Environmental effects on the availability of shallow and deep-water hake to the demersal trawl survey in Namibian waters - DTU Orbit (18/08/2019)

Studies on several demersal fish species have shown that variability in environmental conditions (including oxygen, temperature, wind and time of day) during trawling may result in differences in the catching efficiency of the trawl gear, which may cause differences in abundance estimations of stocks. This is even complicated in the case of the Cape hakes, Merluccius capensis and Merluccius paradoxus, which are known to perform diurnal vertical migrations possibly for spawning or in search of food. These abundance estimations, together with commercial catch-at-age and catch per unit effort (CPUE) indices, are key input data into the stock assessment model that guides scientific TAC (Total allowable catch) recommendations and other management measure advices, for the Namibian hake stocks. The overall aim of this PhD study was to investigate the effects of environmental conditions (close to the sea bed during trawls) on trawl survey abundance indices through an analysis of existing survey CPUE data, in order to gain a better understanding of the behavioral processes involved. This is crucial for improving the reliability of the hake stock assessment, and it is directly linked to the validation or modification of the current assessment practices. This PhD thesis is made up of a synthesis of four papers with varying objectives. Paper I attempted to study diel patterns in survey trawl catch rates for Namibian hakes using the solar zenith angle of the sun as a proxy for light level near the bottom. The main aim was to examine the effect of diel bias on catchability within and between years, and to explore the implications for survey abundance estimation and the consistency of the survey time-series. Results indicate that time of day has an effect on survey catch rates, mostly for M. capensis, where lower catch rates were obtained during the night, in shallower waters. The second objective (Paper II) was to study the effects of environmental variables and other covariates (temperature, oxygen, salinity as well as geographical position, time of day and year) on survey trawl catch rates at different size groups (juvenile, small, medium and large) of the two hake species. Most of the years, the environmental data were collected independent of the fishing operations usually on few selected transects with limited spatial overlap between the CTD and the trawl stations. The results, however, indicate that the most important covariates affecting catch rates were bottom oxygen, bottom depth, geographical position and bottom temperature. This is an indication that the size structure of the two species as observed in the survey may have been affected by the behavioral reactions in response to the environmental conditions. These results were confirmed by those of Paper III, which used data collected by a trawl-mounted instrument package, which allows the data collection simultaneously to the trawl operations. There is an indication that the use of a trawl-mounted instrument package can provide reliable information on environmental variables for an improved understanding and interpretation of survey catch rates and subsequent use in stock assessment models for provision of scientific advice on resources. Paper IV was an investigation into diel feeding ecology through food composition based on recent stomach samples in order to gain insight into biological explanation of the observed dynamics of survey catchability. Both hake species fed more on semi-demersal and demersal components of the prey field, which predominantly consisted of horse mackerel, jacopever and Atlantic green eye for M. capensis, and grenadier and cephalopods (squid and cuttlefish) for M. paradoxus. Other prey items were pelagic like krill and myctophids. Hake-on-hake predation was observed, with both hake species occurring as prey in the stomachs of M. capensis while only M. paradoxus occurred in the stomachs of M. paradoxus. This study was unfortunately limited by an insufficient number of samples and inadequate geographical coverage. It can, however, be used as a basis to plan future studies that should then also encompass the use of a gastric evacuation model to estimate the time of the day for ingestion of individual prey items and to quantify hake cannibalism from stomach content data. Results of the different papers are synthesized in relation to diagnosing environmental effects on survey catchability and then suggestions for time series adjustments is provided.

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