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SOUTENANCE DE THÈSE

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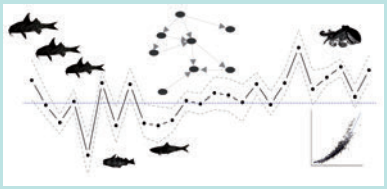
Cyria Meriem BENSEBAINI

Influence of environmental factors and changes in fishing effort on the main fish stocks exploited in the Gulf of Lions



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RÉSUMÉ In the Gulf of Lions (GOL), despite the development of numerous ecosystem models, stock assessments are still based on monospecific models. This thesis arose from the need to develop models that are complex enough to integrate environmental and fisheries factors, and simplified enough to remain practical for operational management. The main objective of this thesis was to create a practical framework for progressing towards a model of intermediate complexity for ecosystem (MICE) in order to assess the effect of reduced fishing effort on the main fish stocks in the GOL, in the context of environmental changes. This thesis allowed to study the changes in the GOL demersal community in terms of density and body condition (BC) in response to the environmental shift (mid-2000s). These strong changes appeared to be environmentally driven and synchronous with those observed in the small pelagic fish community, and species response presented higher diversity in both direction and magnitude. Interactions between BC and density have been highlighted in the hake population during the shift period, which may partly explain how this population still resists to a heavy fishing pressure. Then, a relatively simple method was set up to statistically detect key interactions and forcings in the GOL ecosystem. 3 statistical interaction networks (SINs) were highlighted using pairwise Granger causality tests and Multivariate Auto-Regressive (MAR) models : the first one highlighted statistical interactions between blackbellied angler (*Lophius budegassa*), hake (*Merluccius merluccius*), grey gurnard (*Eutrigla gurnardus*), and John dory (*Zeus faber*), and the effect of phosphate concentration. The second focused on blackbellied angler, red mullet (*Mullus barbatus*), anchovy (*Engraulis encrasicolus*), under the combined influence of demersal trawlers, Sea Surface Temperature (SST) and nitrate concentration. The third one included horned octopus (*Eledone cirrhosa*), capelan (*Trisopterus capelanus*), sardine (*Sardina pilchardus*), and the effect of nitrate concentration. These SINs provided a synthetic overview, and successfully restricted the complexity of the ecosystem to the main biotic interactions and abiotic drivers in the GOL fisheries. Once the key components of ecosystem had been identified, the SINs provided long-term predictions of the species' response following different scenarios, and showed that a decrease in phosphate concentration would be slightly unfavorable adult grey gurnard and, to a lesser extent, juvenile and adult hake, while a drop in nitrate concentration would be highly advantageous for juvenile blackbellied angler, thus supporting measures to reduce water pollution in the Rhône, particularly nitrogen pollution. Scenarios on fishing effort showed that reducing the fishing effort of demersal trawlers can have a considerable impact on adult red mullet through a direct effect, and on juvenile blackbellied angler through an indirect. The scenarios of combined effects of SST, nitrate concentration, and fishing effort revealed the key role of SST in the current improvement of the red mullet population, and the amplifying effect of positive interactions between species. Some limitations of this study were identified and some ideas on to overcome them were proposed. The length of the series was identified as the major constraint in this thesis. Other limitations linked to a lack of knowledge about the processes underlying the environmental shift and interactions between species were also pointed out. It was also difficult to find the right compromise between complexity and operationnality of the models identified. Finally, a few broad perspectives have been suggested for future studies like simulate catches of non-modelled species in bio-economic models using long-term predictions, or develop a two-stage population dynamics model using the SINs identified in this study and complement this model by adding a small bioeconomic part.

MOTS-CLÉS Demersal fish community / Multivariate Auto-Regressive models / Statistical interaction networks / Environmental effects / Fishing effects / Gulf of Lions

> jury

Jean-Marc FROMENTIN
Cadre scientifique Ifremer Sète,
UMR MARBEC,
Directeur de thèse

Olivier LE PAPE
Professeur Institut Agro Rennes-Angers,
UMR DECOD,
Rapporteur

Anna GARDMARK
Professor Swedish University of Agricultural Sciences,
Rapportrice

Daniela BANARU
Maître de conférences,
Mediterranean Institute of Oceanography,
Examinatrice

Catherine ALIAUME
Professeure Université de Montpellier,
UMR MARBEC,
Examinatrice

Olivier THÉBAUD
Cadre scientifique Ifremer Brest,
UMR AMURE,
Co-directeur de thèse

Sophie GOURGUET
Cadre scientifique Ifremer Brest,
UMR AMURE,
Co-encadrante de thèse

Grégoire CERTAIN
Cadre scientifique Ifremer Sète,
UMR MARBEC,
Co-encadrant de thèse

> lieu

Salle St Clair, Station Ifremer,
Avenue Jean Monnet, 34203 Sète

> lien zoom à venir

IRD Institut de Recherche pour le Développement FRANCE
Ifremer
cnrs
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