) is well known to be a key stone species in the arctic marine food web, transferring energy from zooplankton to top predators such as sea-birds and seals. However, there is a lack of knowledge about its ecology and biomass. This is especially true for winter time, when this fish lives under the ice sheet and its access is difficult. Hydroacoustic is a good tool to palliate this difficulty and it has been used during CASES expeditions. Here are presented a part of the acoustic results from an overwintering station in the Beaufort Sea (***Fig. 1***).

Objectives

1 – Establish the evolution of acoustic densities during winter

2 – Discriminate arctic cod from zooplankton using multifrequency acoustic classification

3 – Link the acoustic densities of arctic cod with environmental conditions

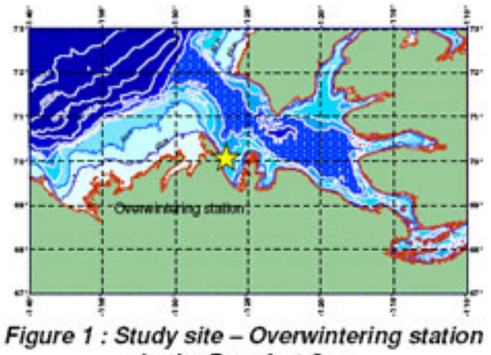

Figure 1 : Study site – Overwintering station in the Beaufort Sea

Materials and methods

Data sampling

- Hull mounted multifrequency split-beam echosounder on the CCGS Amundsen research Ice-breaker
- Ice-breaker frozen at a fixed station
- 38, 120 and 200 kHz – SIMRAD EK60
- Recording during all winter from Dec. 18th 2003 to May 30st 2004

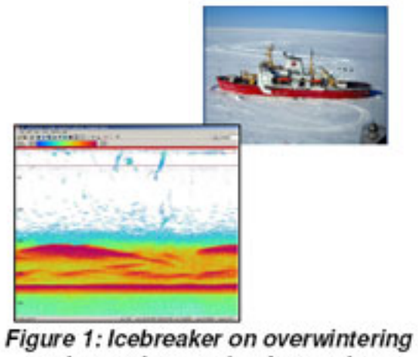

Figure 1: Icebreaker on overwintering station and example of a one hour echogram on April 2nd 2004.

Data selection

Systematic sampling = 1h./day (from 12h to 13h), every 2 days
➔ 59 hrs. along winter

Data analysis

- Conversion of the files to the international standard HAC format
- Edition of the data (using CH2 software) to remove bad data and interferences
- Multifrequency echointegration : Sv38, Sv120 and Sv200 (grid cell size = 3m × 60 pings), Sv unit : dB re $1m^{-1}$

Results

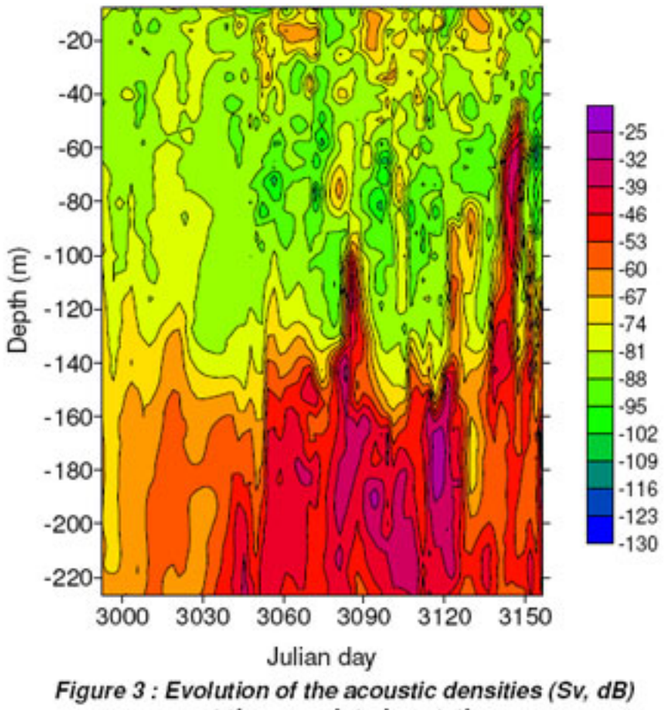

Figure 3 : Evolution of the acoustic densities (Sv, dB) at the overwintering station

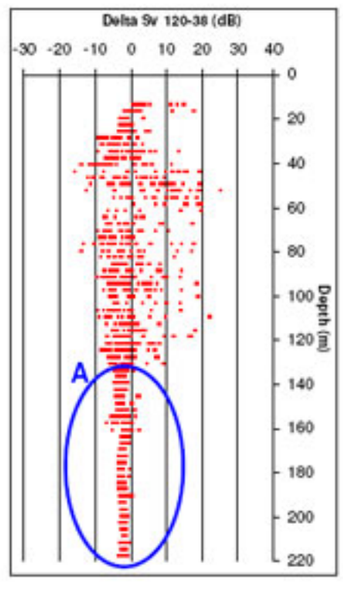

Figure 4 : ΔSv_{120-38} on March 9th 2003 (Julian day = 3074)

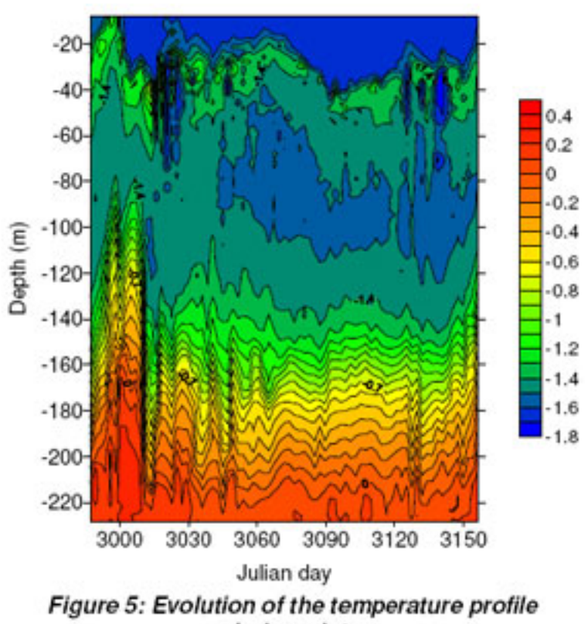

Figure 5: Evolution of the temperature profile during winter

Overwintering CTD data show, that "warmer" waters are in the lower part of the water column. The high Sv layer upper limit correspond to the -1.4°C isotherm (***Fig. 5***).
This suggests that arctic cod would choose the warmest temperatures.
The arctic cod densities increase during winter. This could be linked to an active process (spawning / feeding aggregation) with or without the combination of passive physical process (advection of waters masses rich in arctic cod).

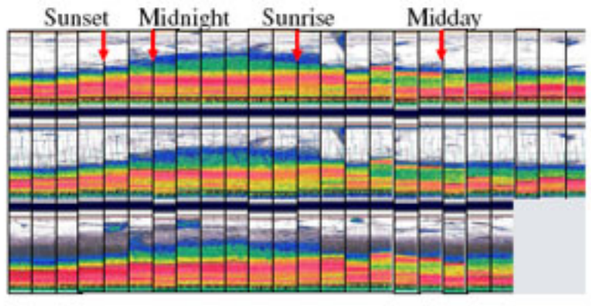

Figure 6 : 24 h echogram (from 2 min. sections) On April 11th, 2004

The Sv time series (***Fig. 3***) shows that higher densities are found in the lower half of the water column (130-220 m). In early February (J.D. 3044), densities increase in this layer until ice break-up on 1st of june (J.D. 3157). Some ascents of these very high densities can be observed several times during winter. Multifrequency acoustic classification (***Fig. 4***) shows a rather stable ΔSv_{120-38} in the high-density layer with values likely for arctic cod since ΔSv120-38 <0 dB (A) can be attributed to fish (Kang *et al.*, 2002). More scattered and higher ΔSv120-38 values in the upper layer would be associated to zooplankton. Moreover, nets results show that 95 % of the adults fish catch are from arctic cod with a modal length of 16 cm (not shown).

Conclusions and future work

These results show that in winter, arctic cod are found under the sea ice in dense layer in the lower part of the water column. Arctic cod also seems to prefer warmer temperatures. The reason for the huge increase of fish density during winter needs to be understood and will be more investigated using circulation data in particular.
Preliminary results show that there are diel vertical migrations under the sea ice during winter, tightly linked with photoperiod (see ***Fig. 6*** for an example). This will be studied in details in future work.

Reference:
Kang M., Furusawa M., and Miyashita K. (2002). "Effective and accurate use of difference in mean volume backscattering strength to identify fish and plankton." ICES Journal of Marine Science 59(4): 794-804.