Complex small pelagic fish population patterns arising from individual behavioural responses to their environment

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Reçu le 01/04/2018; publié le 15/06/2019

Abstract

Small pelagic fish (SPF) species are heavily exploited in eastern boundary upwelling systems (EBUS) as their transformation products are increasingly used in the world food chain. Management relies on regular monitoring, but there is a lack of robust theories for the emergence of the populations’ traits and their evolution in highly variable environments. This work aims to address existing knowledge gaps by combining physical and biogeochemical modelling with an individual life-cycle based model applied to round sardinella (Sardinella aurita) off northwest Africa, a key species for regional food security. Our approach focused on the processes responsible for seasonal migrations, spatio-temporal size-structure, and interannual biomass fluctuations. Emergence of preferred habitat resulted from interactions between natal homing behaviour and environmental variability that impacts early life stages. Exploration of the environment by the fishes was determined by swimming capabilities, mesoscale to regional habitat structure, and horizontal currents. Fish spatio-temporal abundance variability emerged from a complex combination of distinct life-history traits. An alongshore gradient in fish size distributions is reported and validated by in situ measurements. New insights into population structure are provided, within an area where the species is abundant year-round (Mauritania) and with latitudinal migrations of variable (300 to 1200 km) amplitude. Interannual biomass fluctuations were linked to modulations of fish recruitment over the Sahara Bank driven by variability in alongshore current intensity. The identified processes constitute an analytical
framework that can be implemented in other EBUS and used to explore impacts of regional climate change on SPF.

**Keywords**: pelagic fish, model, DEB, Icthyop, ROMS, Pisces, CCLME.
International Conference
ICAWA 2017 & 2018
Extended book of Abstract

THE AWA PROJECT
Ecosystem Approach
to the management
of fisheries and the
marine environment
in West African waters

ISBN: 978-2-9553602-0-6

Trilateral German-French-African research initiative
Edited by
Patrice BREHMER (IRD, France)

Technical support: Ndague DIOGOUL (IRD, Sénégal), Cordula Zenk (Geomar, Germany) and Mahaut de Vareilles (UiB, Norway)

With the collaboration of
Noel Keenlyside (Norway), Jorge M. NASCIMENTO (CABO VERDE), Vito Melo RAMOS (CABO VERDE), Bamol Ali SOW (SENEGAL), Heino FOCK (GERMANY), Joern SCHMIDT (GERMANY), Werner EKAU (GERMANY), Adama Mbaye (SENEGAL), Assane FALL (MAURITANIA), Ivanice MONTEIRO (CABO VERDE), Aka Marcel KOUASSI (IVORY COAST), Osvaldina SILVA (CABO VERDE), Timothée BROCHIER (FRANCE), Moussa SALL (SENEGAL), Mohamed MAYIF (MAURITANIA), Yamara KONÉ (IVORY COAST), Thomas GORGUES (FRANCE), Carlos FERREIRA SANTOS (CABO VERDE), Idrissa Lamine BAMY (GUINEA), Iça Barry (GUINEA BISSAU), Momodou Sidibe (THE GAMBIA), Hamet Diaw DIADHIOU (SENEGAL)

ISBN: 978-2-9553602-0-6

Cover design: AWA (BMBF – IRD) project

Logo and flyers: Laurent CORSINI (IRD)

The both last ICAWA edition, 2017 and 2018, was done as a joint event with other closely related meeting. In 2017 with the inauguration of the OSCM in Cabo Verde underlining AWA cooperation with INDP and UNICV as well as Geomar and collaborators. In 2018 ICAWA was join to Preface final meeting following the memorandum of understanding signed a couples of years before between the two consortium and which have led at the end to a common policy session followed by the redaction of a policy brief taking advantage of the results of the both projects. Some abstract aside ICAWA joint session are missing see the organiser to get more information.

Sponsors ICAWA 2017 and IACAWA 2018

These two edition of ICAWA were joint with OSCM inauguration and the final meeting of the European preface project, respectively in 2017 and 2018.
International PREFACE International Conference on Ocean, Climate and Ecosystems joint with ICAWA 5th, edition 2018

Session 4: «Climate prediction Marine ecosystems, fisheries management and climate change». Thursday 19th April 2018

Poster presentation