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# Analysis of the genetic structure and life history of albacore tuna in terms of diversity, abundance and migratory range at the spatial and time scales:

**Project GERMON** (**GE**netic st**R**ucture and **M**igration **O**f albacore tu**N**a)

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## Summary

Tunas are important commercial species that represent a share of about 8 percent of total fish exports. In 2010, the total catch of tuna in three oceans was about 6.6 million tons, 4.3 million tons for the most marketed species, a level roughly stable since 2002 (FAO 2012). Among these tuna species, there are in descending order of capture: skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), albacore tuna (*Thunnus alalunga*) and bluefin tuna (*Thunnus thynnus*).

Overall, the biology of albacore stock in the Indian Ocean is not well known and there is relatively little new recent information on albacore stocks. Albacore life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. This species is a highly migratory species. It is found around the world in warm, temperate waters and can migrate thousands of kilometers each year across an entire ocean, but the relations between albacore populations across the oceans are uncertain. This species has been studied mainly in the Atlantic and the North Pacific, and very little is known about this species in the southern regions and tropics. In the Pacific and Atlantic oceans there is a clear separation of southern and northern stocks associated with the oceanic gyres that are typical of these areas. In the Indian Ocean, it is thought that there is only one southern stock, distributed from 5°N to 45°S, because there is no northern gyre and low caught in northern regions. This hypothesis needs to be investigated and more particularly the link that does exist between Indian Ocean and south Atlantic. In South African waters, huge numbers of juveniles are observed and the source is still unknown. Determinate this source is of primary concern for Regional Fishery Management Organization which amounts to the question of the relationship between these two oceans (Figure 1).

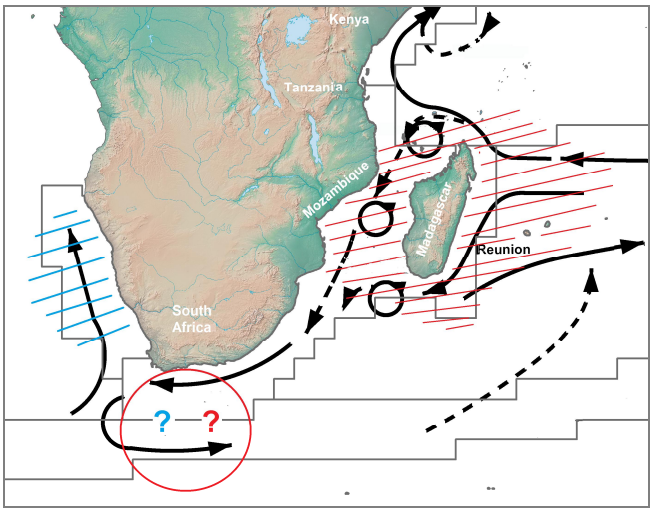


***Figure 1.*** *Main issue of the project: what is the link between the Indian Ocean (red) and South Atlantic (blue) albacore tunas and from which juveniles observed in South Africa come from? The hatched shows the sampling areas. The black arrows are the main regional currents.*

## Context Scientific

First estimates suggested that this species in the Indian Ocean decreased with higher exploitation rates these last decades (IOTC 2012) particularly since 2006 (Figure 2). Recent catches levels of Albacore have been well above the estimated MSY level in the Indian Ocean, recent fishing mortality was expected to exceed $F_{MSY}$, and spawning biomass is considered to be at or very near to the $SB_{MSY}$ level (IOTC 2012). The IOTC working Group of temperate Tuna concluded that fishing mortality in this Ocean needs to be reduced by at least 20% to ensure that spawning biomass is maintained at MSY levels (IOTC 2012), although there is substantial uncertainty remaining on the catch estimates. Because of the recent increase of the piracy of the coast of east Africa, most of the fishing fleets targeting tropical tunas and swordfish (mainly Fresh-tuna and Freezing longlines) operate much more in the southern waters of the Indian Ocean, increasing the catches of albacore tunas and probably contribute to the decrease of the stock observed.

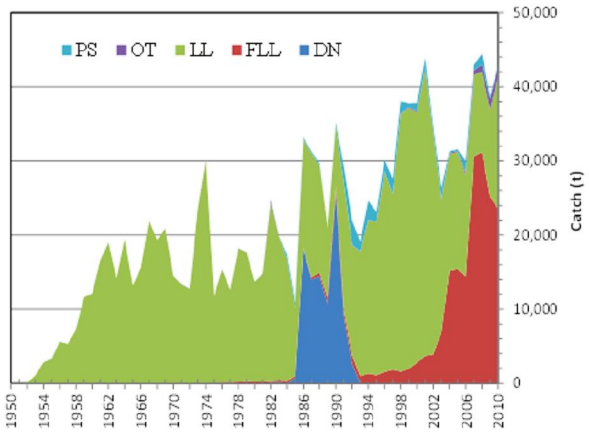


***Figure 2.*** *Annual catches of albacore by gear recorded in the IOTC Database (1950ï 2010) (Data as of June 2012). Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT) (IOTC 2012).*

In the meantime, most scenarios indicate that the south Atlantic albacore stock is both overfished and suffering overfishing (ICCAT 2011). It is considered north and south stocks are separated in Atlantic Ocean (ICCAT 1996). Beardsley (1969) proposed that small numbers of albacore may undertake inter-oceanic migrations between the South Atlantic Ocean and the Indian Ocean (Davies 2011); however, such claims remain to be substantiated through genetic and tagging studies, because the Indian and Atlantic Oceans population are currently managed as a separate stock (Chen et al. 2005).

With regard to the decrease of albacore tuna in both south Atlantic and Indian Oceans and the importance of this stock for some fisheries in the Indian Ocean, particularly in the western area, a study estimating the state of the stock should be of great help for future stock assessment and sustainable management in both Oceans.

**Brief process**

To address the question on the albacoreôs stock status in the Indian Ocean and the connectivity with the southern Atlantic, we proposed to use fisheries related data from the Reunion longline fishery operating in the southwestern area and genetic data across the Indian Ocean and South Atlantic.

1- Catch data analysis will allow to produce a new time series of standardize Catch Per Unit Effort as a French contribution to coming WPtmT. Such new analysis will help improving the stock assessment of this species mainly caught in the SWIO. The time series data that will be used are from 1995 to 2012 covering a wide range of 5° and 1° statistical square around the Reunion Island and Madagascar (Figure 2, red line). We also propose to establish length/length (data available in IFREMER database since 2001) and length/weight relations that is not currently available for this species and that could be of great use for follow catch at size, and long-term average size evolution of this species.

2- To a better assess the stock of this species, understanding the genetic structure of albacore tuna and the relationships that exist between the Atlantic and Indian Oceans are key issues for stock management. Genetic tools have already proven their efficiency in tracing migration and distinguishing fine structure inter-and intra-populational as between populations of albacore tuna in the Mediterranean and North Atlantic (Davies et al. 2011). Furthermore it is a less expensive tool to trace the history of a population or a species and by the way the influence of climatic and human changes. Here, we will use some new genetic models (VarEff, NeTMRCA, DemoDivMS, see Nikolic and Chevalet 2012 and the website https://qgp.jouy.inra.fr/) to access diversity, abundance, and history of this species in Indian Ocean developed by one of the project leaders. The structure and pattern of migration to determinate the link between both oceans and the root of juveniles in the South Africa will be analyzed by using classical model using probabilities of assignment and Euclidean distance. Concerning the samples, immature and mature individuals will be considered and integrated separately in view to likely difference range.

3- Biological characteristics and consequences in terms of structure are clearly the result of a change related to the environment of each ocean but also at the intra-ocean regional level (such as ecological Longhurst provinces): plasticity of life cycles, migration, reproduction, growth, movements (trophic and food) would be the consequence of the adaptation of eco-physiological characteristics to the environmental conditions of each ocean (Fonteneau 1998) and anthropogenic disturbances. Thus to display spatial structuring, we suggest to analyze

jointly habitat data and other information biological information inferred from other markers (Isotopes, stomach contents, otolith microchemistry, otholithometry, etc.).

**Collaborations**

The members of the IOTC (Indian Ocean Tuna Commission) Working Party of temperate Tuna recommended, to the IOTC Scientific Comity in 2012, that research aimed at determining albacore stock structure, migratory range and movement rates in the Indian Ocean are considered a high priority research project by the Scientific Committee in 2013. We therefore also suggest that understanding the links with the Atlantic should be added as a key research issue for the future. This expected project is not yet funded and is under development. Led by IFREMER in collaboration with other regional institute and organization, we expect to start it mid 2013 for a 3 year periods. Based on the first results and along with our partners, we expect to develop this project providing a spatial dynamic component such as tagging and satellite tracking juveniles from South African waters. However, such a component will be first discussed and developed in close relation with both IOTC and ICCAT Commissions.

Expected partners:

- IRD : Francis Marsac, Frédérique Menard, Michel Potier
- CapFish ï South Africa: Chris Heineken
- IPIMA Portuguese Sea and Atmosphere Institute (Portugal): Miguel Neves dos Santos
- AFRDEC

**Reference**


Beardsley F. 1969. Proposed migrations of albacore, *Thunnus alalunga*, in Atlantic Ocean. Trans Am Fish Soc 98:589ï 590.

Davies CA, Gosling EM, Was A, Brophy D, Tysklind N. 2011. Microsatellite analysis of albacore tuna (*Thunnus alalunga*): population genetic structure in the North-East Atlantic Ocean and Mediterranean Sea. Marine Biology 158, 2727-2740.

Chen IC, Lee PF, Tzeng WN. 2005. Distribution of albacore (Thunnus alalunga) in the Indian Ocean and its relation to environmental factors. Fisheries Oceanography.

FAO. 2012. La situation mondiale des pêches et de lôaquaculture 2012. 1er Partie. http://www.fao.org/docrep/016/i2727f/i2727f01.pdf

FOC. 2010. Germon ou Thon Blanc. Fisheries and Oceans Canada. http://www.dfo-mpo.gc.ca/international/facts-faits/tuna-thon-alba-fra.htm

ICCAT. 2011. Report of the 2011 ICCAT South Atlantic and Mediterranean Albacore stock assessment sessions. Madrid, Spain.

ICCAT. 1996. Report of the final meeting of the ICCAT Albacore Research Program. Sukarrieta, Vizcaya.

IOTC 2012. WPTmT04. Report of the Fourth Session of the IOTC Working Party on Temperate Tunas. Shanghai, China, 20ï 22 August 2012

Nikolic N, Chevalet C. 2012. Detecting past changes of effective population size. Plos Genetics. Submitted.

SIH. Rapport national CTOI UE-France 2012. In preparation.