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On the dynamics of the common Octopus off Senegal: upwelling as an external forcing.

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The octopus figure (page 51 of your WP3 document, the Appendix III initial page) ..(or fig p 39).

Abstract

The following material is a compilation of the preliminary results on Senegalese *Octopus* data on age class/size (5=recruits; 6-14+=adult stock) numbers (monthly means) for years 1996-1999. In our theoretical groundwork, we propose the dynamics of exploited stock nucleii, populations and fisheries as a dynamical continuum (with multiple orbits of stability) governed by a variable (multivariate) carrying capacity. In this study, we take the preliminary steps to analyse aspects related to the (i) dynamical qualities of the population seen as a system, (ii) temporal evolution of numbers and (iii) the upwelling as an external forcing which may strongly contribute to shape the temporal evolution of the population/ stock.

Location of the study

Introduction

This study is a first attempt to analyze series of monthly abundances and catches by age group for an exploited octopus stock, considered as as a multioscillary system. At this stage only four years of data are available to test the approach. To go further, we have planned a sampling program to complete the series. At this stage, the results shows the potential of the method. Additional data will allow to go further in the analysis and interpretations of the observed dynamics.

Potential of this approach on monthly and age structred series

As this series grow, we will be able to address the dynamics of:
(i) different age classes/sizes and possible differential effects of external perturbations upon them;
(ii) (finely tuned) stock-recruitment relationships for different stocks/nucleii;
(iii) within (for each cohorte and/or reproduction/ recruitment peak) and between years (multivariate/ combined external effects) parametrization of the variable carrying capacity).
Also, such georeferenced data would allow a forward ("avant-garde") approach to the topological, temporal evolution of the exploited stock

Methodology

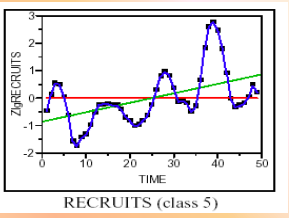
The multioscillatory system approach

To be added: a brief description of the approach (with bibliographic references if needded).

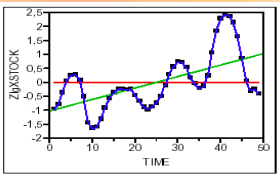
Data: monthly series on the Senegalese octopus stock

The data were collected between 1996-1999 during the « Octopus » research program (a cooperation program between IRD and CRODT*). Fisheries societies were sampled in addition of the landings surveys made and in routine by CRODT. The series concern: (1) 1996-1999 monthly catches by commercial size (ten size group: according to Mitzubishi classification), for the whole Senegalese EEZ and (2) 1996-1999 monthly abundance of the Senegalese stock by âge groups (in months) as estimated by a virtual population analysis (VPA) on the basis of the former series (of âge-structured catches).

Results

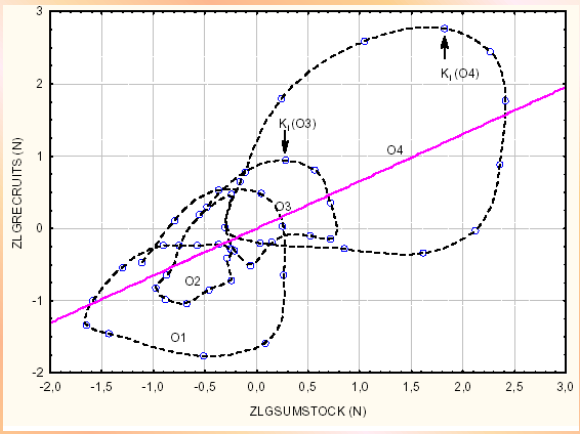


RECRUITS (class 5)



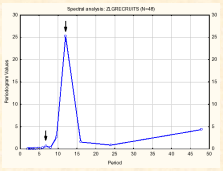
MEAN ADULT STOCK (classes 6-14+)

The data are put into a sequential table made up for "stock-recruitment", that is: age class 5 (recruits) against the remaining of the classes (6-14+) which we assume as the adult stock. Data was log transformed (to meet conditions for statistical normality) and standardized (with mean = 0) to facilitate visual comparison. On the figure, we see the strongly auto- and cross correlated series.

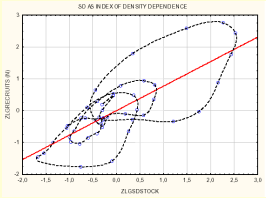


Phase plane (Stock-Recruitment) relationship

The HIGHER orbit of stability (O4) shows a clear divergence between maxima and minima: in our framework, we propose that the amplitude in the orbits may diverge as the system evolves towards either the (variable) carrying capacity of the orbit (ki) or that of the system (Kmax or the maximum allowable carrying capacity) after which the system will "jump" onto LOWER orbits of stability (this is what it happens).
The INTERMEDIATE orbits of stability (O3 and O2) could also be regarded as a "transition zone": they show a similar amplitude; dynamically seen, they could be regarded as "neighbours" where as the high and low orbits (O4 and O1) may be more distinct. Ki (O4) and Ki (O3) are regarded as the carrying capacities of theorbits O4 and O3, respectively.



The SPECTRAL ANALYSIS shows the annual (large) peak clearly and a (less clear) small peak for the intra-annual periodicity. It looks like this for the age class 5 (recruit) series (and similar for the adult stock).



Another interesting aspect is that the temporal evolution of the Standard Deviation (SD) may be used as an index or measure of DENSITY DEPENDENCE in the population system: higher orbits of stability will show higher SD values- and the inverse for lower orbits may hold true, as well. In short, we may estimate the behaviour of the system knowing the SD in the abundance of the stock (or even less: in the abundance of some of the intermediate, adult age/size classes).

Conclusion

These results are preliminary and longer series are needed to go further in the analysis. Anyway considering the 4 years series analysed here, some preliminary conclusions can be stated: Senegalese *Octopus* appears to be more "r-selected" as it reaches maturity, recruits (at smaller sizes) and reach maximum sizes which appear to be less that stock at higher latitudes: this may have many implications from within the assumptions of our non-linear framework some of which (as compared to higher Latitude stocks) may be shortly listed as follows: (a) faster capacity for rehabilitation in case of low to very low orbits of stability or population collapse due to the combined effects from fishing mortality and environmental stress; (b) faster "turn over" speed or stock replacement (which will have implications on proposed exploitation strategies and ranges of sustainable catches) and –among other factors- (c) faster and stronger responses to environmental perturbations.

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