

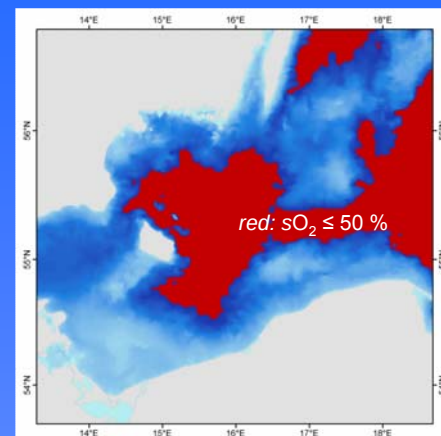
Atlantic cod *Gadus morhua* L. in the Baltic Sea visit hypoxic water briefly but often



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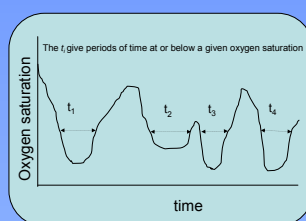
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Prolonged exposure to hypoxia decreases growth and predatory performance of fish. Hypoxic events are observed with increasing frequencies in lakes, coastal regions and deeps of semi-enclosed seas (right). In order to understand how predatory fishes can cope with hypoxia, and if there are behavioural mechanisms to counteract hypoxia induced decrease in growth and food consumption, individual behaviour of fish in the presence of hypoxic water was measured *in situ*.

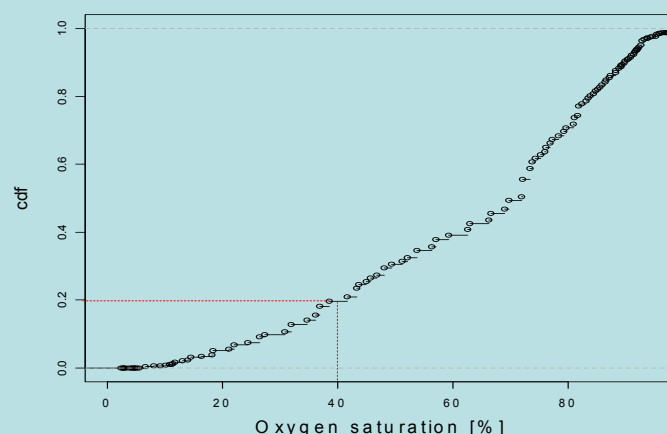
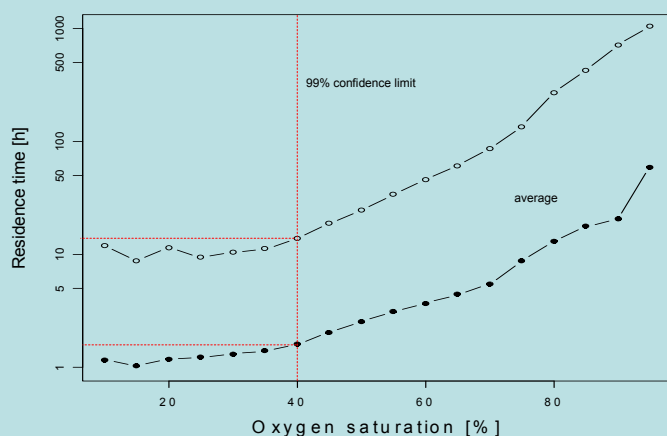


Electronic archival tags measured individual depth experience, and subsequently depth experience was converted to oxygen experience by applying measured vertical profiles of oxygen saturation (left).

In 2004 and 2005, 141 and 167 cod >45 cm total length were tagged with electronic data storage tags. The tags were of the type Star-Oddi CTD, and each was programmed to record pressure, ambient temperature, and conductivity once every 12 min. Pressure was measured accurate to ± 0.2 dbar. Temperature and conductivity measurements were used to verify that the cod used later in the analysis did not leave the basin while at large. Hydrographical data from the Bornholm Basin were used to identify two periods in 2004 and 2005 with constant vertical oxygen saturation gradients in the basin. In 2004, oxygen saturation was constant between samplings taken on Julian days 151 and 200, while in 2005 oxygen saturation was constant between samplings taken on Julian days 150 and 205. Individual depth records of the tagged cod during these periods were merged with the average vertical oxygen gradients and fish that were periodically subjected to hypoxia ($n=10$ in 2004, and $n=17$ in 2005) were identified. For these 27 fish, the empirical cumulative density function of time spent at or below oxygen saturation was calculated. Maximum residence time was defined as the 99 % percentile of residence time at a given maximal oxygen saturation. A value of 10 hours at 30 % oxygen saturation, for example, indicates that 99 % of the residence times cod stayed at oxygen saturation between 0 % and 30 % were at or below 10 hours.



Atlantic cod in the vertically stratified Baltic Sea spent about a third of their time at oxygen saturation below 50 % (right). However, maximal residence time per visit in such hypoxic water was limited to few hours (below). Hence, the fish visited hypoxic waters briefly but often, probably to feed on benthic organisms.



Benthic organisms which usually are burrowed but had to emerge due to lack of oxygen in the sediment. Hence, hypoxia in the lower part of the vertical range of the cod probably increased food availability. This dynamic has to be accounted for when relating hypoxic events to changes in growth and food consumption.