Genetic population structure of the Swordfish (*Xiphias gladius*) in the southwest Indian Ocean: sex-biased differentiation, congruency between markers & its incidence in a way of stock assessment

Authors: Muths D.[1,3], Grewe P. [2], Jean C. [1] and Bourjea J.[-1]

Presented by: J. Bourjea: Jerome.bourjea@ifremer.fr

[1] IFREMER Délégation Réunion, Rue Jean Bertho, BP60, 97822 Le Port, France

[2] CSIRO Marine and Atmospheric Research, Castray Esplanade, Hobart, Tasmania 7000, Australia

[3] Institut de Recherche pour le Développement (IRD), Parc Technologique Universitaire, 2 rue Joseph Wetzell, 97492 Sainte-Clotilde, France

Abstract

Genetic variation was surveyed at eleven microsatellite loci and at 517bp of the mitochondrial control region to investigate the presence of genetic stock structure in swordfish (*Xiphias gladius*) in four proximal localities of the southwest Indian Ocean. One aim of this study was to serve as a preliminary examination for congruency of structure detected by these two genetic markers, prior to conducting a more comprehensive basin-wide survey of the Indian Ocean and nearby surrounding areas. Analyses of multi-locus microsatellite genotypes and mitochondrial control region sequences both revealed a great homogeneity between samples. Genetic diversity detected at the regional scale was not significantly higher than detected at the local scale. Results suggest that the southwest Indian Ocean globally functions as a unique panmictic population. However, some discrete genetic differences appeared that could possibly indicate influence from a second genetic pool in the northern part of the Indian Ocean. This structure appeared to be sex-dependant with genetic differences higher among female than among male samples. This result may indicate a higher level of spawning area fidelity for females with a subsequent sampling bias tending to homogenize male genotypic distributions.

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6th WIOMSA Symposium

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MUTHS Delphine (IFREMER) GREWE Pete (CSIRO)
JEAN Claire. (Kélonia) & BOURJEA Jérôme (IFREMER)

Worldwide fish found in
all tropical to temperate oceans

< -600 m during the day
In superficial water at night

Not in shoals

Use to migrate from feeding
areas to spawning zones but
assumed to be a *viscous* stock

Indian Ocean is considered
as a unique stock

Greatest commercial value
of the billfish resource
in the World

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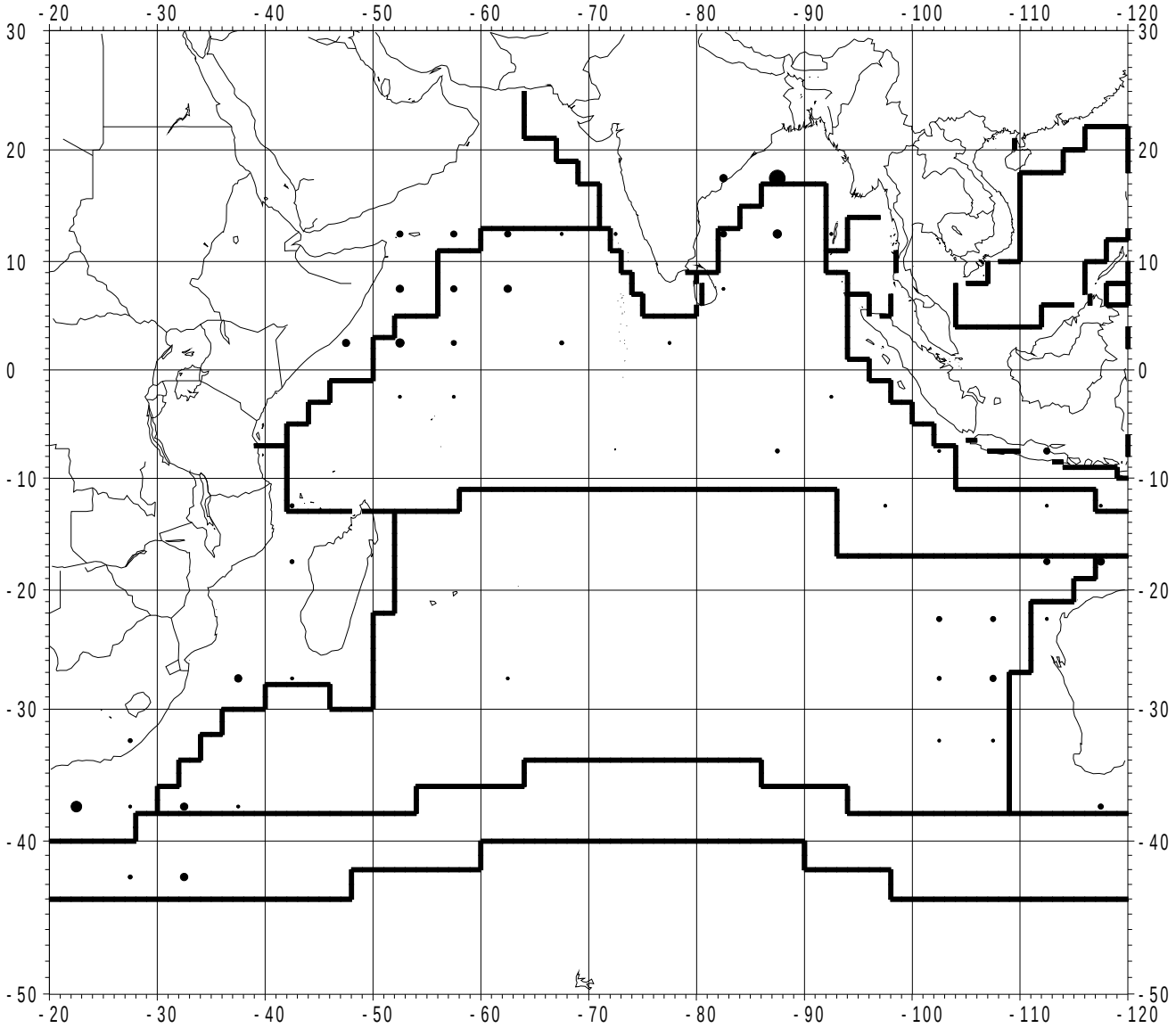

SWO catches all LL 1955-1979

SWO ● 200

1955 – 1979 catches

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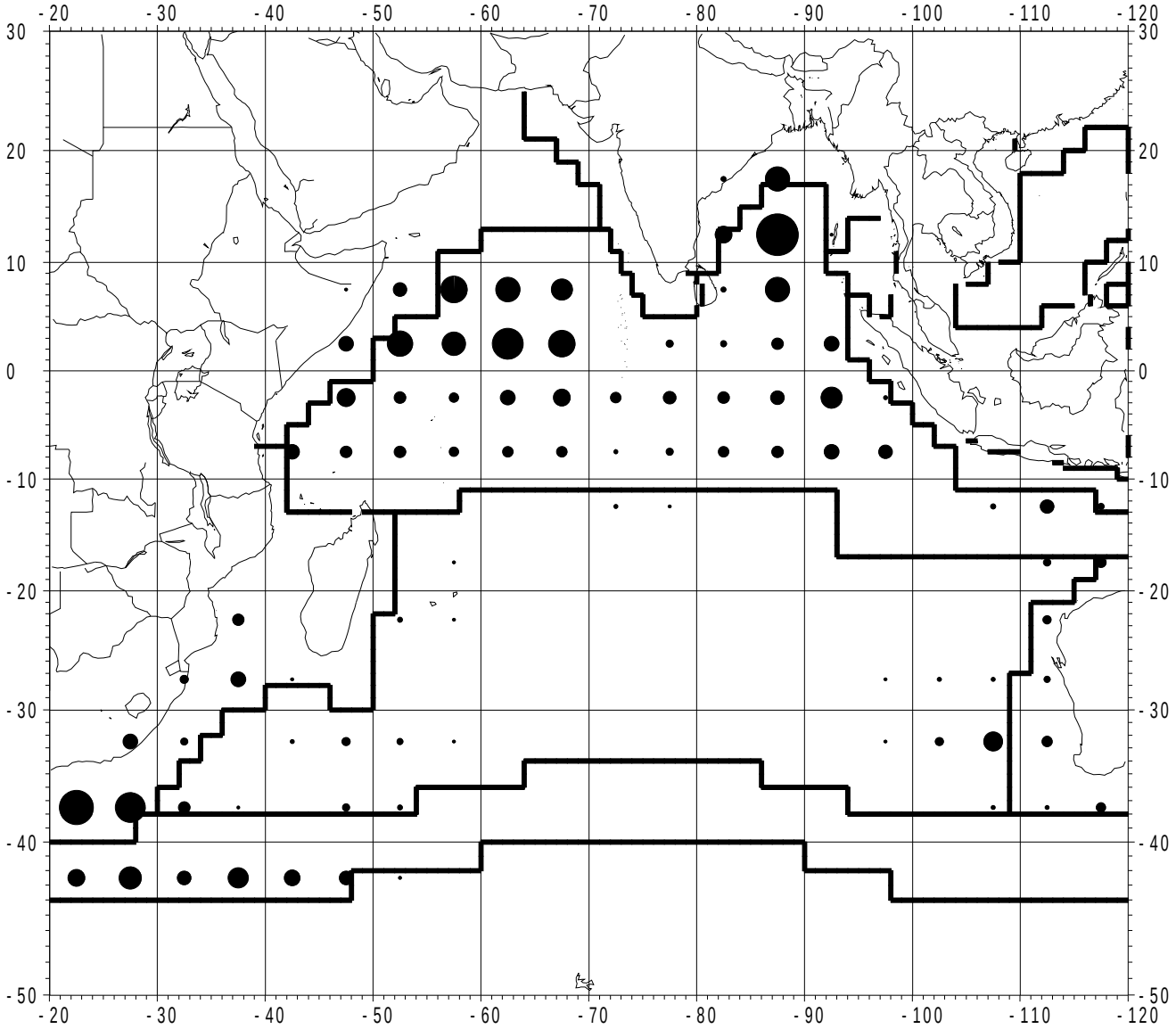

SWO catches all LL 1980-1984

SWO 200

1980 – 1984 catches

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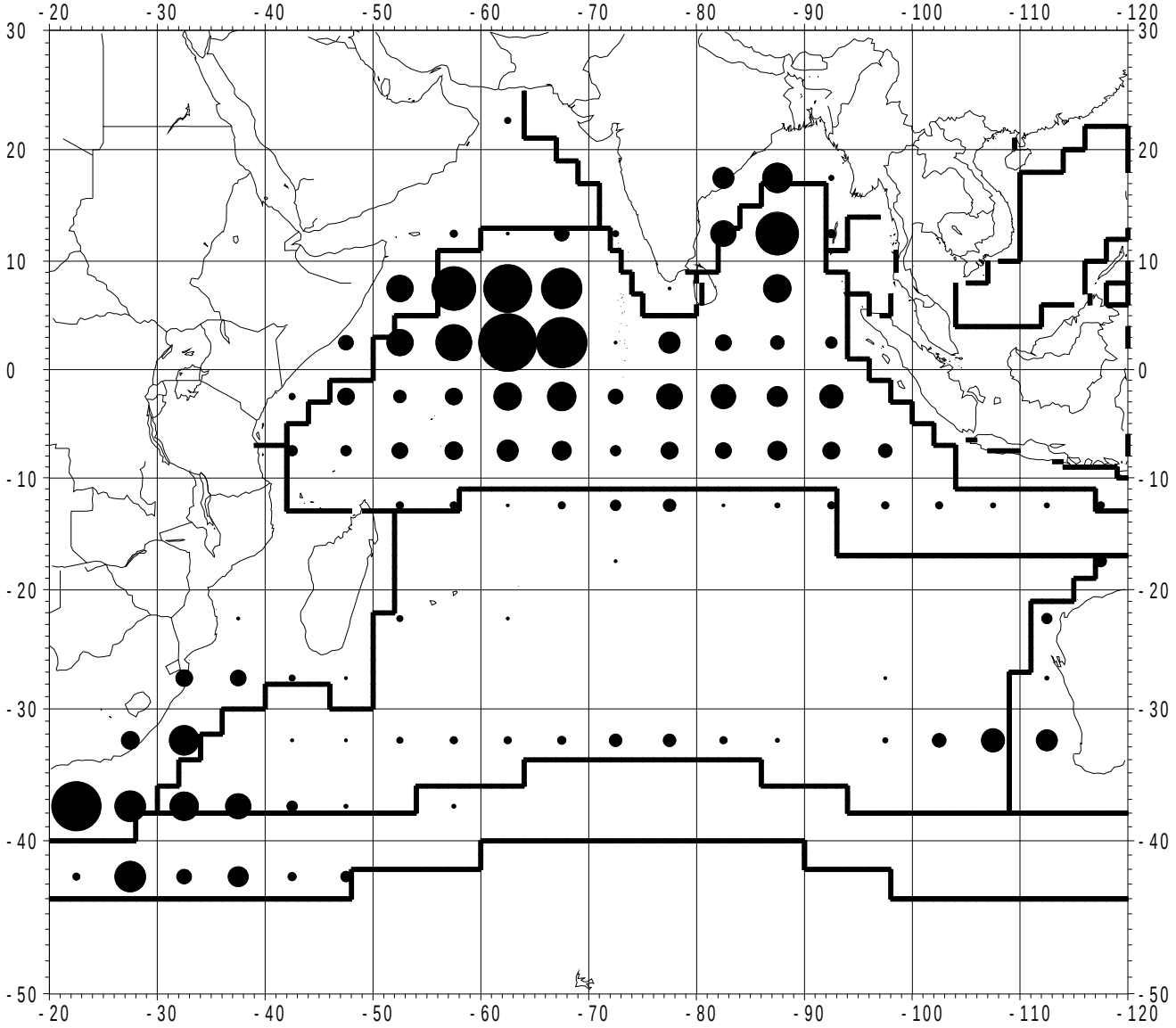

SWO catches all LL 1985-1989

SWO 200

1985 – 1989 catches

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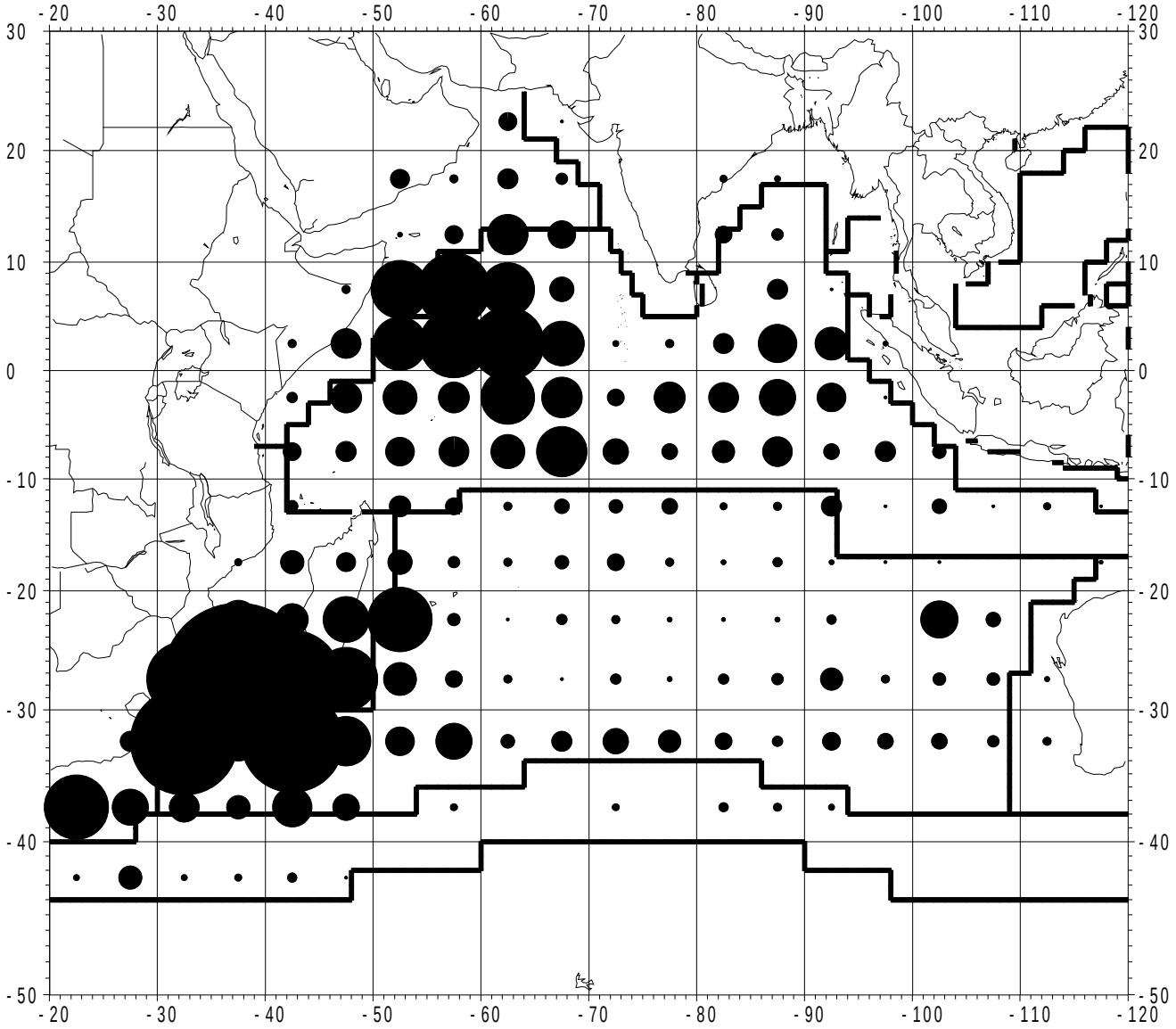

SWO catches all LL 1990-1994

SWO 200

1990 – 1994 catches

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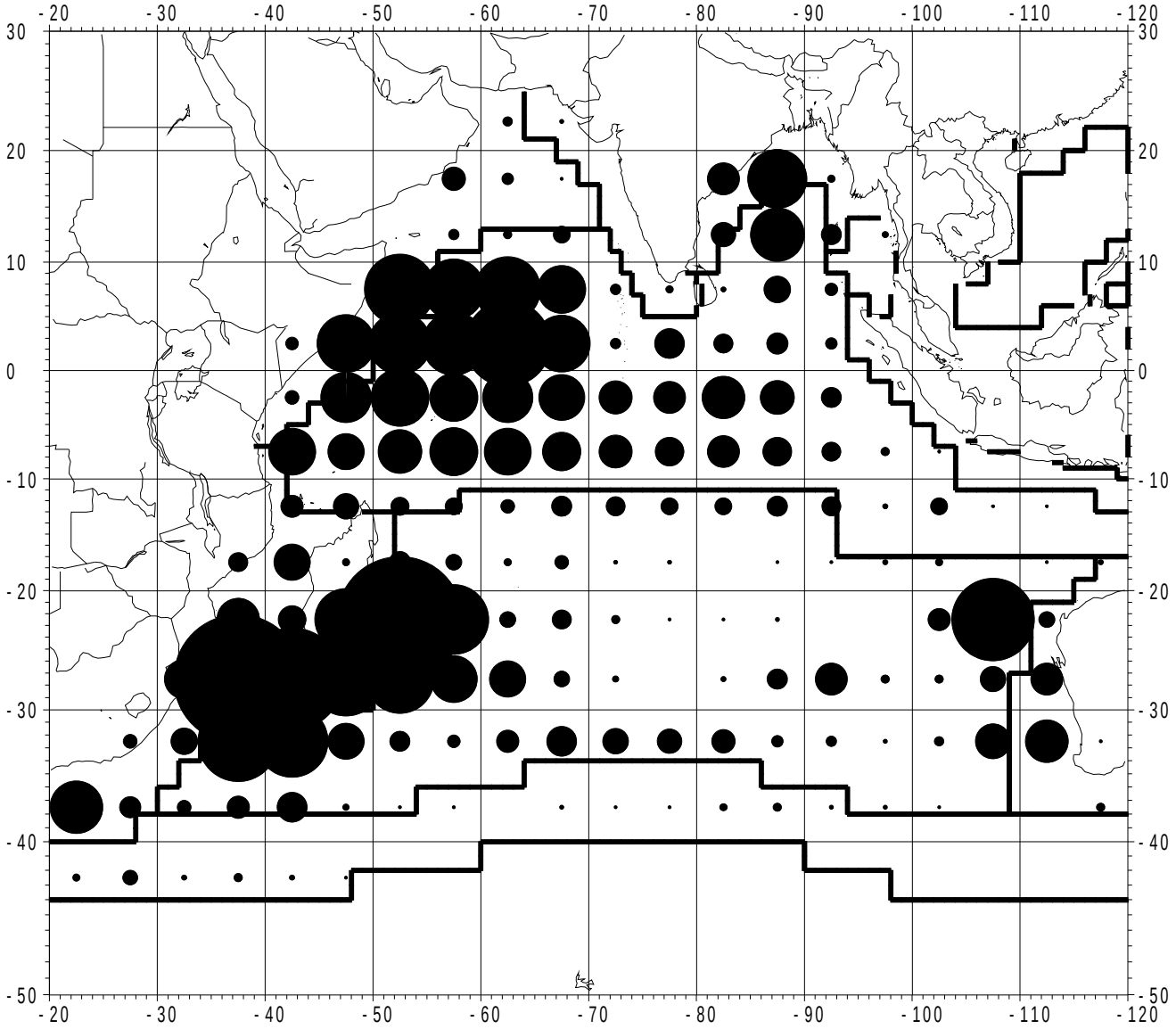

SWO catches all LL 1995-1999

SWO 200

1995 – 1999 catches

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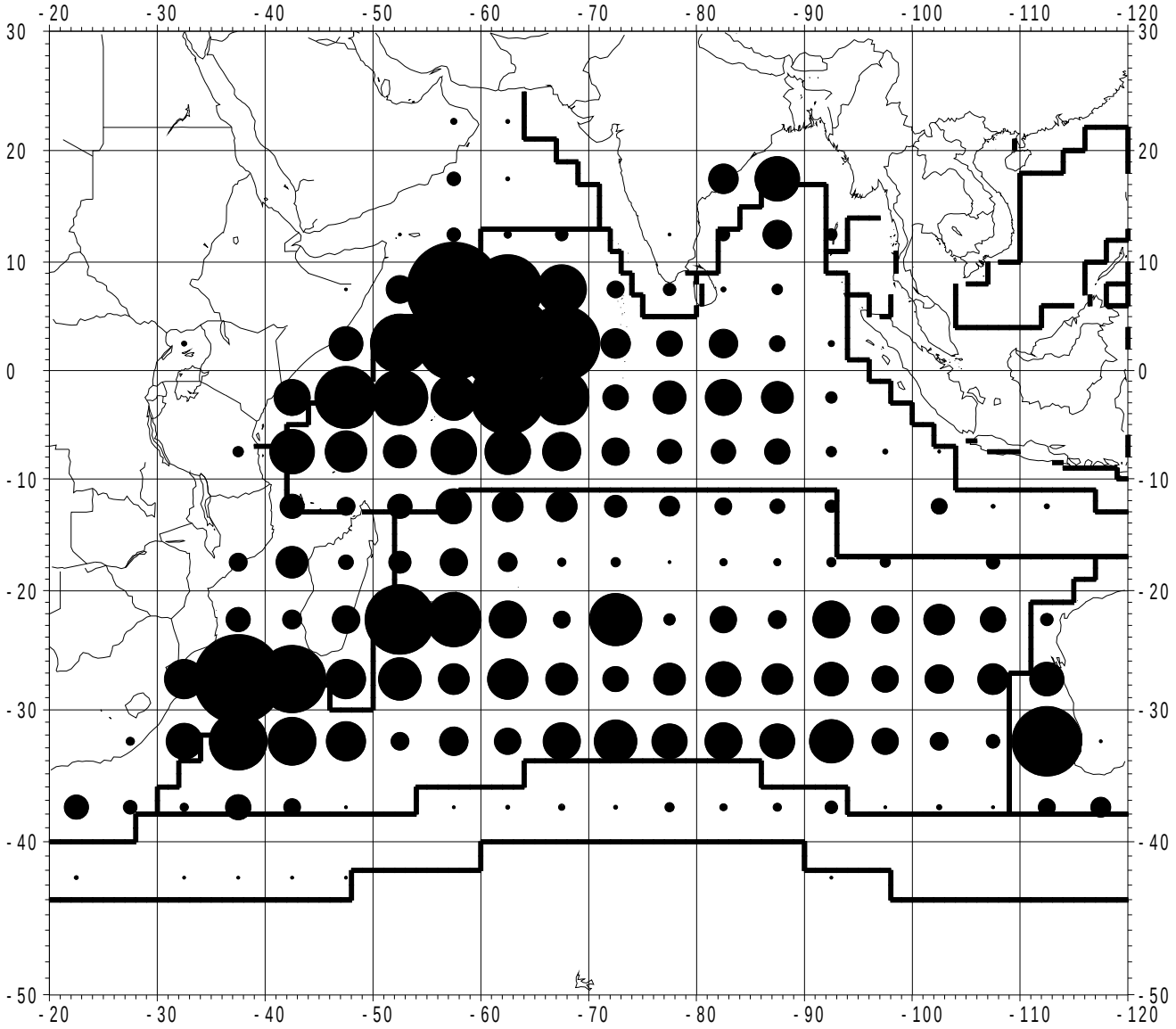

SWO catches all LL 2000-2004

SWO 200

2000 – 2004 catches

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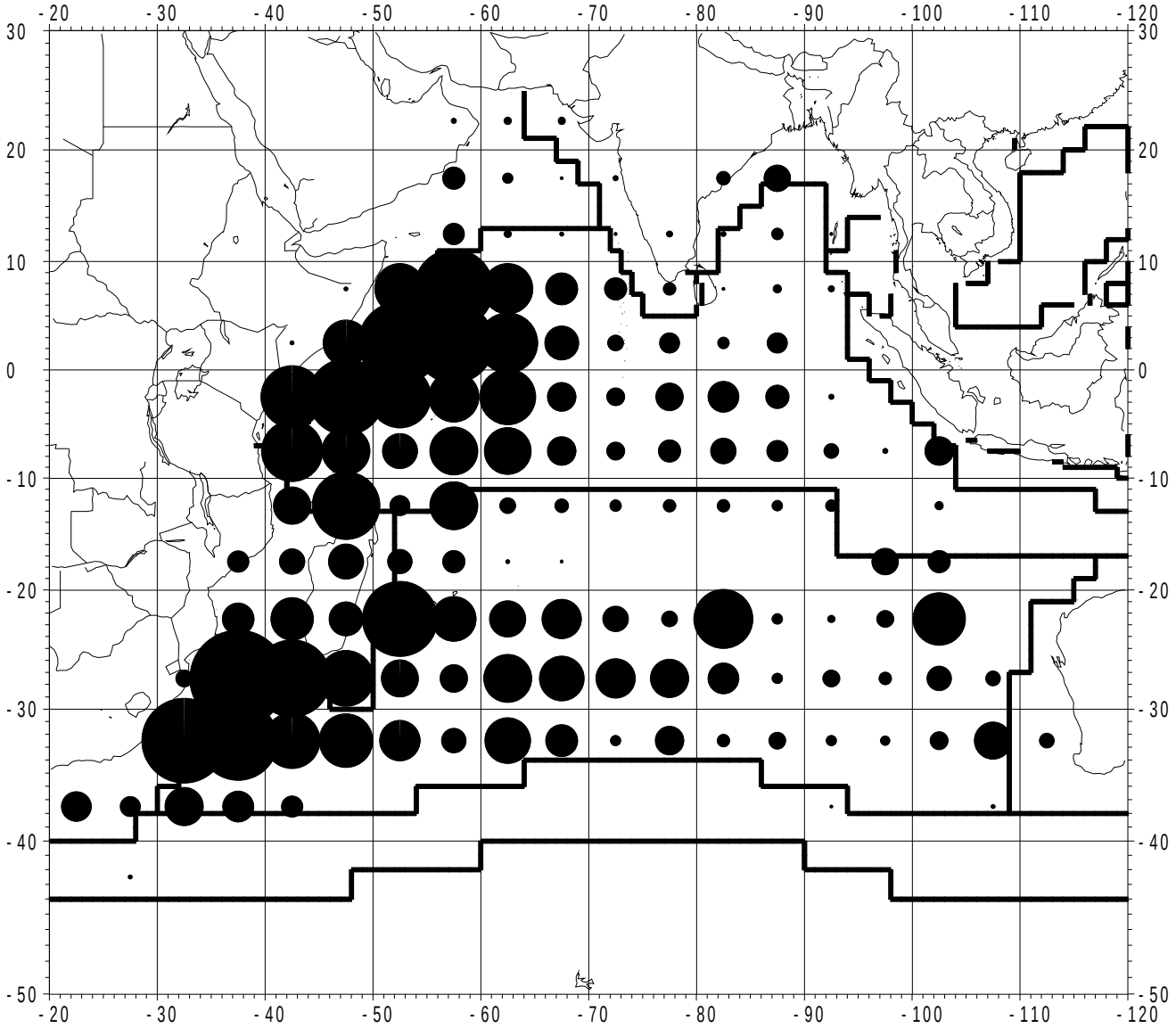

SWO catches all LL 2005-2007

SWO 200

2004 – 2007 catches

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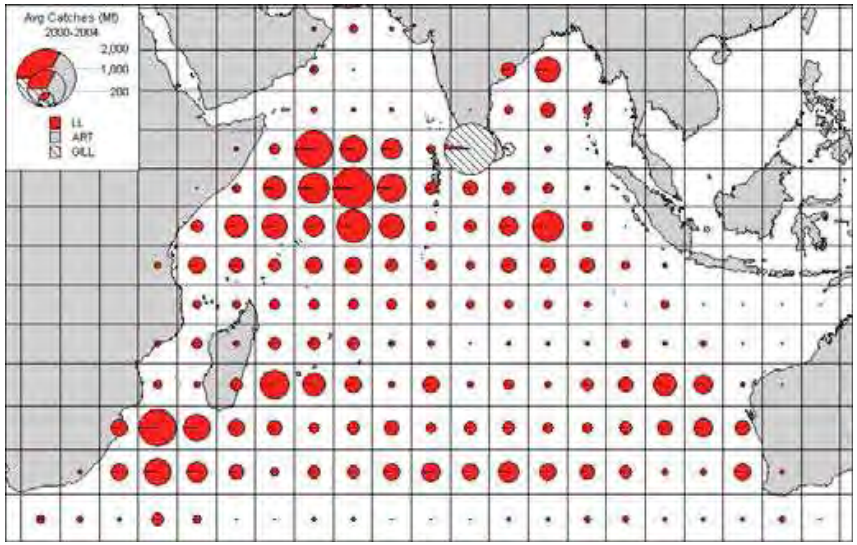
IOTC current Status of Swordfish stock in 2008



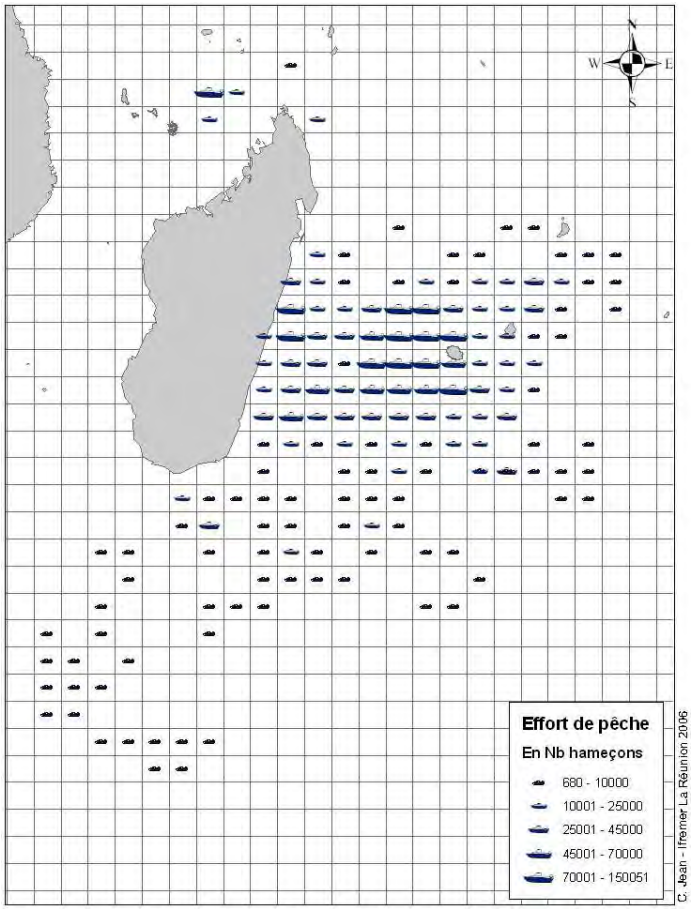




Location of longliners swordfish catches



Current catch of swordfish
is around 30,000 tons



Distribution of French LL effort in the SWIO

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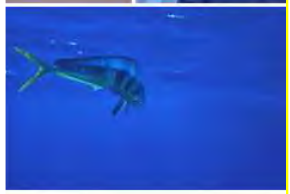
IOTC current Status of Swordfish stock in 2008




2009 IOTC Stock Assessment conclusions...

- **MSY** : Most modeling approaches suggest that MSY could reasonably be in the range of ~28-34,000 tons
- **Constant decrease of CPUE since the last 10 years**
- **the stock is full exploited, and probably over exploited in some area : SWIO and NWIO**
- **large gaps remains in terms of biology, structure and behavior of the species to improve the stock assessment**

…and Research Priorities :

« The WPB still considered determination of stock structure as a research priority as the information available tends to indicate localized depletion in certain areas »

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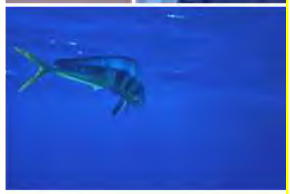
Preliminary study on swordfish genetic structure in the SWIO




Main issues of the study :

- Test the congruence of conclusions based on the two genetic markers for this species

- To assess the level of connectivity between swordfish sampled in four different localities of the SWOI

- To Evaluate the feasibility of leading a project at the Indian Ocean Scale

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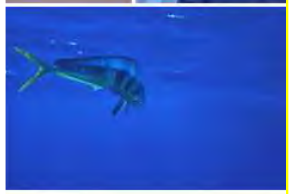
Preliminary study on swordfish genetic structure in the SWIO




<u>337 samples in 4 sites</u> :

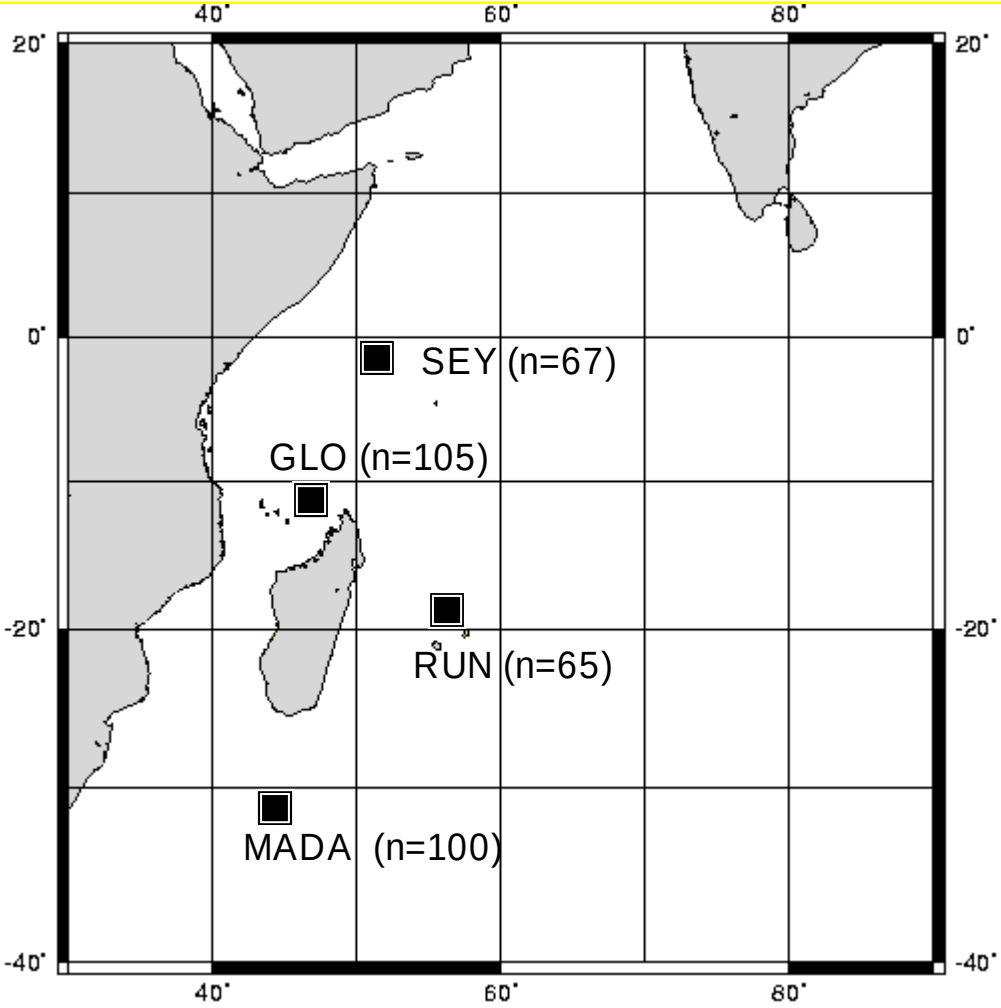
- Seychelles, Glorieuses, La Reunion, Southern Madagascar

- Tissues, sex and size data

<u>2 markers used</u> :

- mtDNA control region

- 11 microsatellites



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Samples and genetic diversity







		GLO	MADA	RUN	SEY
Sampling	*N*	105	100	65	67
	Mean size (cm)	73.7 ± 19.0	90.1 ±9.4	87.2 ±21.5	75.2 ± 18.4
	Prop. of females	0.47	0.67	0.13	0.58
Mitochondrial diversity	*h*	90	90	59	60
	Hd	0.997	0.997	0.997	0.996
	π	0.020	0.019	0.021	0.019
	Tajima's D	-1.54	-1.45	-1.74	-1.41
	Fu's F	-1.52	-1.84	-2.54*	-2.04
Microsatellites diversity	*Mean Nall*	17.5	16.0	14.3	15.2
	Mean Rs	14.6	13.7	13.3	14.2
	Private Nall	16	8	3	9
	Hnb	0.784	0.780	0.776	0.771
	Hobs	0.720***	0.667***	0.640***	0.658***
	Ne estimate	879	585	277	506

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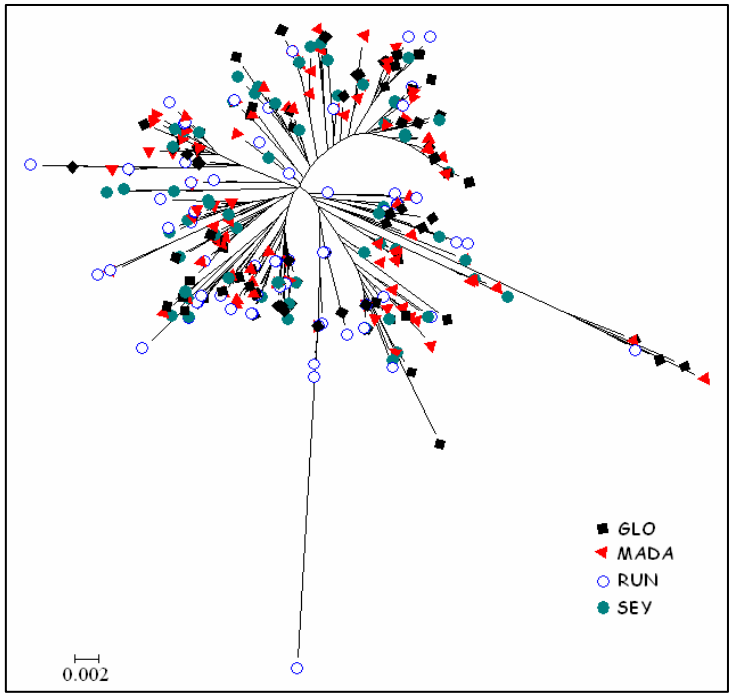
Samples and genetic diversity

High genetic variability within the samples

mtDNA

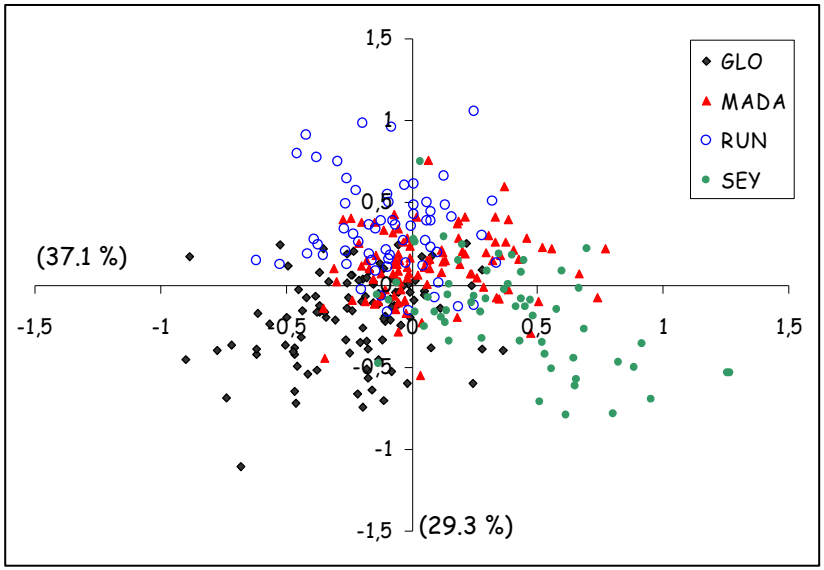
- *Haplotypic diversity ≈ 1*
- *Neighbour joining tree:*



- *Snn Statistics* → association between geographic and genetic data not significant

MICROSATELLITES

- *CFA genotypes frequencies*



- *AMOVA (*99% of genetic variance is intra-pop)

- *Structure analysis: 1 Group*

➔ a unique **panmictic population** at the level of the SWIO?

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Samples and genetic diversity

We have a High genetic variability within the samples…
But if we look in details, there is some differences…

Fst

	GLO	MADA	RUN	SEY
GLO		0.000	0.000	0.001
MADA	0.001		0.001	0.001
RUN	0.000	0.000		**0.003***
SEY	**0.005*****	0.002	0.003	

(mtDNA)

(microsatellites)

➔ Where do come from these differences in Seychelles?

	GLO	MADA	RUN	SEY
GLO	**0.005*****	0.005	**0.005***	0.001
MADA	0.005	0.000	0.006	0.000
RUN	0.009	0.000	0.010	0.005
SEY	**0.013*****	0.004	0.006	0.003

(male)

(female)

⇒ Females are different in Sey and Glo

⇒ Male and female are different in Glo

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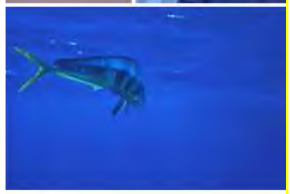
First conclusions…

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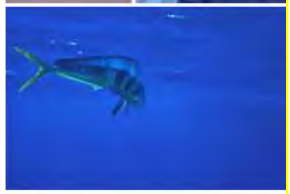
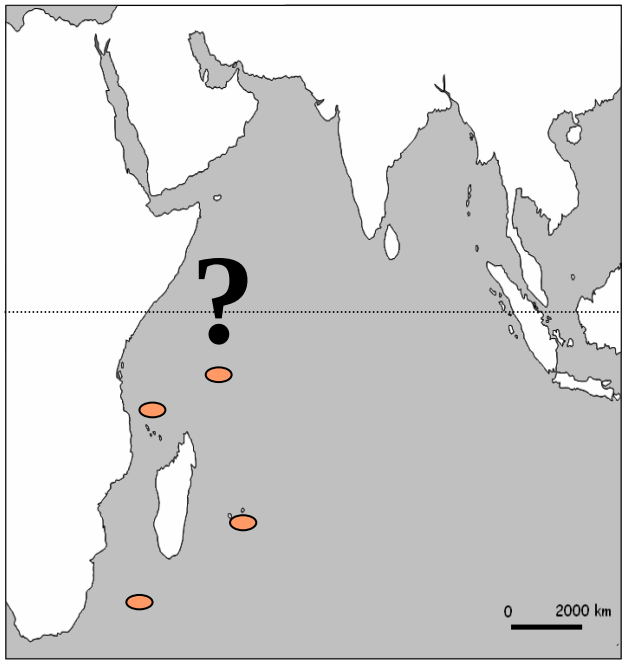
First conclusions…




1- **A unique** panmitic population **for the 4 localities sampled in the SWIO…**

…but the influence of **a second one in the northern area?** = at least 2 populations in the WIO? What about relationship with East?



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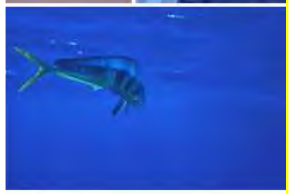
And what do we learn?




2- the 2 markers detect some differentiation between Seychelles and the other southern sites = congruence of markers that can be useful for genetic structuring

3- The importance of biological data in genetic data interpretation

4- The need of enlarging the sampling area to the whole Indian Ocean and it connection

5- The need in investigate the temporal effect and the stability of the structure

⇨ **THE IOSSS PROJECT**

IOSSS
ESPADON

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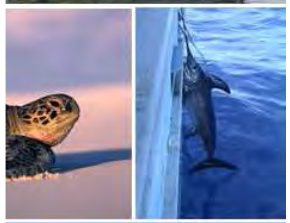
IOSSS Project/ ESPADON



Team leader : IFREMER

Partners: CSRIO (Australia), IRD (France), SFA (Seychelles), AFRDEC (Thailland), CapFish (South Africa), Apollo Marine International (Sri Lanka)

CSIRO
IRD Institut de recherche pour le développement
SFA
CapFish

Funded by European Union (FEP)
France
Région Réunion

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
REGION REUNION

Started in February 2009

IOTC
CTOI

REPRODUCTION

Ifremer

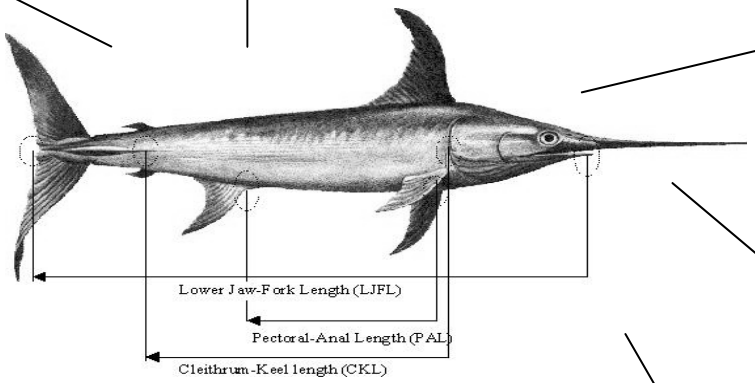
IOSS
ESPADON

ISOTOPES
Feeding behaviour

IRD
Institut de recherche pour le développement

OTHOLITHES

CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE



GENETIC
- *mtDNA*
- *20 microsatellites*
- *SNPs*

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CSIRO

Data collection on
- Size
- Sex ratio
- Maturation stages

PARASITES GENETIC

Tuna Research and Conservation Center

CapFish

IRD
Institut de recherche pour le développement

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SPA

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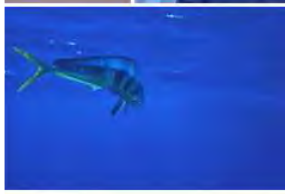
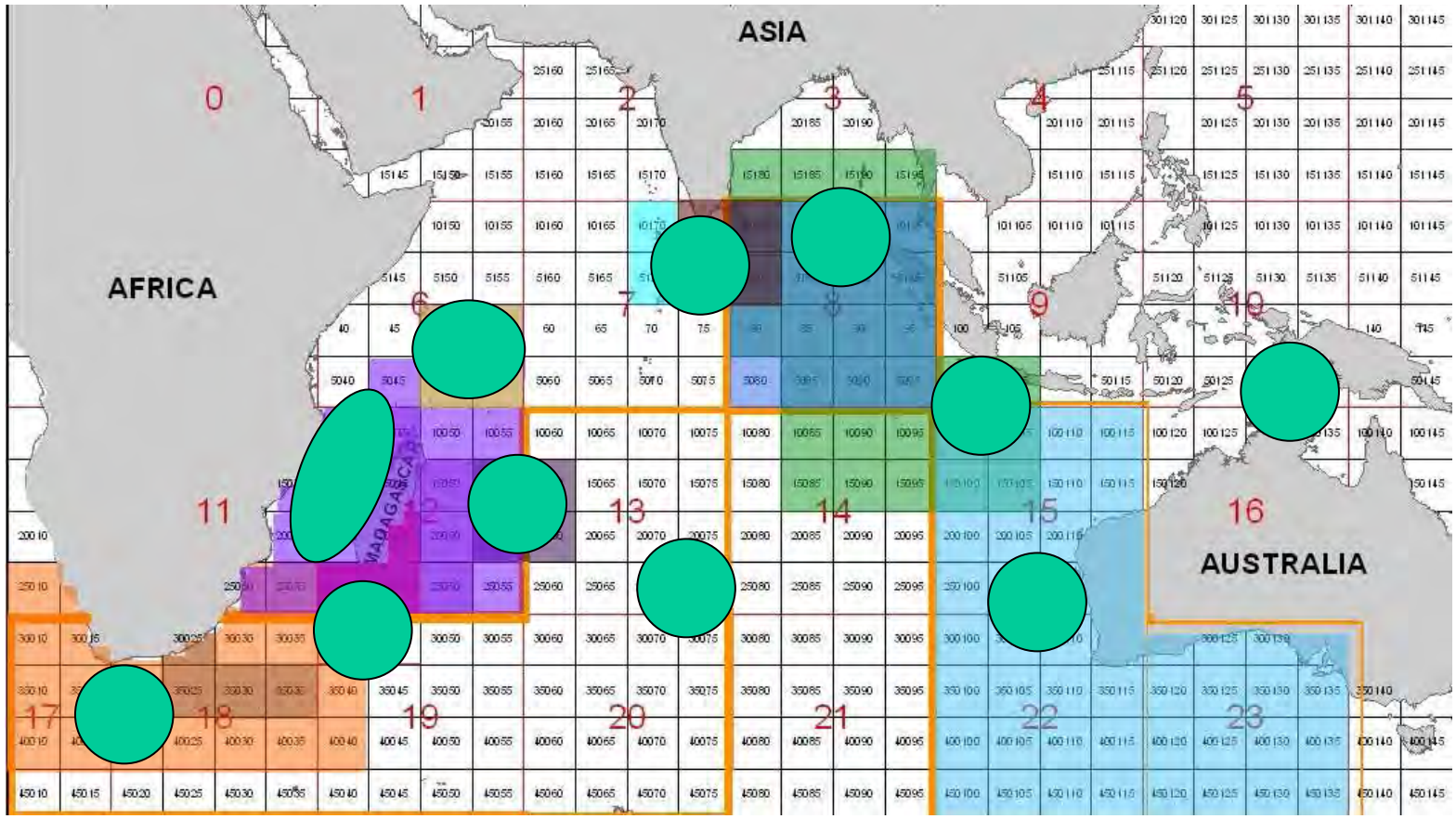
IOSSS sampling scheme

IOSSS
ESPADON



100 samples per area, 2 Seasons 2 years, for genetic, isotopes biometry, otolith collection, stomach content, gonad analysis

6th WIOMSA Western Indian Ocean Marine Science Association

SCIENTIFIC SYMPOSIUM
24 -29 August 2009
St. Denis, La Réunion

See you in
the next
WIOMSA
for the results!

Thank You!

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VALORISONS NOS ATOUTS

IOSSS
ESPADON