

Population genetics

Or the study of the geographical genetic differences

In population genetic studies, we examine small portions of DNA called "markers". These markers are transmitted from one generation to another.

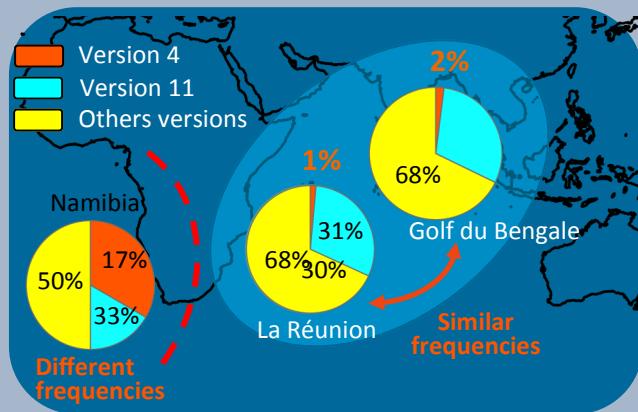
When changes in the DNA sequence occur accidentally (mutations), there is creation of a new version of the marker (e.g. marker ND2 studied in this project IOSSS with 282 different versions).

Each new version is only transmitted to the descendants of the individual carrying the mutation.

Genetic differentiation is calculated from the frequency of different versions of the marker:

- ⇒ If the frequency of different versions is similar between two populations, then genetic differentiation is low and populations are connected to each other.
- ⇒ If the frequency of the various versions differs from one population to another, then the genetic differentiation is high and populations are isolated from each other.

For example: frequency of versions 4 and 11 of the marker ND2 of swordfish in 3 different regions



Under the project IOSSS-ESPADON, two types of markers were studied:

- The **mitochondrial marker ND2** (sequence of 1007 base pairs) only transmitted through the female line.
- and **20 nuclear markers** (like microsatellites) transmitted equally by male and female lines.

Population genetics: useful and powerful tool for managers

The mitochondrial marker has proved to be very efficient in identifying the swordfish stock structure at the scale of the Indian Ocean, instead of nuclear markers that did not reveal any clear structure.

These results underline (1) the importance of using several kinds of genetic markers, (2) the need to use complementary approaches to identify relevant stock structure for a species (i.e. otolith shaping, parasite studies, isotopes....)

Population genetics must be integrated into a multi-disciplinary approach .

The IOSSS project is not only a population genetic study, but also involved:

- The collection of more than 700 otolith pairs in order to confirm (via morphological and microchemical studies) the structure found with the genetic approach
- The study of swordfish biology :
 - ⇒ More than 6000 biometric measurements were carried out in order to determine the population size structure
 - ⇒ Sex and maturity stage on more than 1000 swordfish were determined to identify areas and periods of reproduction
- The study of feeding ecology :
 - ⇒ The analysis of more than 535 stomach contents revealing the main preys species of swordfish.
 - ⇒ The study of the isotopic ratios of nitrogen and carbon in order to locate the swordfish in the marine food chain

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<http://wwz.ifremer.fr/lareunion/Les-projets/IOSSS-ESPADON>

Funding partners:



Scientific partners :



IOSSS-ESPADON PROJECT

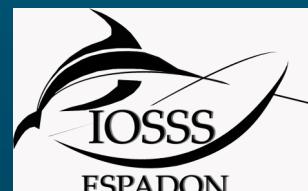


Ifremer

Indian Ocean Swordfish Stock Structure

Structure du Stock d'Espadon
de l'Océan Indien

2009 — 2012



Objective: **To study** the population structure of swordfish in the Indian Ocean in order to better **assess** and **manage** the resource.

The Indian Ocean Tuna Commission (IOTC) manages large pelagic fishes in the Indian Ocean and evaluates annually, the status of the swordfish resource. The latest evaluation has shown (1) a resource fully exploited across the Indian Ocean, and (2) large uncertainties in the southwest area (possible localized overexploitation).

The main challenge in order to improve these assessments and ensure the sustainable management of the resource is to **define the population structure of swordfish** in the Indian Ocean. Stocks identified will then be managed as separated units upon which can be applied appropriate management measures (i.e. TACs and quotas, area closures, limitation of fishing effort, ...).

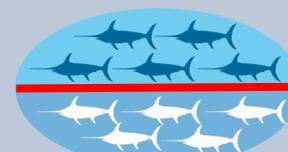


A fish **stock** is a subgroup of individuals (belonging to the same species) largely isolated and independent from the rest of the population. Individuals of a stock breed within this stock, and not with individuals of other stocks.

Population genetics is a tool for **identifying stocks**. It allows scientists to calculate the genetic differentiation between populations, and to infer their isolation or their connectivity to each other.



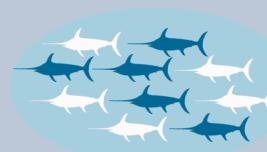
If genetic differentiation is **high**, the population of North and South are **isolated** and belong to two different stocks.



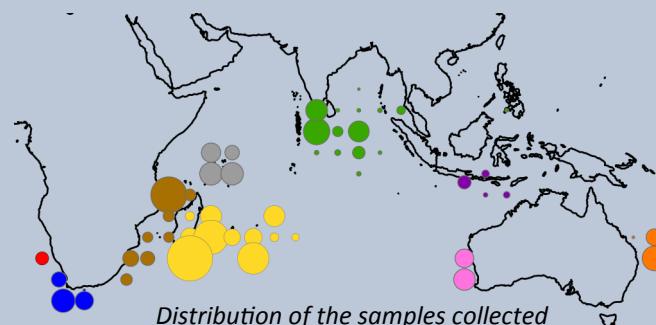
Swordfish from the North

Swordfish from the South

If genetic differentiation is **low**, the population of North and South are **connected** and belong to the same stock.



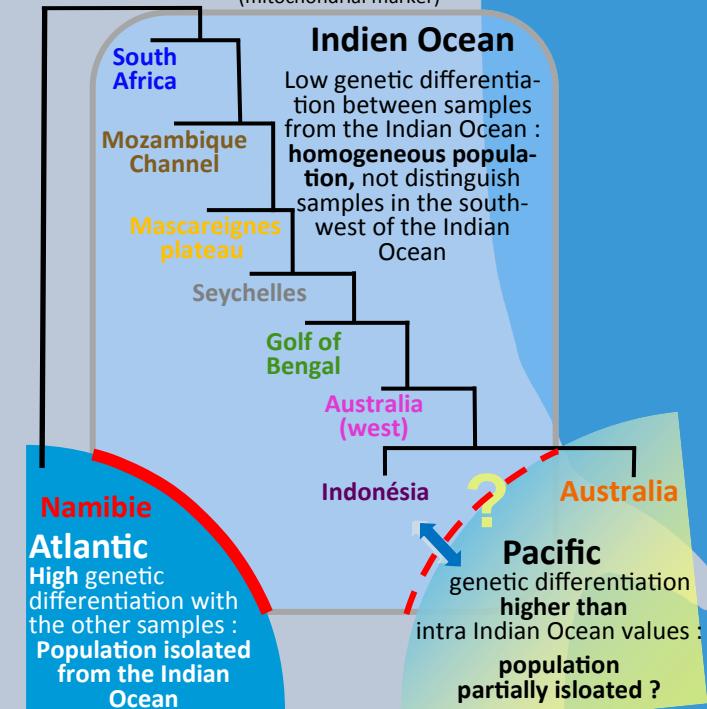
More than **2500** swordfish samples were collected under the project **IOSSS-SWORDFISH** via a **stratified sampling strategy over time** (4 seasons from 2009 to 2011) and **space** (9 zones in the Indian Ocean, an area in the southeast Atlantic and another in the southwest Pacific). This sampling was made possible through an **international network of scientific partners**. These samples were analyzed in the population genetics laboratory of Ifremer Indian Ocean in respect of its quality approach, ensuring traceability and reliability analyzes.



Distribution of the samples collected

Neighbor joining tree of genetic differentiation

The value of genetic differentiation is symbolized by the long black line.
(mitochondrial marker)



The population of swordfish in the Indian Ocean acts **as a single stock**, including the southwest area. The Indian Ocean as a whole can be considered as a **management unit of swordfish**.

The Indian Ocean stock is clearly **isolated** from the population of **South Atlantic**, but relations with the **Pacific** are more complex: all the evidence suggests that there is **limited interaction** between these two oceans.