Diurnal variation in acoustic densities: why do we se less in the dark?

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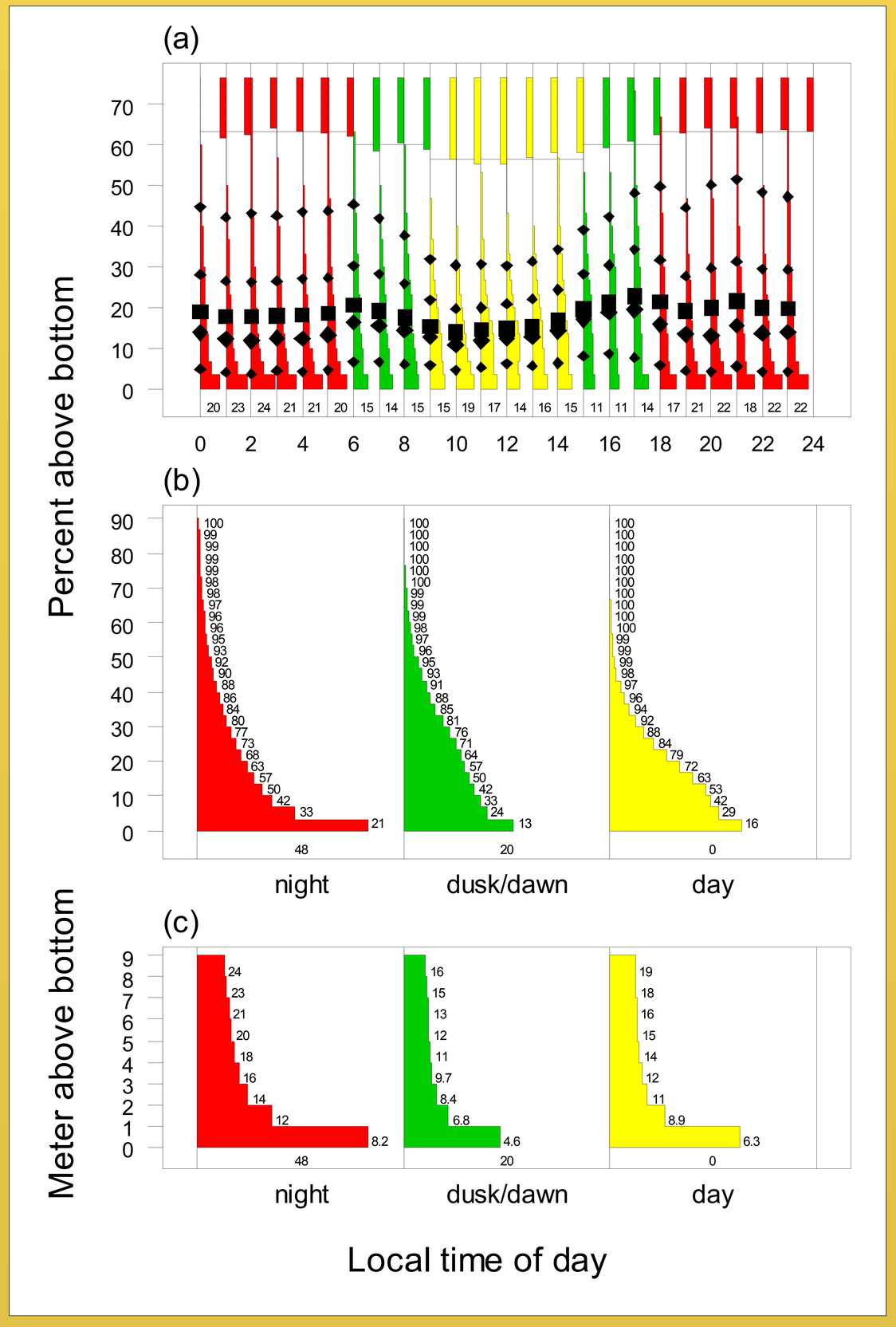
Introduction

In the Barents Sea, the echo abundance of demersal fish is about 50% higher at day than at night. Three possible reasons are:

- Fish hide in the bottom dead zone at night.
- Fish target strength changes due to pressure-related swim-bladder changes during vertical migration.
- Fish target strength varies due to higher variation in the tilt-angle distribution at night.

It is very often claimed that the dead zone is most important. We argue that variation in tilt-angle may also be important.



Materials and Methods

Data from the combined acoustic and bottom trawl winter survey in the Barents Sea from 1997 to 2002, covering a total of 38638 nautical miles, were analysed. Diurnal patterns in total echo abundance and vertical density profiles of demersal fish (including cod, haddock, redfish, polar cod and blue whiting) were studied, with particular emphasis on the near-bottom part of the profiles. A randomization technique was used to test the significance of diurnal patterns.

Results and Discussion

The echo abundance distribution was highly skewed, with the 1% highest values disturbing the general distribution pattern. When these were removed, a clear, symmetric diurnal pattern emerged, both as regards total echo abundance and the vertical distribution (Fig. 1). The echo abundance was highest during day, and the fish were more dispersed at night.
The pattern was consistent between years and species, and statistically highly significant.

The exponential increase in density with decreasing height above the bottom in Figure 1c indicates that a large amount of fish is standing in the dead zone both day and night. However, the similarity in day and night pattern suggests that not all of the 48% "missing" echo abundance at night can be found in the dead zone. A possible additional explanation is that due to less organized fish behaviour at night, a higher variation in the tilt angle distribution leads to a decrease in the average target strength.

For details, see Hjellvik, Godø and Tjøstheim 2004. Diurnal variation in acoustic densities: why do we see less in the dark? Canadian Journal of Fisheries and Aquatic Sciences. In press.

Figure 1. (a): Vertical density profiles for demersal fish. Samples larger than the 99% quantile are excluded. The area of each bin of each profile is proportional to the average echo abundance over all samples taken in the actual time interval and the actual fraction (3.33%) of the water column. Small diamonds indicate the 25, 75 and 90% quantiles of the profiles, large diamonds indicate medians, and squares indicate means. The length of the bars at the top is proportional to the average echo abundance. The solid lines indicate averages at night, dawn/dusk and day. The number at the bottom of a profile indicates the percentage of the total echo abundance that is contained in the bin closest to the bottom. **(b):** Same as (a), but with data grouped in night, dusk/dawn and day. The numbers at bottom indicate the percentage that must be added to the observed total echo abundance to reach the day level of echo abundance. The numbers to the right of the bins indicate the cumulative percentage of the total observed echo abundance. **(c):** Same as (b) for the 10 meters closest to bottom. The height of each bin is 1 m.