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Vertical movements of Atlantic cod (*Gadus morhua*) in the Baltic and the North Sea

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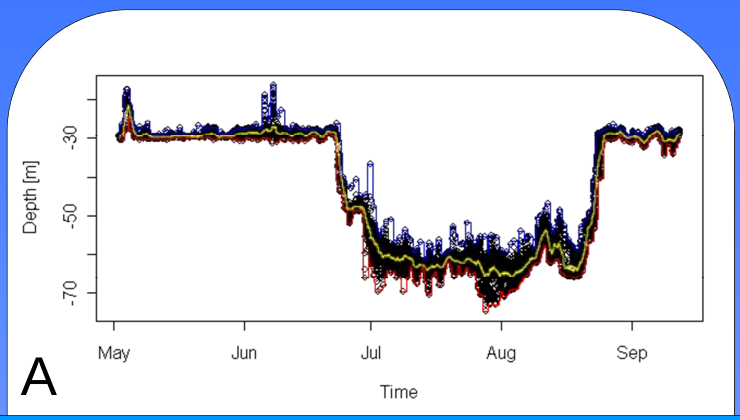
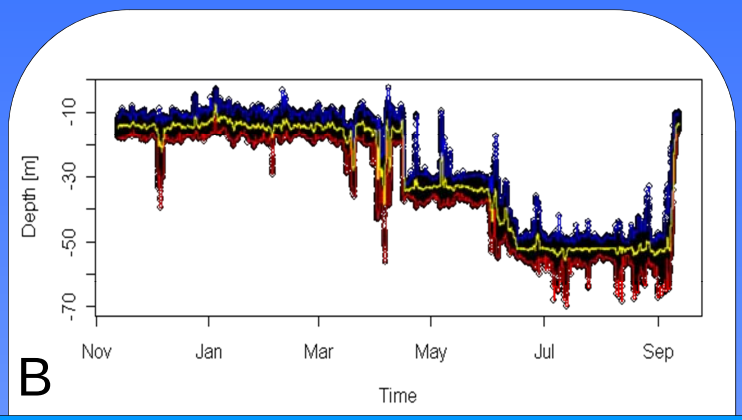
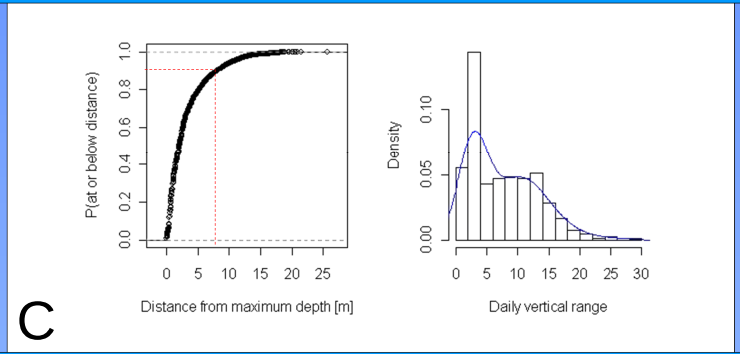
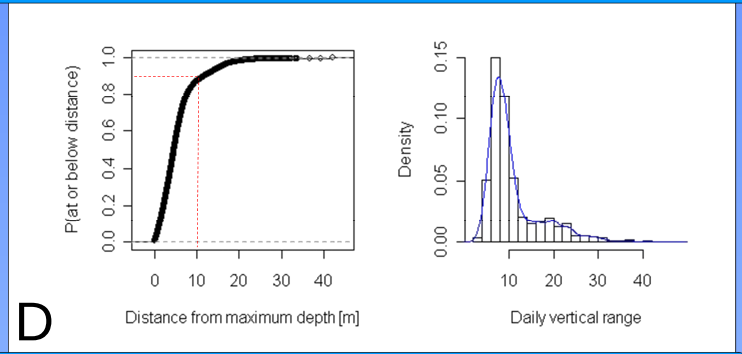
Fish behaviour has profound effects on catchability, yet knowledge of fish behaviour is under-utilised when fish survey data are interpreted. In particular, the vertical movements of fishes determine their accessibility to trawl and acoustic gears. In addition, vertical movements have a significant effect upon the target strength of roundfish that have closed swimbladders because swimbladder size or tilt angles change as fish move up or down in the water column. In consequence, trawl and acoustic surveys designed to assess the abundance and biomass of fish populations suffer from bias. This bias may vary from place to place and between seasons and years. We used electronic data storage tags to record individual depth experience of Atlantic cod in the North Sea and the Baltic Sea, with the aim to **quantify vertical behaviour, in relation to the probability of capture by a trawl and on *in situ* swimbladder size** in these two systems.



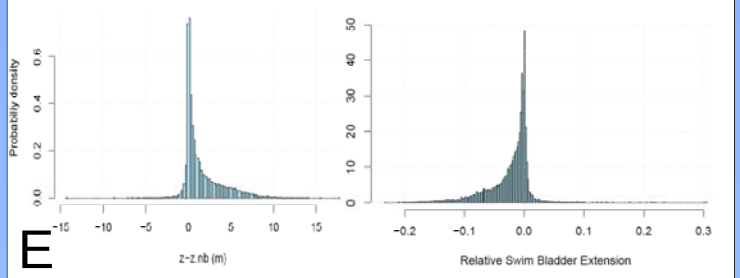


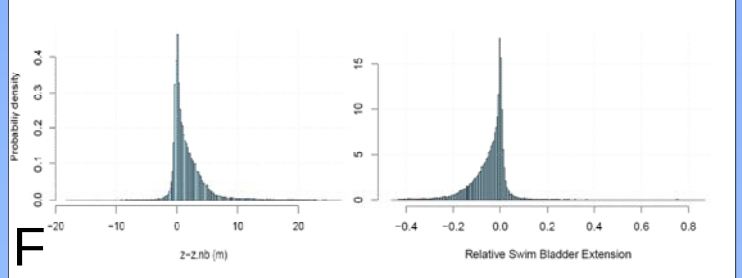
The running 24 hour mean (yellow), maximum (red) and minimum (blue) depths were chosen to represent vertical range for a Baltic cod (panel A) and a cod from the Southern North Sea (panel B). Maximum depth does not necessarily represent bottom depth, which is a problematic concept at rough bottom types anyway. Bottom depth cannot be measured by archival tags, yet.





The Baltic example cod remained below 8 m above maximum depth in 90 % of the recorded time interval (panel C, left). Daily vertical range (between minimum and maximum depth, panel C, right) was between 0 and ca. 20 m. The cod from the southern North Sea remained 90 % of the time below 10 m above maximum depth (panel D, left). Daily vertical range (panel D, right) was with 0 to ca. 30 m slightly larger than for the Baltic cod.





We calculates the neutral buoyancy depth of a cod as a function of time. The calculations are based on the model of Strand *et.al.* (Ecological modelling 185 (2005) 309-327). The metabolic rate is not calculated explicitly, but instead is simply treated as a constant parameter which can be fed in at the users will. **Both cod are negatively buoyant most of the time, and their swimbladders are almost always compressed.**

Scaling from individuals to populations:

The metrics used here can also be calculated for many cod at once and thereby give populaioth estimates including confidence limits.

Acoustic biomass estimates:

If the swimbladders are compressed most of the time, acoustically derived biomass estimates have to be corrected.

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