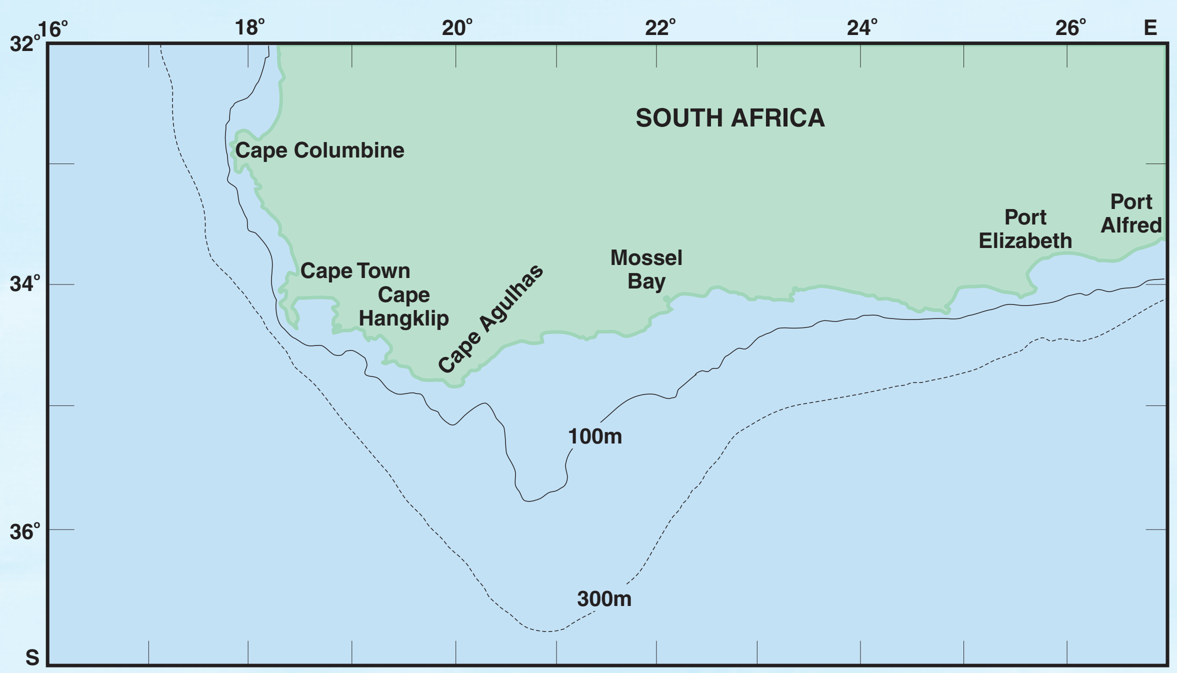
INVESTIGATION INTO THE DECLINING TREND IN CHOKKA SQUID CATCHES FROM THE SOUTH AFRICAN TRAWL FISHERY

by Beatriz A. Roel

The South African chokka squid *Loligo vulgaris reynaudii* is caught by a local jig fishery, which targets primarily spawning aggregations off the South African south coast, and mainly as a by-catch in the bottom trawl fishery, which targets Cape hake (*Merluccius* spp.) and Agulhas sole (*Austroglossus pectoralis*).



Catch and effort data from the local trawl fishery for the period 1978 -1996, in the area of distribution of chokka, were used to obtain annual estimates of catch per unit effort (CPUE) for that period. Catch data were reported by drag and consisted of close to 175000 observations.

Examination of the nominal trend in CPUE of chokka revealed a sharp decline during the early 1980s (Figure 3).

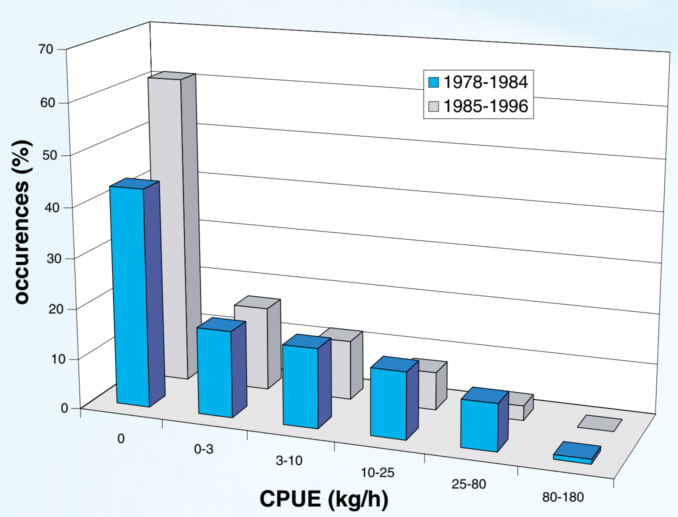


Figure 1. Percentage distribution of trawl CPUE categories for two periods.

This finding is consistent with the perception of trawlermen that the quantity of chokka available to them decreased substantially after the onset of the jig fishery in the mid-1980s (Figure 1). Is this decline an indication of a change in resource abundance or is it the result of changes in fishing strategy, perhaps including a decrease with time in directed fishing for squid?

- Preliminary analysis showed that seasonal trends in trawling effort remained similar throughout the period considered (i.e. 1978 -1996), and
- Obvious differences in CPUE trends between areas were not detected.
- An investigation into changes in the spatial distribution of the trawling fleet, i.e. from areas of high abundance of chokka to areas of low abundance, revealed that they could have been responsible, to some extent, for the observed declining trend in the annual CPUE.

A rigorous analysis of the factors influencing the trawl CPUE was undertaken within the statistical framework of General Linear Modelling (GLM). The algorithm used to model CPUE is

$$CPUE_{yij} = e^{(\ln(CPUE_{111}) + \alpha_y + \beta_i + \gamma_j + \varepsilon_{yij})} - \delta$$

where $CPUE_{111}$ corresponds to the catch rate in year 1, location 1 and vessel attribute 1,

α_y represents abundance in year y relative to year 1,

β_i represents the abundance in location i relative to location 1,

γ_j represents the effect of a vessel having attribute j instead of attribute 1,

δ is the log-transformation constant, and

ε_{yij} is the residual for year y, location i and vessel attribute j.

The factors considered were location factors, such as water depth, target species, season and area in which the trawl was made, plus vessel attributes, such as total length, presence or absence of a kort nozzle and type of propeller. Inspection of the associated residuals from the regression suggested that variables such as vessel length and depth of drag should be treated as discrete Boolean variables.

Results

The results from the GLM indicate a correlation between CPUE and the set of explanatory variables, but a large portion of the variability in the trawl CPUE data (close to 80%) is not explained by the regression. This is to be expected in a data set of such nature, where the error associated with the estimates of CPUE is probably large. Further, CPUE is likely to be influenced by factors such as immediate ground topography, weather condition, current and skipper's skill that are not included in the model.

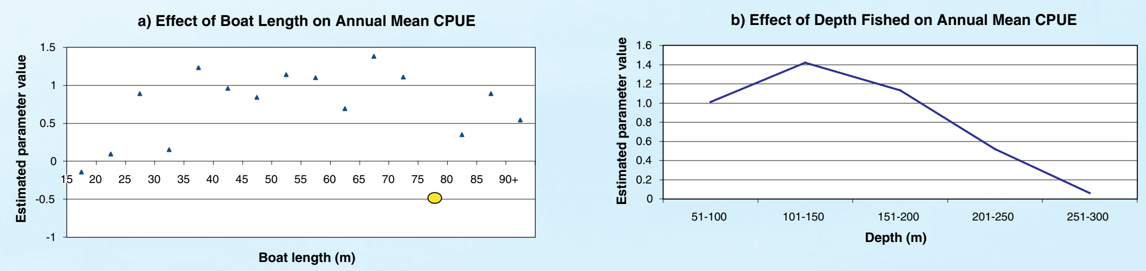


Figure 2. a) Boat length and b) depth fished regression parameters from the GLM. The estimate for the 70-74 m length class, which is considered non-representative, is indicated with a circle in (a).

The variables identified as most influential on the trawl CPUE are vessel length, year, area, depth and season of the drag, and target species. Examination of the regression coefficients indicates higher trawl CPUE in the first three months of the year, between 100 and 150 m deep, and in the area offshore between The Cape of Good Hope and Cape Agulhas. With the exception of the vessels 25-29 m long, the coefficients for vessels <35 m seem to be not significantly different from the intercept which relates to vessels 10 to 14 m long. The fishing power for vessels larger than 35 m appears to increase slowly up to the 65-69 m length class (see Fig. 2). The 75-79 m vessel category represents only two vessels, which operated in different periods. Most of the drags were made by one of the vessels which fished towards the edge of the maximum abundance of chokka (deeper than 150 m), hence giving a relatively low vessel factor. Similar considerations, particularly in relation to the area of operation, may apply to several vessels >70m.

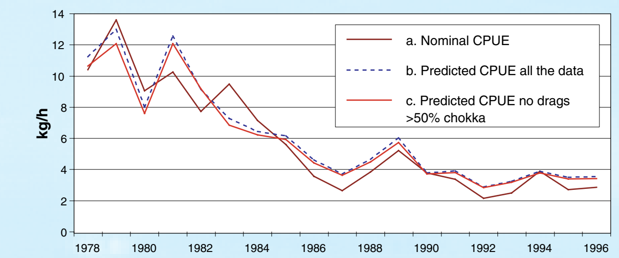


Figure 3. Nominal and predicted CPUE from the GLM analysis. Nominal CPUE computations are based on catch and effort data by boat and accumulated per day. Curve c) was obtained by eliminating the drags with more than 50% chokka in the catch.

The predicted trawl CPUE from the GLM analysis for the most frequent trawling conditions shows a decline from 1982 that is slightly less pronounced than that indicated by the nominal CPUE (Figure 3). Drags where the percentage of chokka in the total catch was >50% could be suspected of being chokka-directed, so as a sensitivity test, the GLM was also run but eliminating from the data those drags with >50% chokka in the catch. The resulting time-series is plotted above and shows a similar trend to that produced including all data (Figure 3).

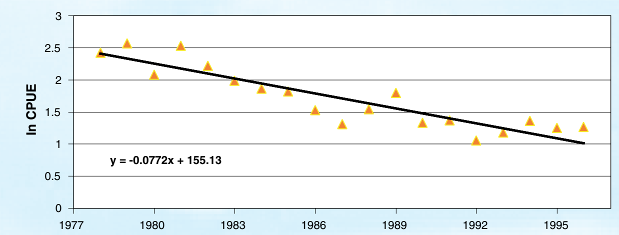


Figure 4. Regression of the natural logarithm of predicted CPUE against year.

The average rate of decline in the CPUE derived from regressing the logarithm of the model prediction against time is 7.7% per year (Figure 4).

Conclusion

The predicted trawl CPUE from the GLM analysis for the most frequent trawling conditions shows a decline from 1982 that is slightly less pronounced than that indicated by the nominal CPUE. However, it still indicates a 7.7% annual decline over the period investigated. This trend can be interpreted as a strong indication of resource decline during the period studied, and it needs to be taken into consideration by those responsible for management of the chokka fishery.

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK

http://www.cefas.co.uk