Atlantic cod in an anthropogenic North Sea: effects of man-made sounds on cod movement behaviour

Van Der Knaap Inge[1,2], Slabbekoorn Hans[2] and Reubens Jan[3]

[1] Marine Biology Lab, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: inge.vanderknaap@ugent.be
[2] Institute of Biology, Leiden University, Sylviusweg 72, 2333 BE Leiden, The Netherlands
[3] Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

The increase in offshore human activity, including shipping, construction, extraction and exploration for energy resources, has resulted in underwater sound pollution at a global scale. This affects the habitat of marine fish and mammals worldwide, with potential consequences for local populations. The North Sea is one of the busiest areas oceanwide and recently published sound maps indicate that the underwater sound levels along the Belgian and Dutch coast exceed the median level by 30dB. Two pronounced sourced of noise come from seismic surveying and pile driving, both causing locally excessive acoustic events. Seismic surveys are commonly used to explore the seabed for fossil fuel deposits and site selection for offshore wind farms and carbon sequestration. Pile driving is an often-used technique for the construction of offshore wind turbines for which piles are hammered 30m deep into the seabed. Both activities can last for months and cause high intensity low frequency sounds that can be heard over hundreds of kilometres potentially impacting a wide range of marine habitats and species. The effects of sounds on marine fish range from physical injuries when fish are present at close proximity, 5 - 300 m, to the sound source, to more subtle effects on physiology and behaviour, which may extend to tens of kilometres from the source. However, data exist for only a few species and are restricted in their scope. Here we present the results of two studies investigating the effects of a real full-scale seismic survey and piling activity on the behaviour of free-swimming Atlantic cod (Gadus morhua). The movement behaviour of cod at the wind farm, was tracked using acoustic telemetry. Mixed models and Hidden Markov models were used for data analysis. From the behavioural analysis we found that during seismic survey, cod decreased their activity. Additionally, diurnal activity cycles were disrupted with lower locally active peaks at dusk and dawn, periods when cod is known to actively feed. Piling effected the movement of the cod and resulted in altered distances travelled during noise exposure. Changes in movement behaviour may ultimately lead to changes in the time animals spend in certain behaviours which can affect their overall fitness and thus have consequences at a population level.. Our results underline the relevance to further assess impacts of man-made sounds on population consequences, and also stress the validity of conservation concerns about anthropogenic noise pollution in the marine environment.

Keywords: Offshore development; Acoustic telemetry; Noise pollution; Marine fish behaviour