MASPAWIO

A collaborative project for supporting MSP development

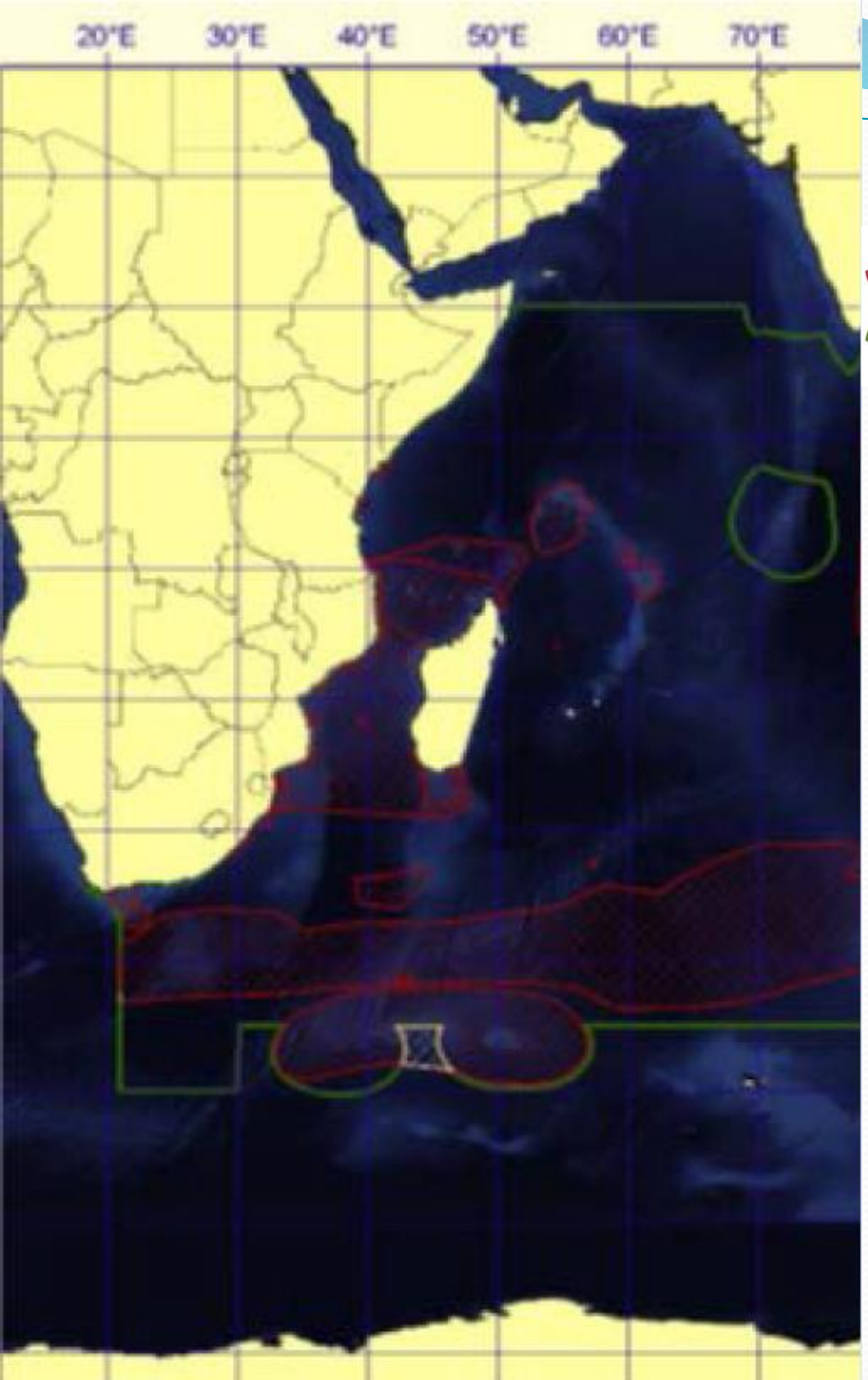
in Western Indian Ocean

FRANCE-IUCN PARTNERSHIP NATURE AND DEVELOPMENT

Liberté · Égalité · Fraternité
RÉPUBLIQUE FRANÇAISE
Le Gouvernement

UICN

AFD



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UICN

AFD

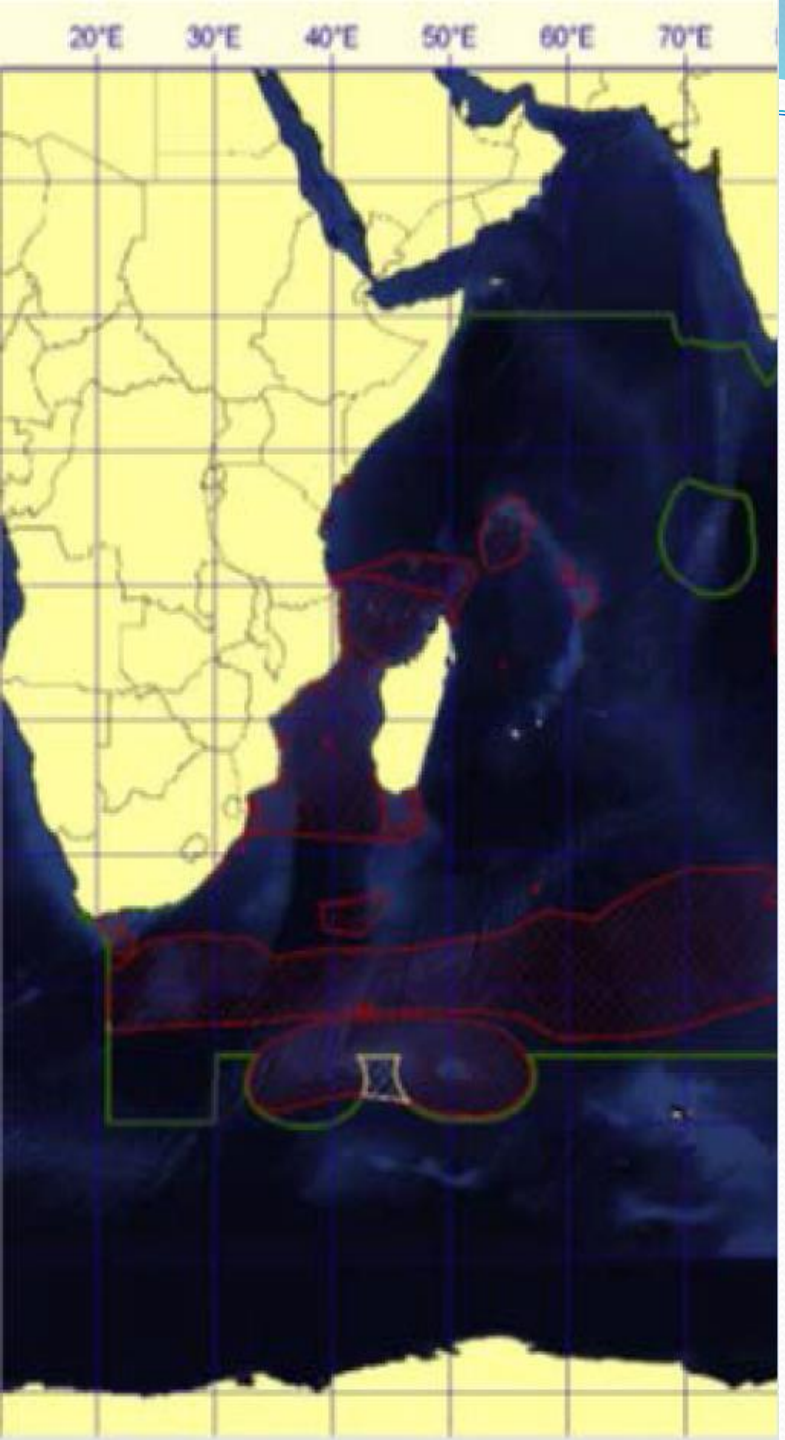
A project managed by UICN
A project implemented in collaboration with CORDIO

A seed-money / pilot project
Aiming at

- fostering regional cooperation on MSP and
- supporting Nairobi Convention and its Parties

Drawn up on interconnectivity and common needs

Driven by a partnership and collaborative approach

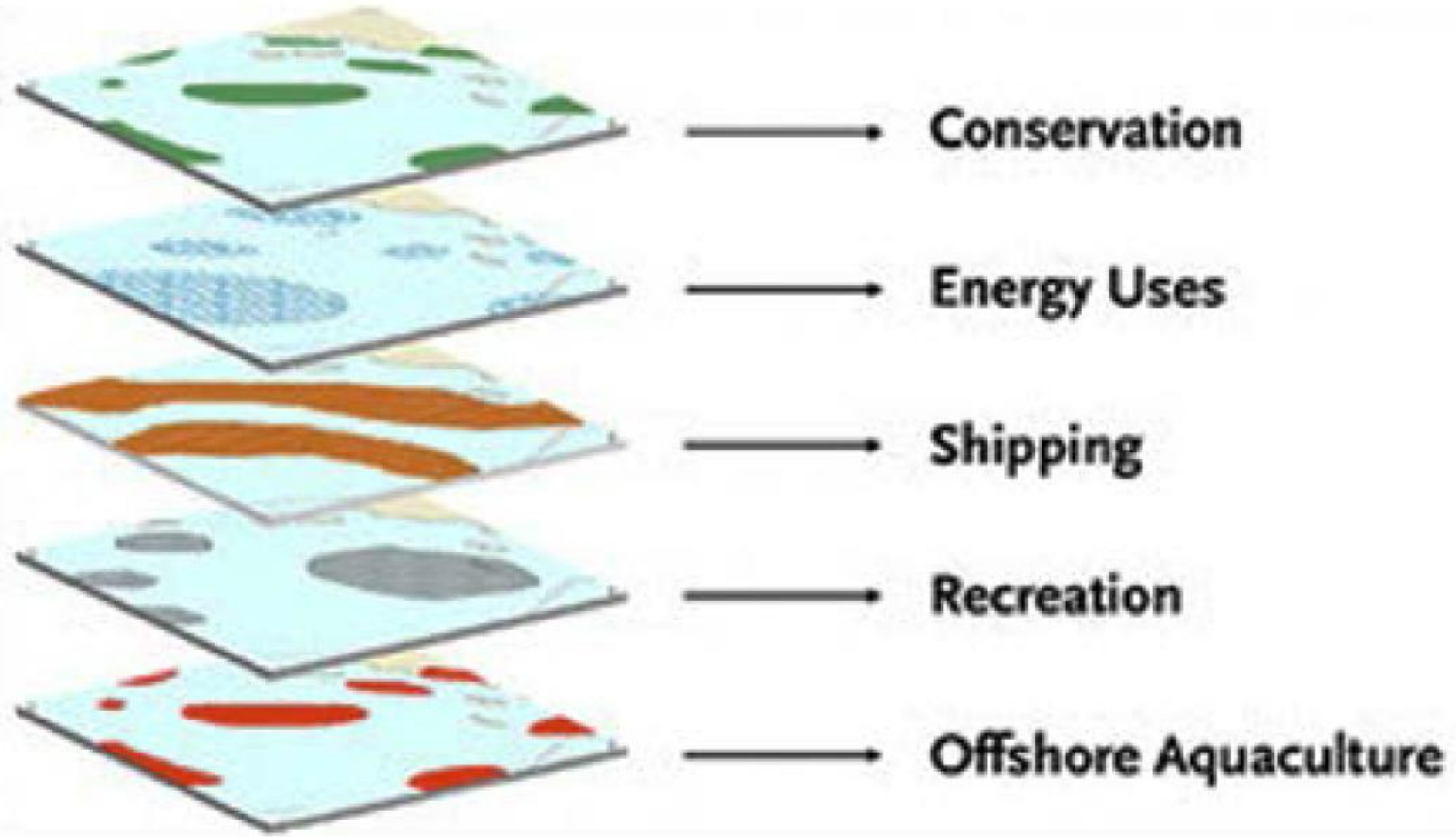


MASPAWIO Objectives / Activities

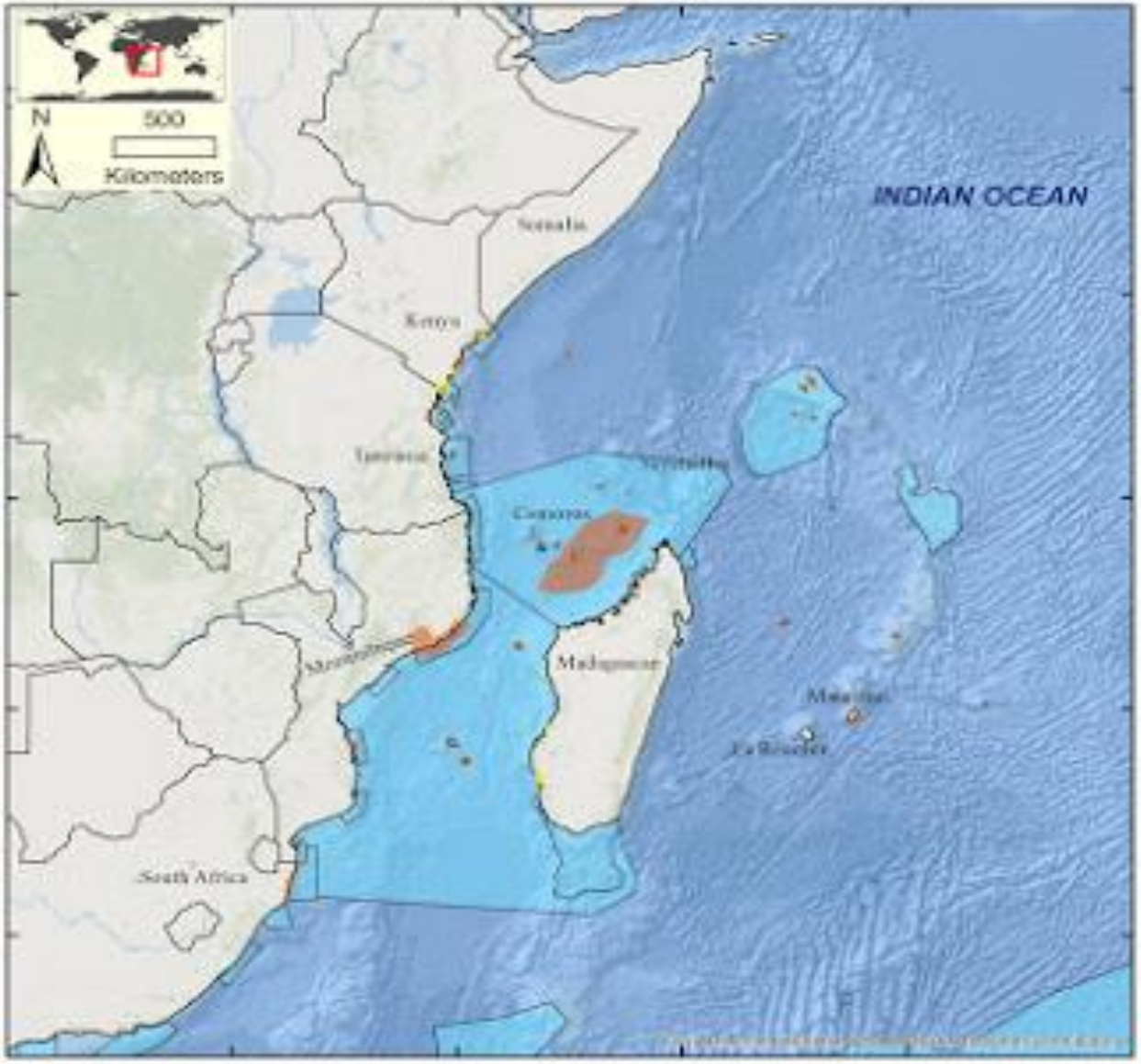
- Supporting Nairobi Convention and its Parties
- Thinking MSP beyond the borders & fostering regional cooperation
- SDGs & Aichi targets
- Sustainable Blue economy

- ➢ Mapping /Atlas with available data
- ➢ Integrating connectivity
- ➢ Modelling connectivity evolution
- ➢ Co-defining strategic orientations

Combining data: integrated vision



Protected Areas and EBSA



LEGEND:

Protected areas

Point locations

- Marine Protected Area
- Locally Managed Marine Area

Polygon locations

- Marine Protected Area
- Locally Managed Marine Area

Ecologically or Biologically Significant Marine Areas

- EBSA

DATA SOURCES:

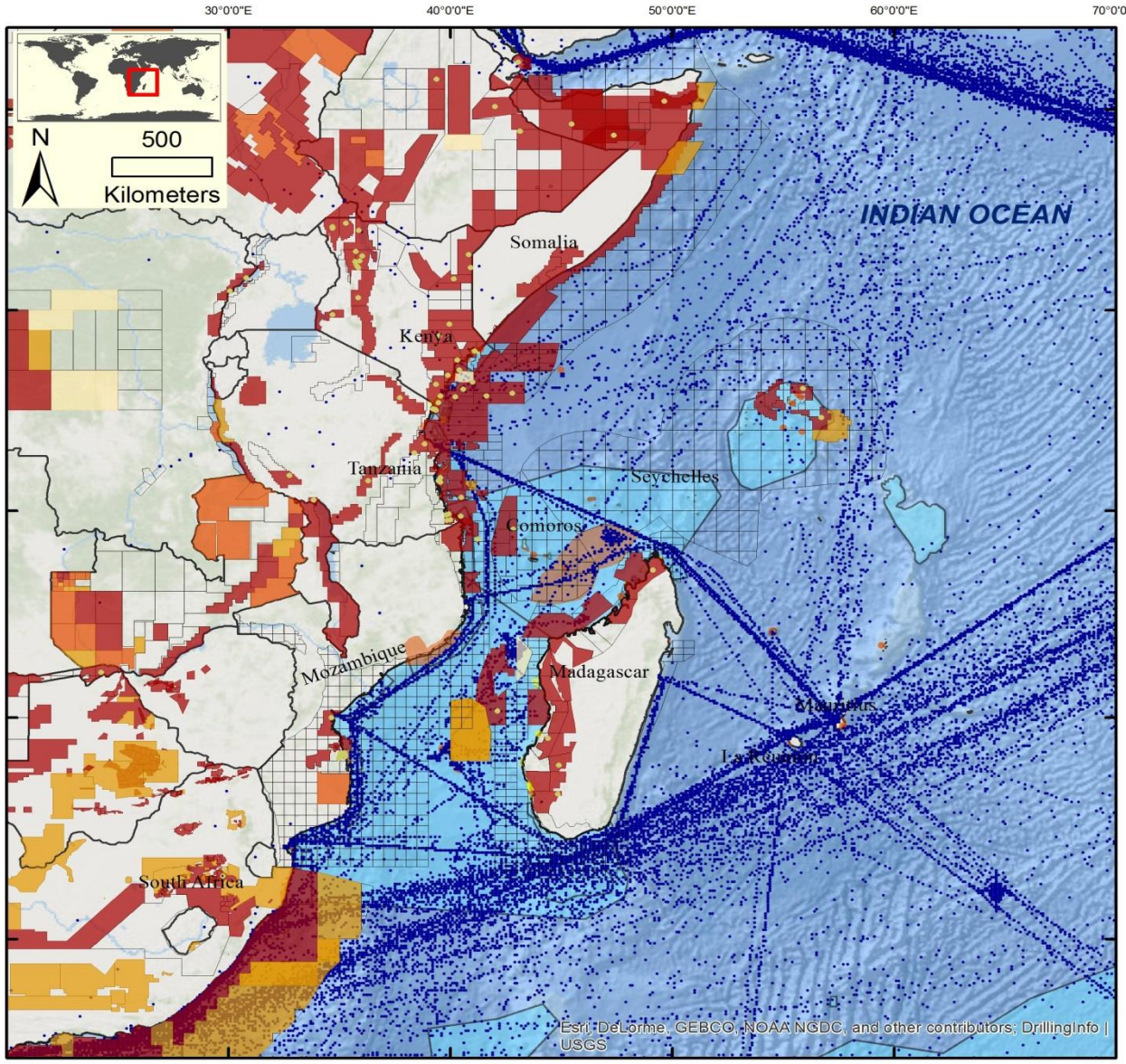
MPAs - UNEP-WCMC. Compiled from various sources including the World Database of Protected Areas (WDPA), local agencies and personal knowledge.
"IUCN and UNEP-WCMC (2015). The World Database on Protected Areas (WDPA) [Online]. Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net"

Convention on Biological Diversity
URL: https://www.cbd.int/ebsa/

Author: E. Crochelet - Date: 12/2015 - Map n° MSP-2

IUCN afd CORDIO East Africa

Protected Areas - EBSA - Commercial shipping - Oil & Gas activities



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Commercial shipping

- Commercial shipping

Oil and Gas activities

- Planned Wells

Contracts status

- Open
- Under negotiation
- Application
- Pre-award
- Force Majeure
- Contract

DATA SOURCES:

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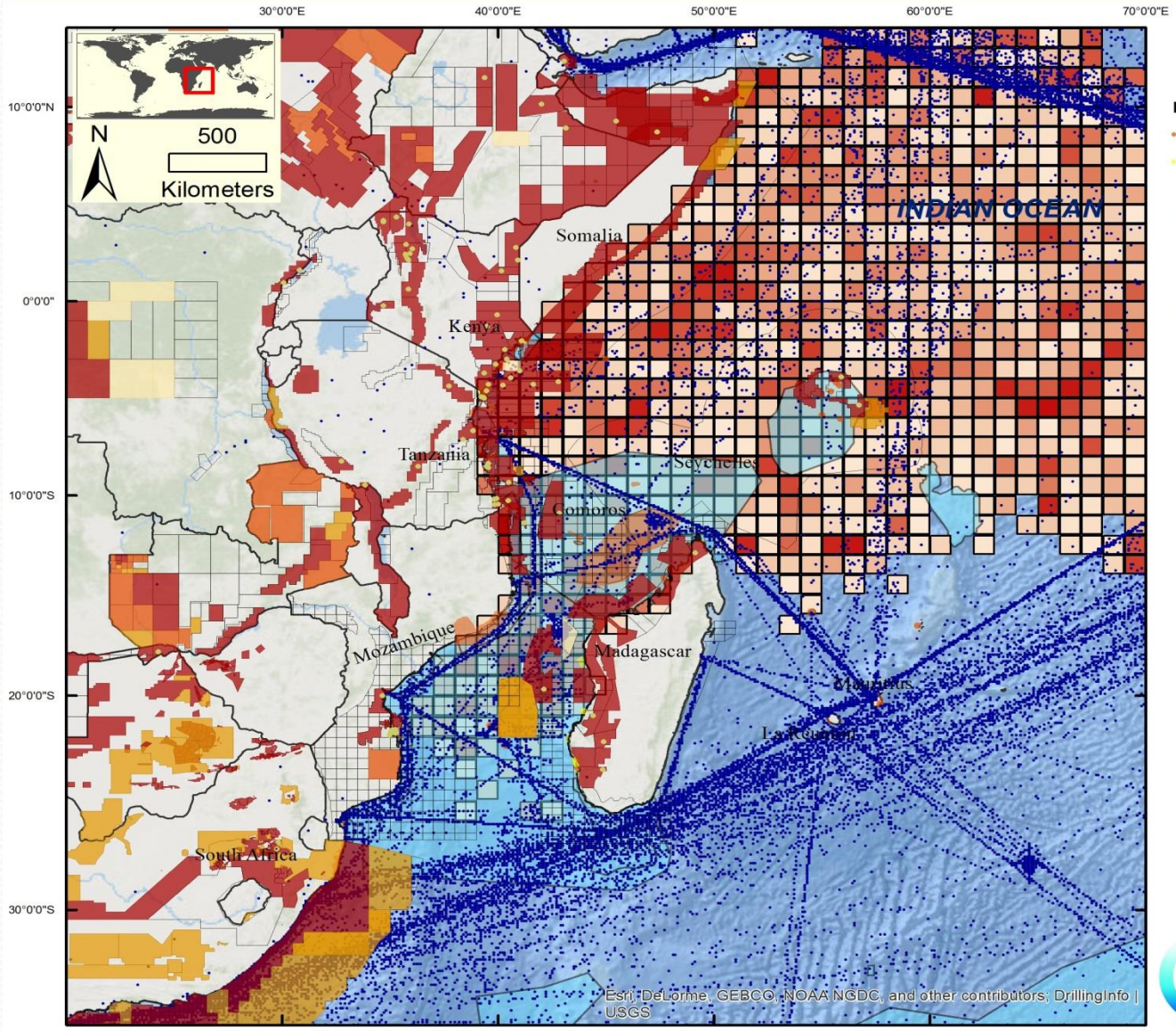
Commercial shipping: JCOMMOPS (2014) - Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) in-situ Observing Platform Support centre (JCOMMOPS)

ALES (2015). Global Drilling Info. USGS. Restricted for WWF use only. Data were downlaoded on May 26, 2015.

Author : E. Crochelet - Date: 12/2015 - Map n° MSP-2

IUCN afd AGENCE FRANÇAISE DE DÉVELOPPEMENT CORDIO East Africa WWF

Protected Areas - EBSA - Commercial shipping - Oil & Gas activities - Fisheries



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Monthly catches of tropical tunas:

Thunnus albacares, Thunnus obesus Katsuwnous pelamis

0 — +1000 metric tons

Statistical unit 1° square
Purse seiner - All fishing mode

DATA SOURCES:

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*IUCN and UNEP-WCMC (2015), The World Database on Protected Areas (WDPA) [On-line], Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net.

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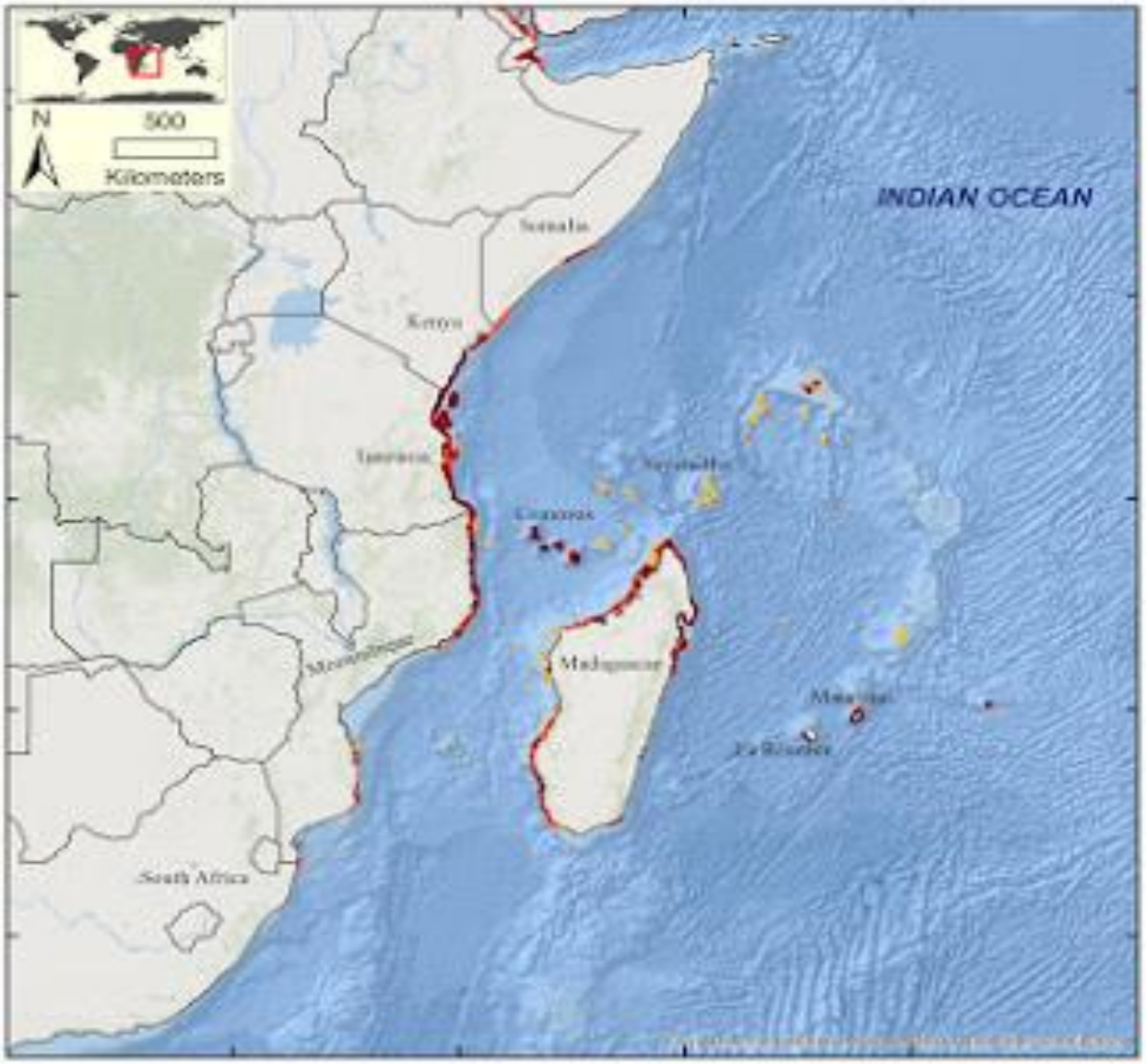
IOTC Secretariat database (2014).

Author : E. Crochelet - Date: 12/2015 - Map n° MSP-2

IUCN · AFD Agence Française de Développement · CORDIO East Africa · WWF

Reefs by Integrated Local and Global Threats in 2050



LEGEND:

Coral reefs classified by integrated local and global (climate-related) threats in 2050*

- Low
- Medium
- High
- Very high
- Critical

* Local threats include: coastal development, overfishing and destructive fishing, marine-based pollution and damage, and watershed-based pollution. Global threats include: thermal stress (ocean warming) and ocean acidification.

DATA SOURCES:

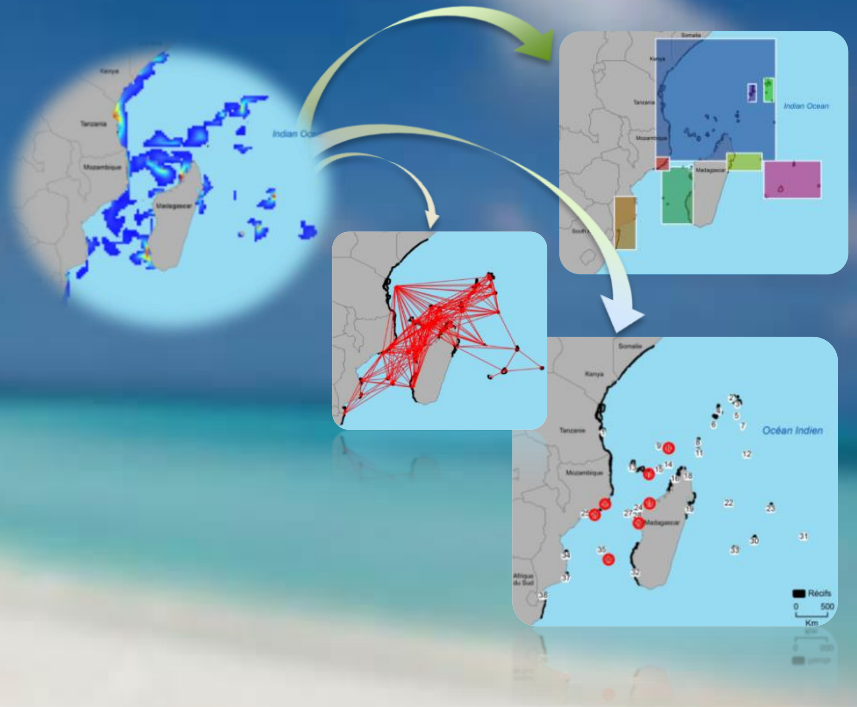
World Resources Institute, Reefs at Risk Revisited, 2011.

Author : E. Crochelet - Date: 12/2015 - Map n° REF-9-1-3

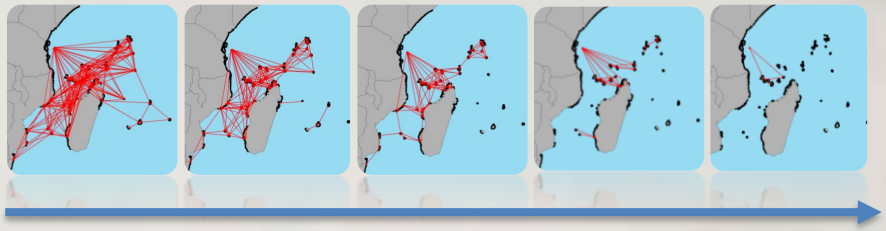
IUCN afd CORDIO East Africa

MASPAWIO Connectivity module Objectives

- To evaluate coral reefs ecosystems connectivity patterns in the Western Indian Ocean, using a dispersal model

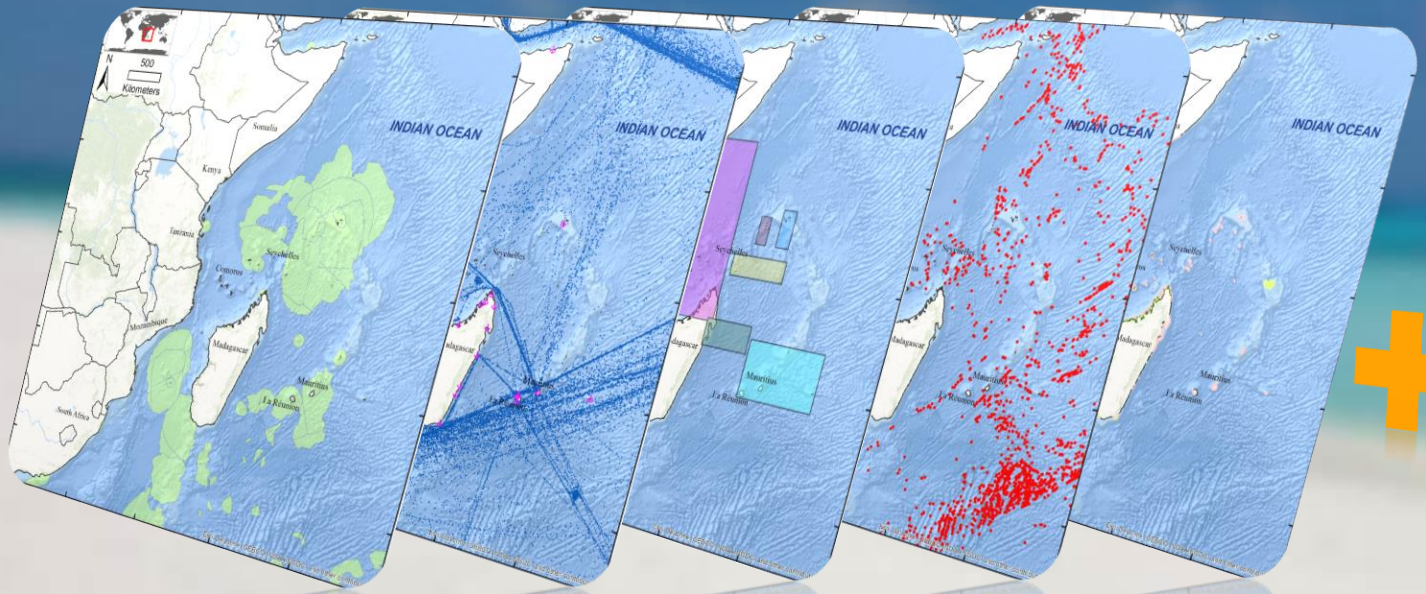


- To test different scenarios concerning habitat degradation consequences on coral reef ecosystems connectivity patterns, to better inform anticipatory planning and management of coastal and marine resources



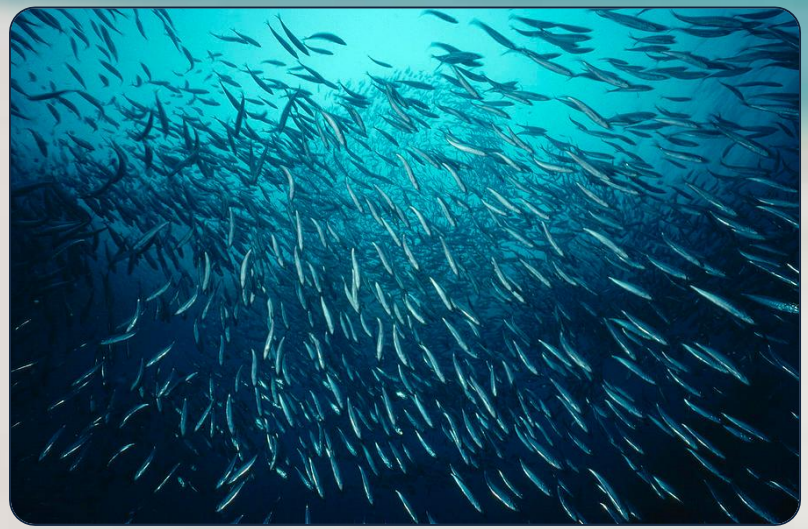
Connectivity data in MSP Process

Centrality sites determined through connectivity analysis



Connectivity Context

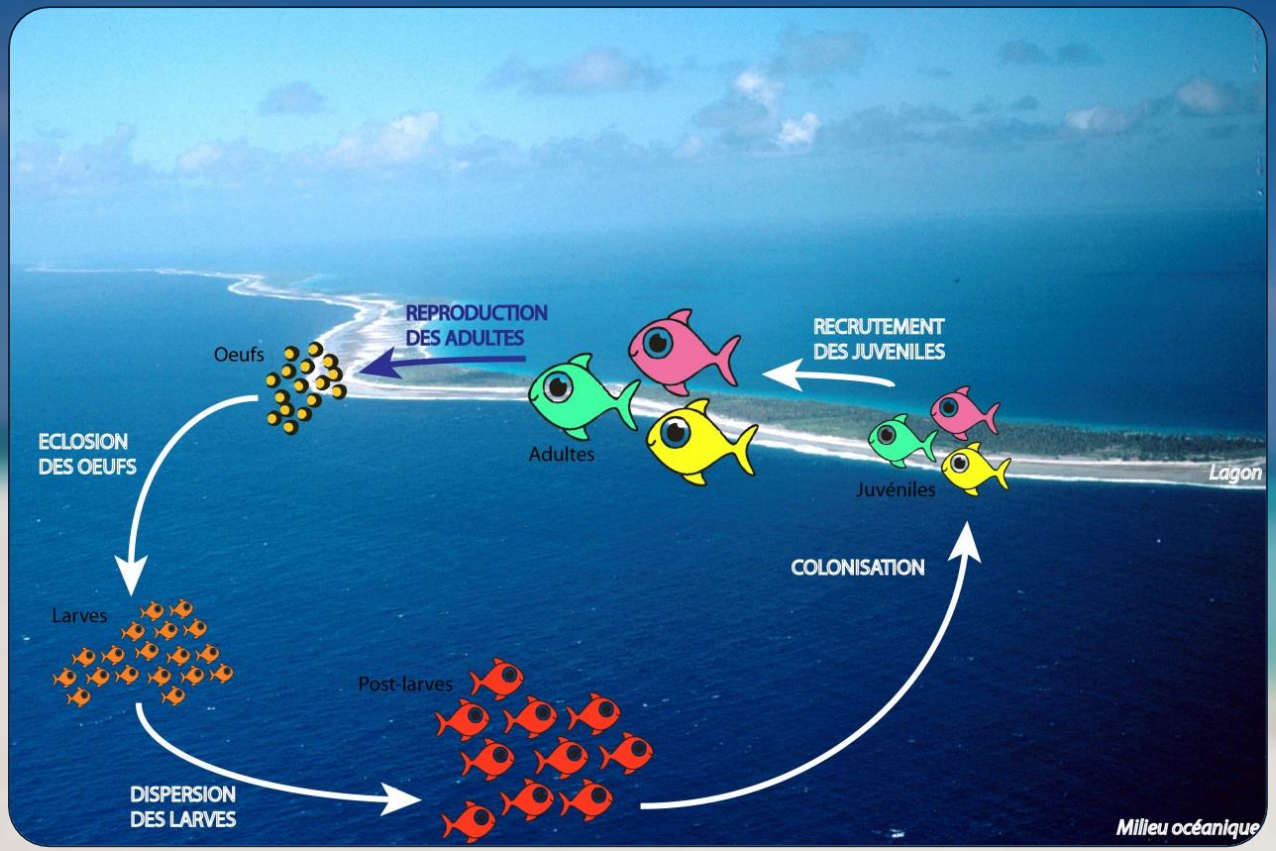
- **CONNECTIVITY = exchanges of individuals between distinct populations (larvae, juveniles, adults)**



- **Larval transport is the main process underlying connectivity.**

→ Difficult to study because of physical processes (hydrodynamic transport : advection / diffusion); biological characteristics (PLD, swimming abilities , behavior, survival)

Reef fish life cycle

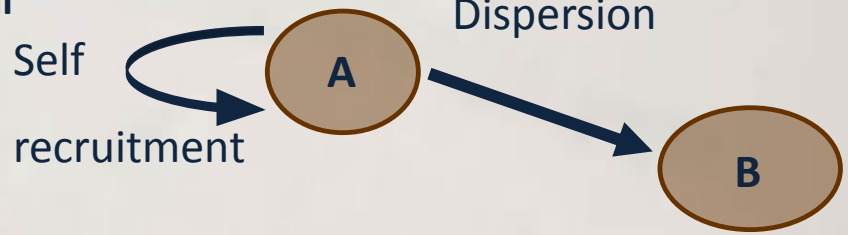


Bipartite life cycle:

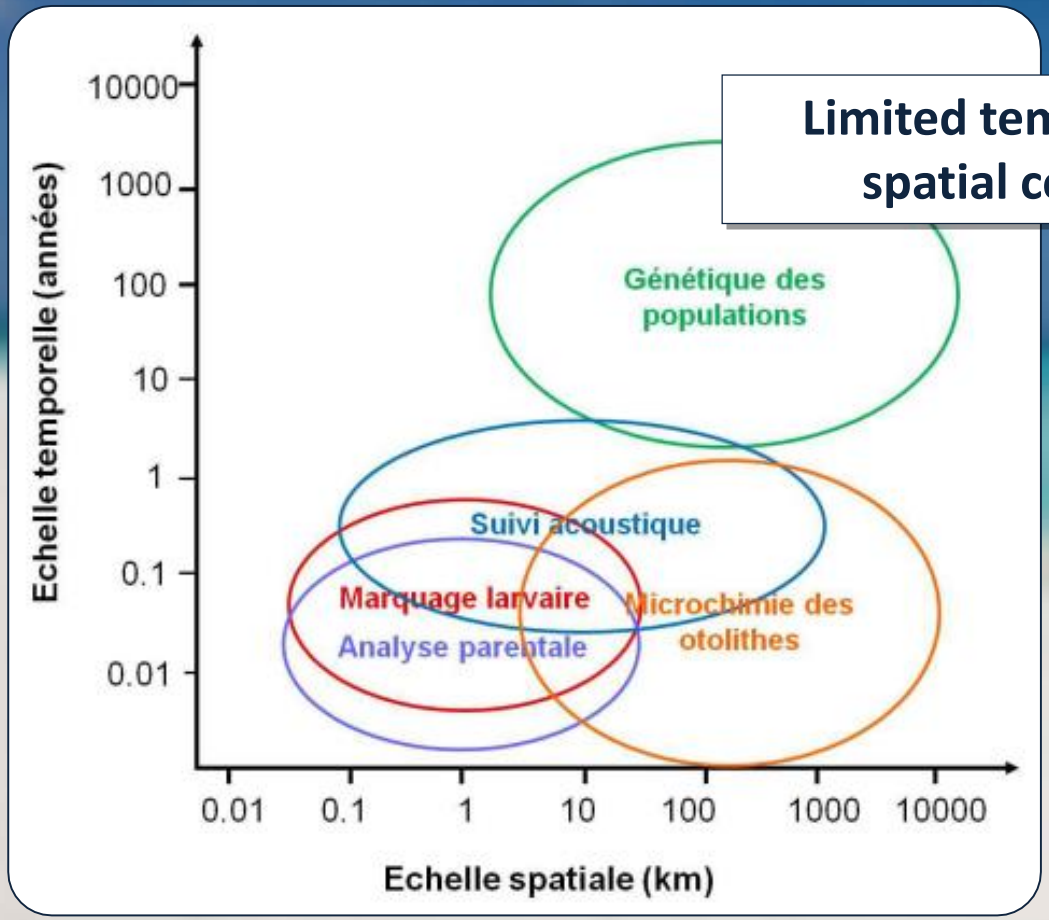
→ **pelagic early life stage**

→ **benthic reef associated stage**

Dispersion is hard to study due to larvae size, long dispersal distance, and depend on species → knowledge of connectivity patterns is crucial for effective management



Several techniques to study connectivity

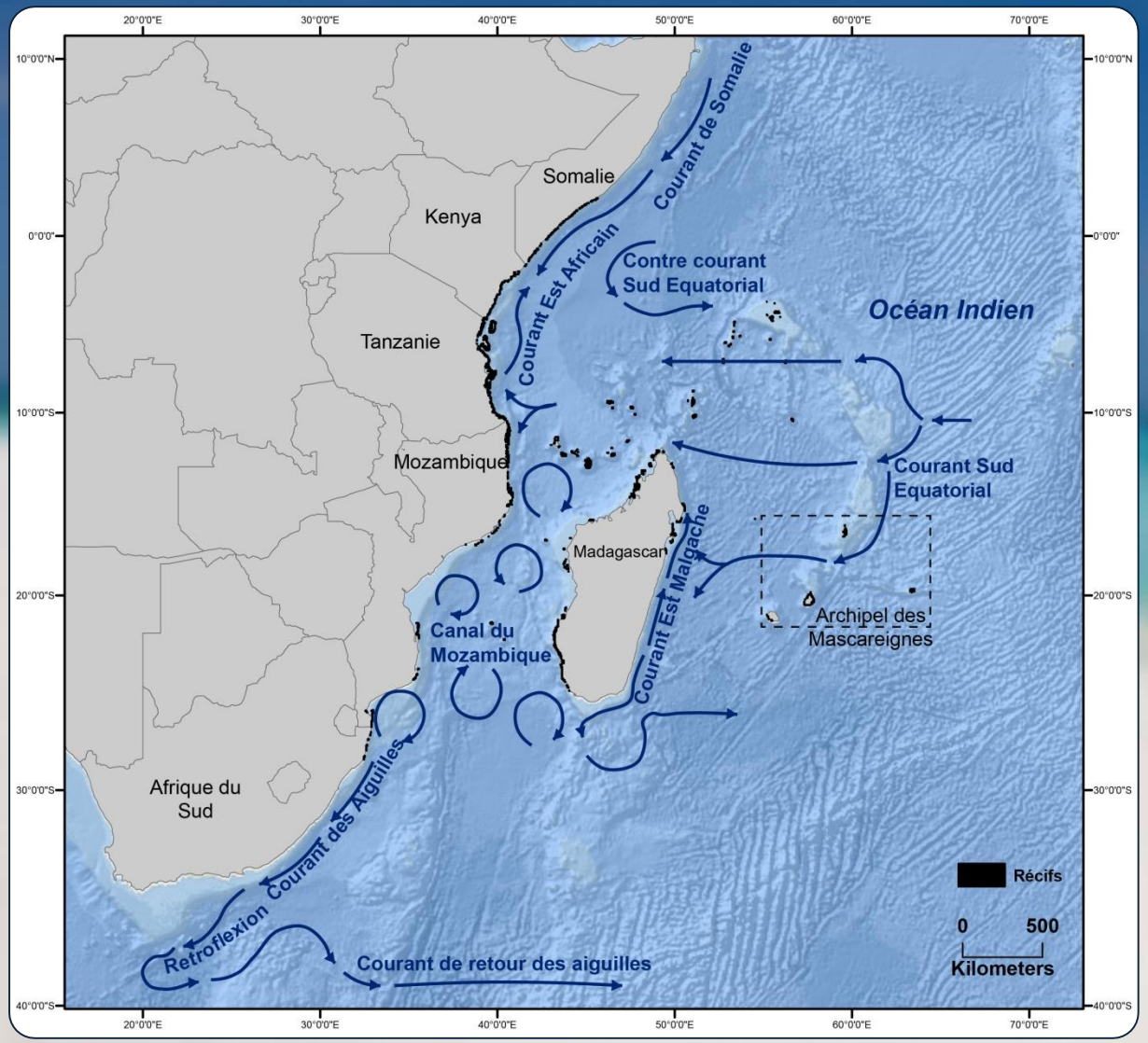


Limited temporal and spatial coverage

Hydrodynamic connectivity models

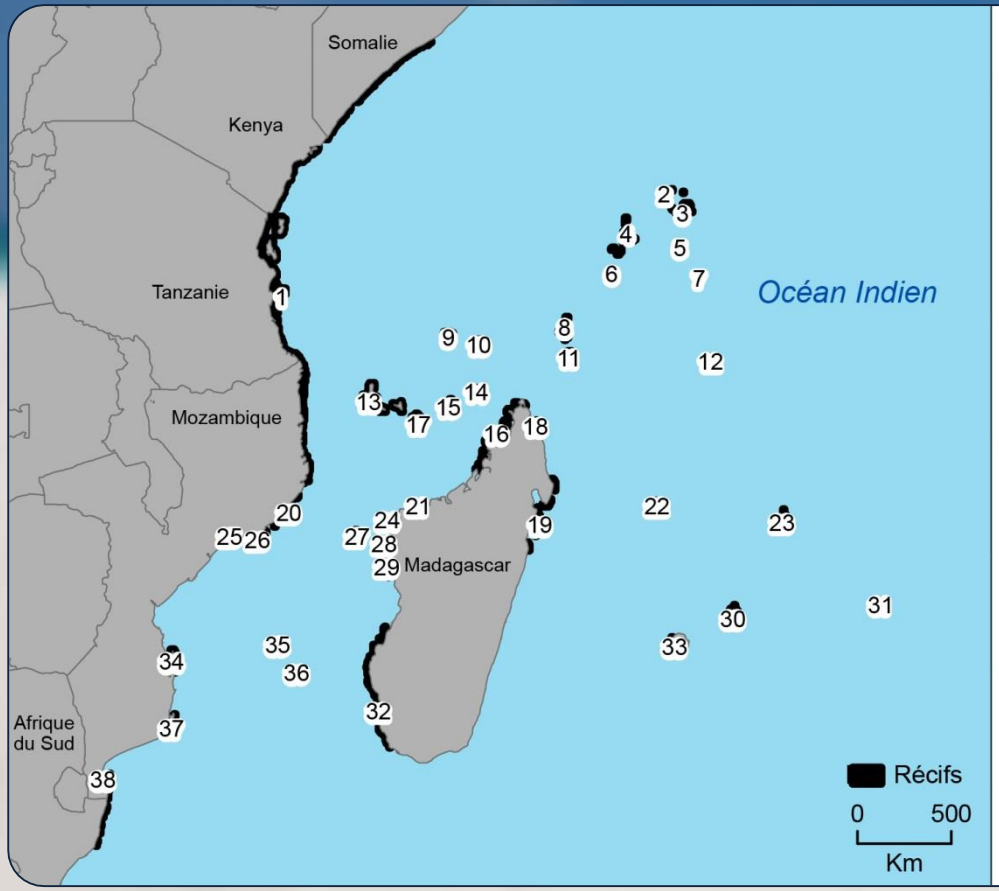
Follow virtual individuals across large scales

Indian Ocean hydrodynamics



- South Equatorial Current
- Mozambique Channel Eddies
- East Madagascar Current
- East African Coastal Current
- Somali Current
- Agulhas Current

Study Sites



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2	Bird	21	Majunga
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5	Platte	24	Besalampy
6	Alphonse	25	Pebane
7	Coëtivy	26	Moma
8	Providence	27	Juan de Nova
9	Aldabra	28	Maintirano
10	Cosmoledo	29	Masoarivo
11	Farqhar	30	Maurice
12	Agalega	31	Rodrigues
13	Comores	32	Morondava - Anakao
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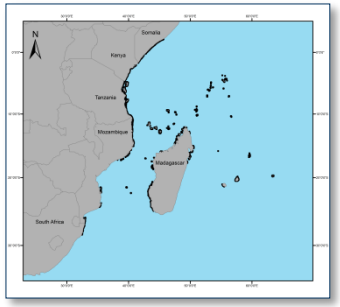
1- Hydrodynamic connectivity model

2D eulerian advection-diffusion algorithm **Larvae = passive particles**

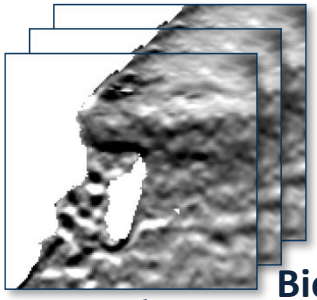
Coral reef ID and % cover maps
habitat, shoreline

1



Ocean currents data
Temporal & spatial resolution depending on the study area

2

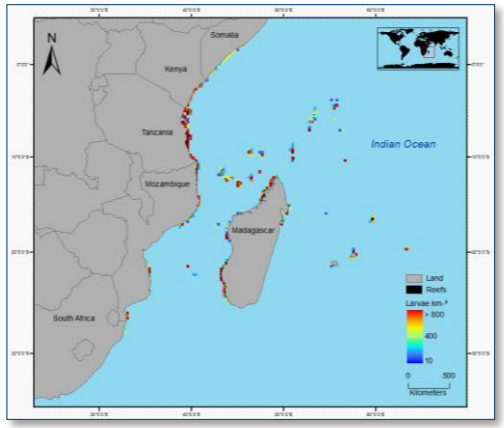


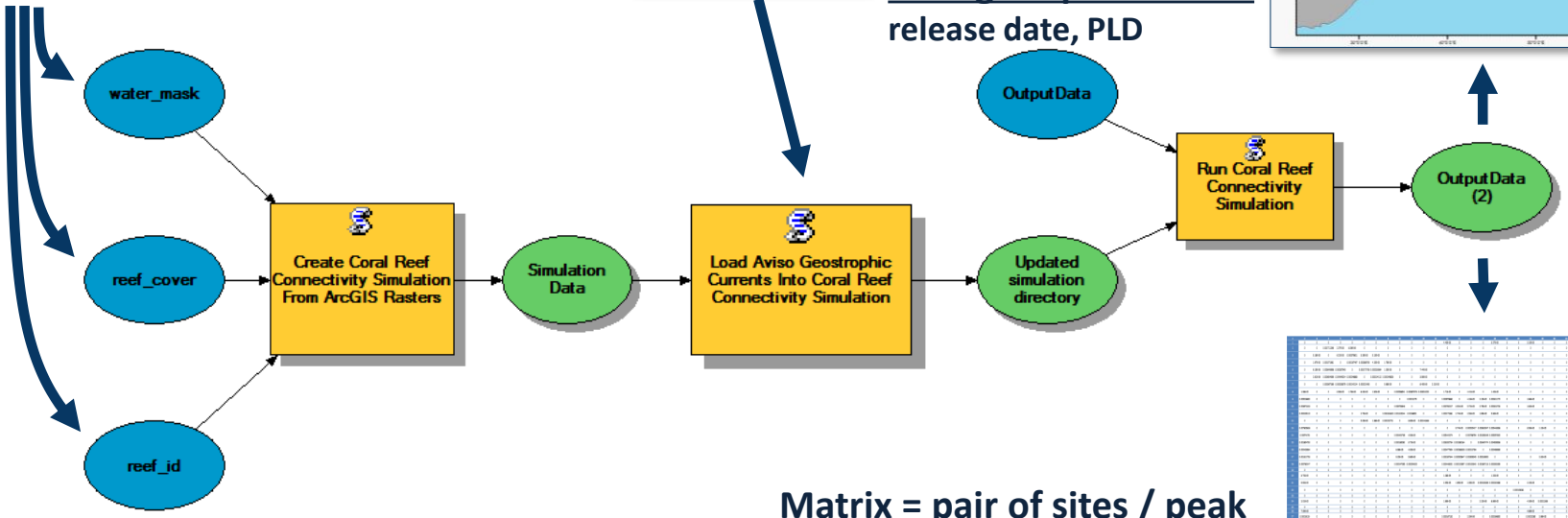
3

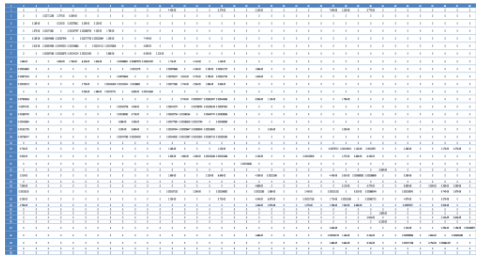
Biological parameters
release date, PLD

Larval density time series rasters

4





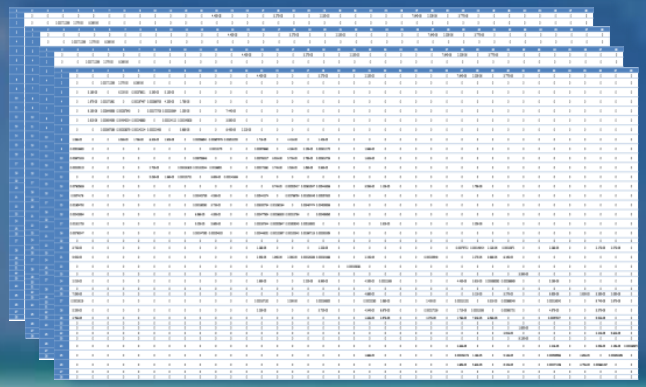


Matrix = pair of sites / peak concentration of larvae

(From Treml & al, 2008)

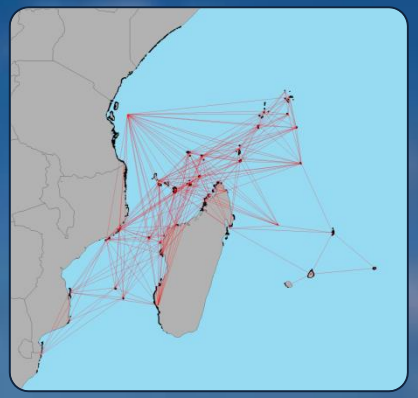
2- Connectivity matrix processing

Connectivity matrices



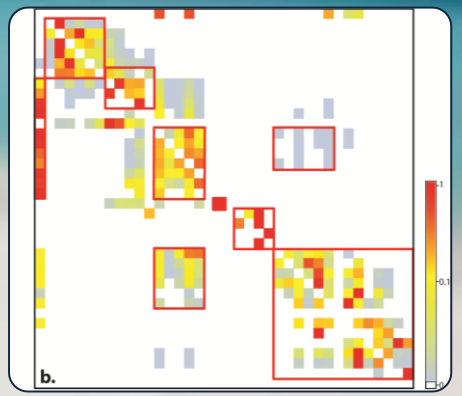
1

Edge list features



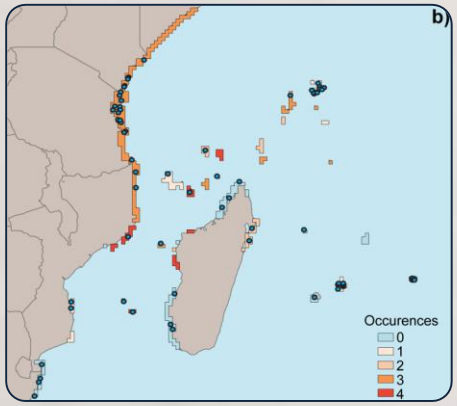
2

Migration matrices



Betweenness centrality index

4



Clustering

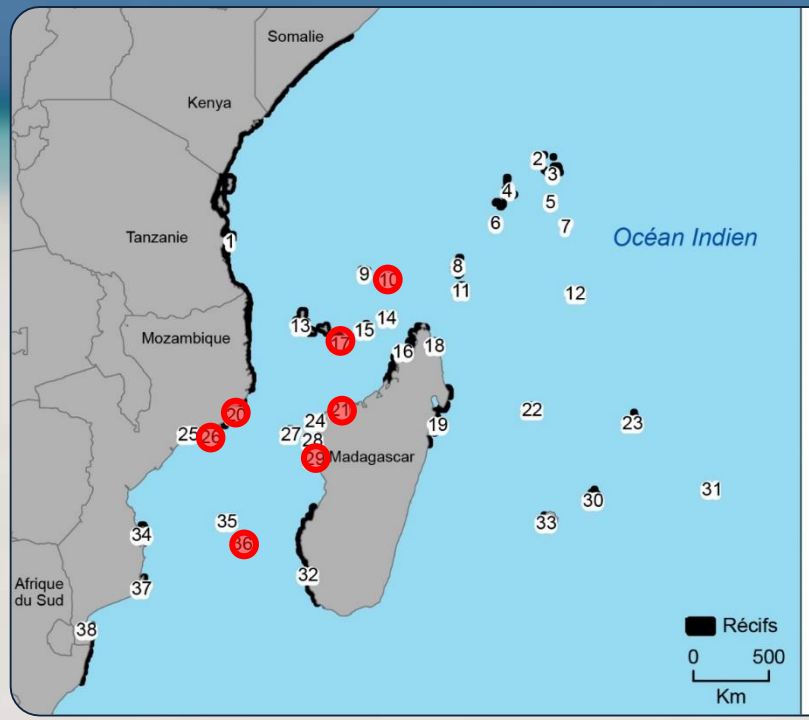
3

Regional connectivity in the Indian Ocean

BETWEENESS CENTRALITY

Récif	D10	D20	D30	D40	D50	Occurences
1	232	82	55	52	115	3
2	4	67	52	36	10	1
3	0	0	108	5	0	1
4	65	0	194	155	24	3
5	0	90	133	122	20	3
6	101	41	28	17	147	2
7	81	17	0	11	12	1
8	15	115	37	79	24	2
9	17	0	27	200	175	2
10	16	130	292	162	142	4
11	102	18	207	41	62	3
12	0	24	133	126	91	3
13	64	0	57	60	19	1
14	0	0	216	36	22	1
15	265	19	29	66	132	3
16	0	20	0	20	0	0
17	49	43	296	171	122	4
18	0	0	0	0	0	0
19	0	0	0	96	90	2
20	89	239	117	110	24	4
21	105	89	0	157	155	4
22	0	0	0	20	23	0
23	0	0	30	34	3	0
24	29	23	0	0	19	0
25	0	0	0	0	0	0
26	113	34	127	124	195	4
27	112	74	129	53	20	3
28	0	35	60	65	78	2
29	37	165	141	131	273	4
30	0	0	2	36	67	1
31	0	0	2	4	4	0
32	38	15	34	29	58	0
33	0	0	0	0	0	0
34	0	86	1	60	56	1
35	81	32	148	83	7	2
36	0	217	185	93	120	4
37	1	0	89	0	0	1
38	0	0	0	0	0	0
MAX.	265	239	296	200	273	
MOY.	42.53	44.08	77.08	64.58	60.76	

7 reefs : Occurrences = 4 → the most important for multigenerational connectivity within the WIO



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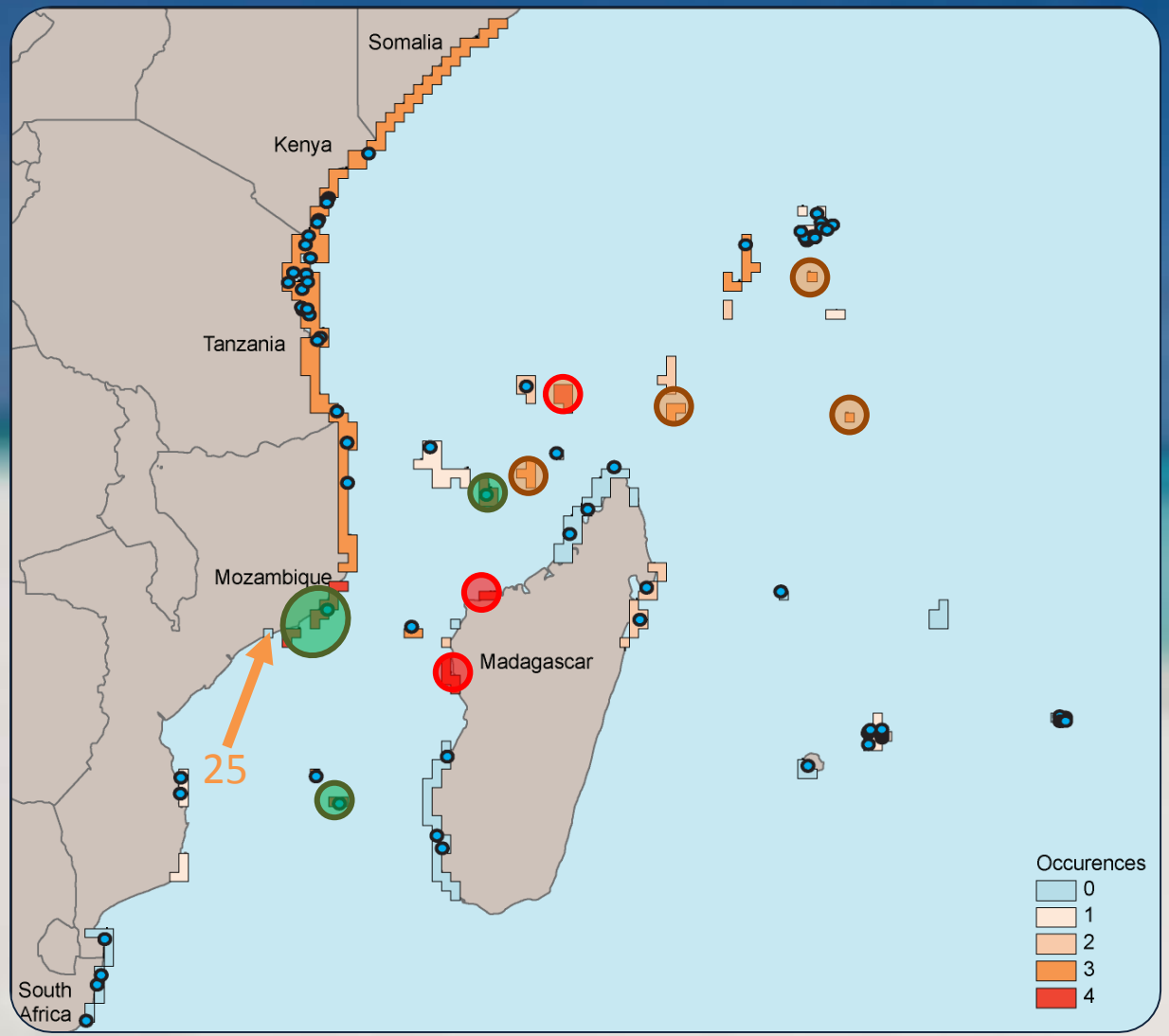
Regional connectivity in the Indian Ocean



- **Only 3 sites of high centrality (Nb. O = 4), hosts an MPA**

Europa, Mayotte, Moma, Angoche

- **Other high centrality sites can be considered as priority sites for MPA implementation**

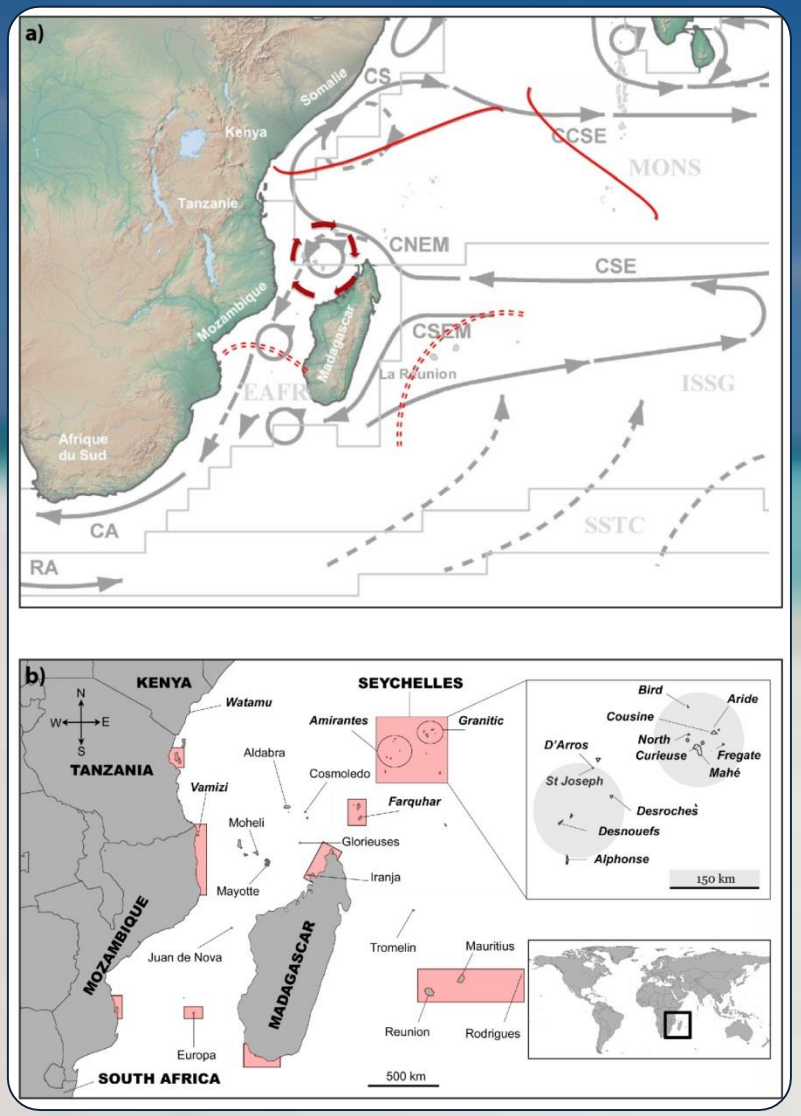
Cosmoledo, Majunga, Masoarivo

- **4 more sites can be added : Nb. O = 3**

Platte, Farqhar, Agalega Geyser

+ Reef 25 (Pebane) **completely isolated for all PLD**

Regional connectivity in the Indian Ocean



Muths et al., 2012 (a); Bourjea, 2014 (b)

- Nb connections ↗ with PLD
- Low regional connectivity
- High interconnectivity within sub-regions (Mozambique Channel, Mascarene archipelago)
- Results congruent with genetic analysis on:

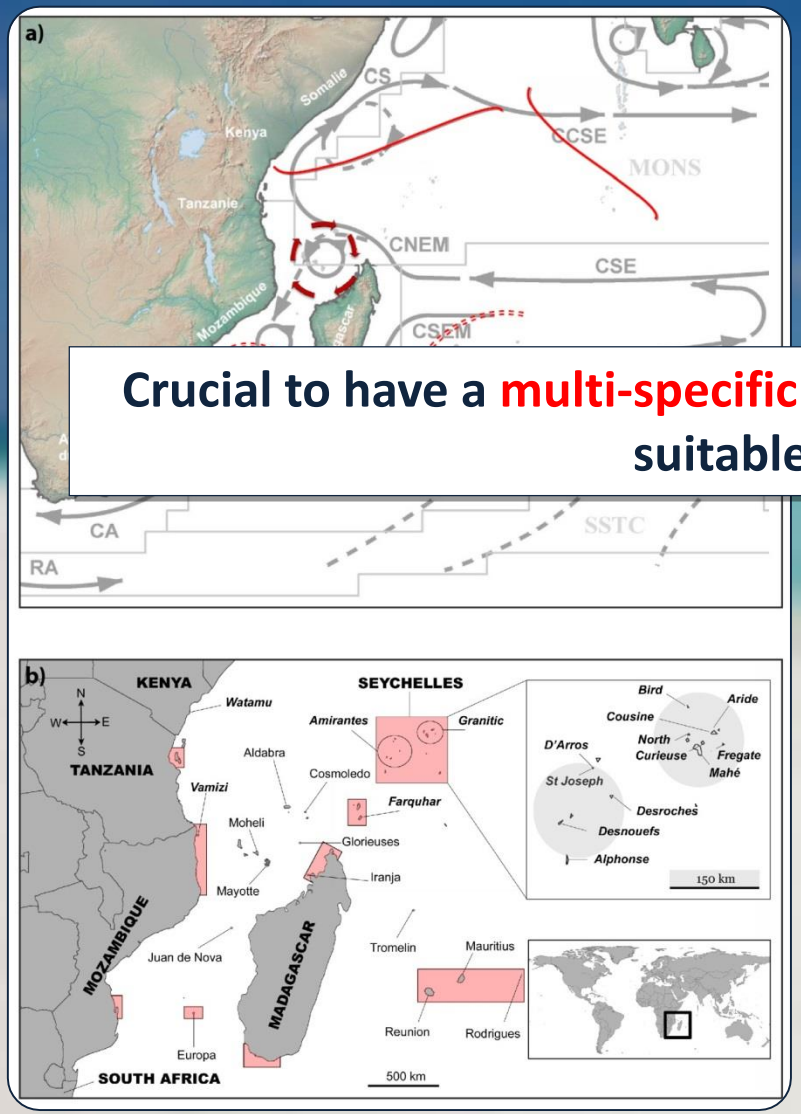
Reef fish → Muths et al. (2011, 2012, 2014): *E.merra, L. kasmira et M. berndti*

Turtles → Bourjea et al. (2007)

Brittle star → Hoareau et al. (2013)

- Results congruent with biogeographic studies → Obura (2012): coral triangle (high diversity - Northern Mozambique Channel)
- Similarities with turtles conservation priority areas → Bourjea (2014)

Regional connectivity in the Indian Ocean



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Crucial to have a multi-specific approach at the regional scale to elaborate suitable management plans

E.merra, L. kasmira et M. berndti

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DEGRADATION SCENARIOS

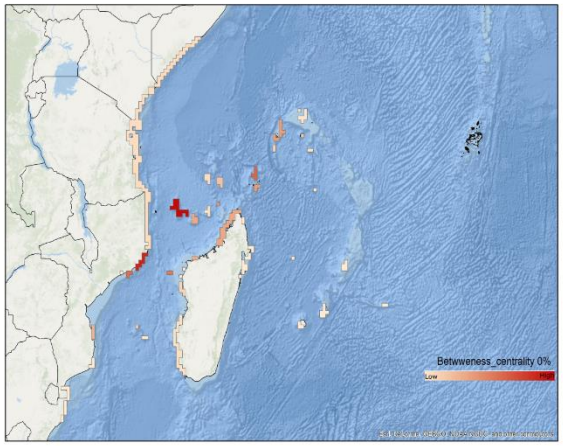
CONNECTANCE

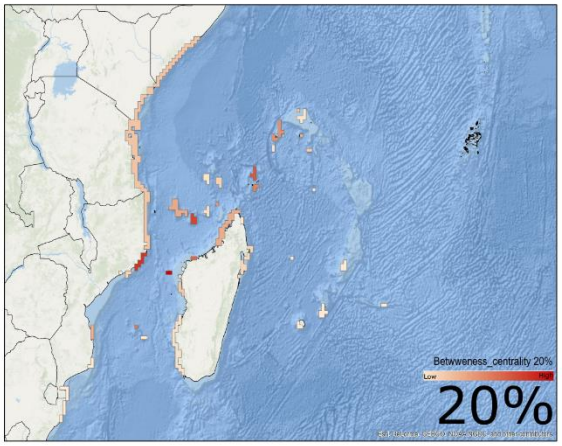
- Connectance, which is quite weak (16%) decreases depending on degradation level to reach 7%.

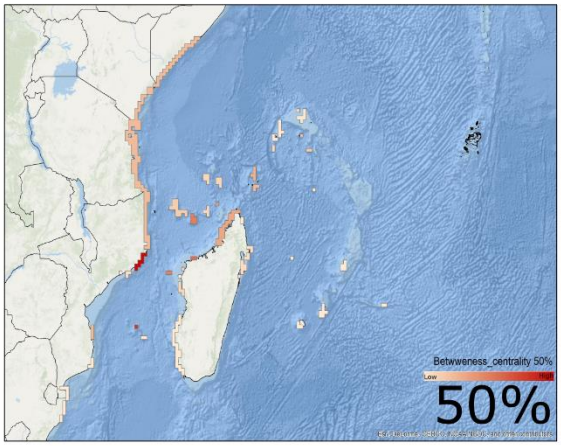
	Degradation level (%)				
	0	20	50	70	90
Connectance (%)	16	15	14	12	7

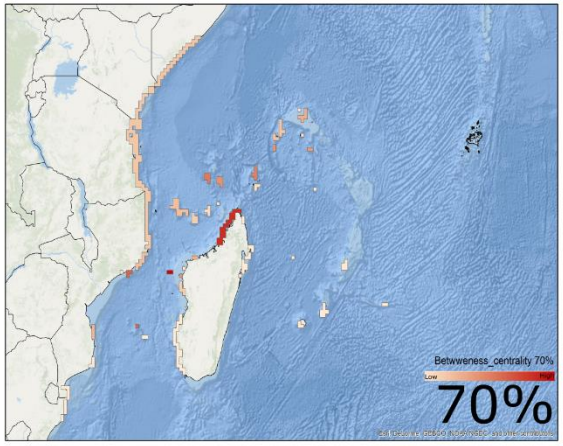
DEGRADATION SCENARIOS

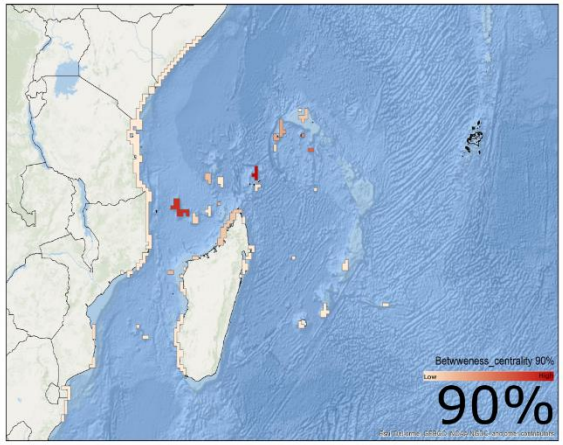
BETWEENESS CENTRALITY





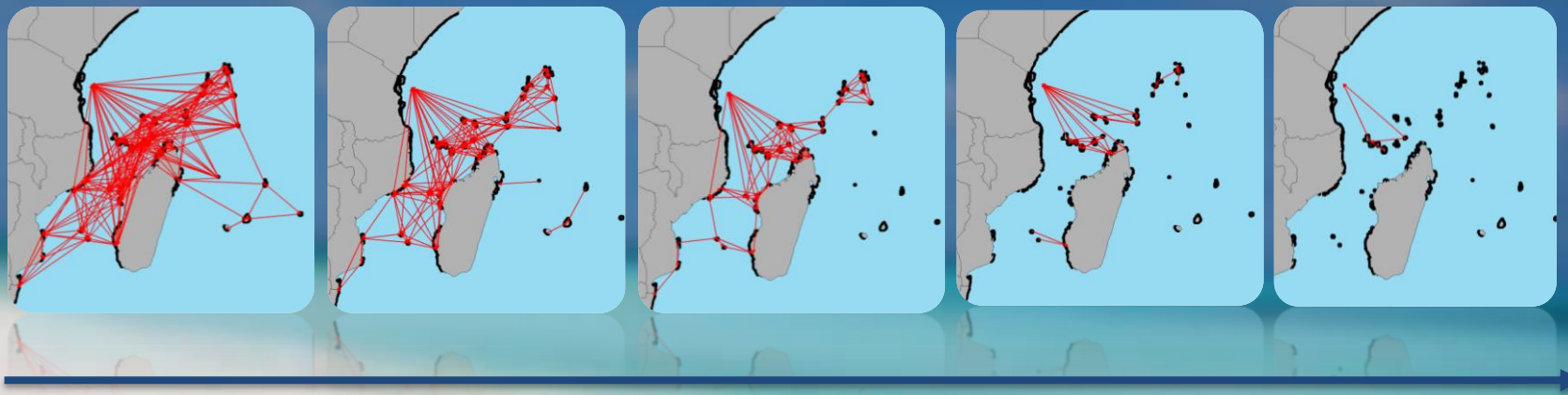






- **Reef centrality change depending on the degradation index**
- **It completely modifies the network nodes for multigenerational connectivity**

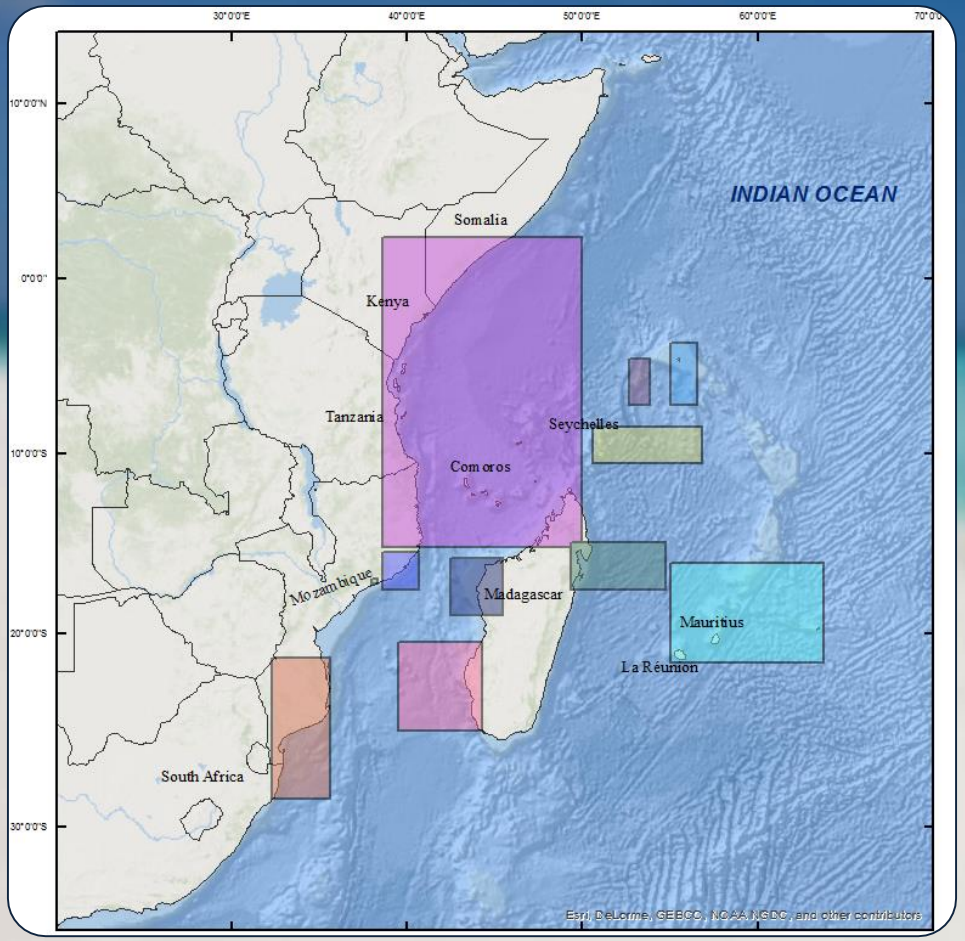
DEGRADATION SCENARIOS



Habitat degradation *20%* *50%* *70%* *90%*

Habitat degradation scenarios

CLUSTERING

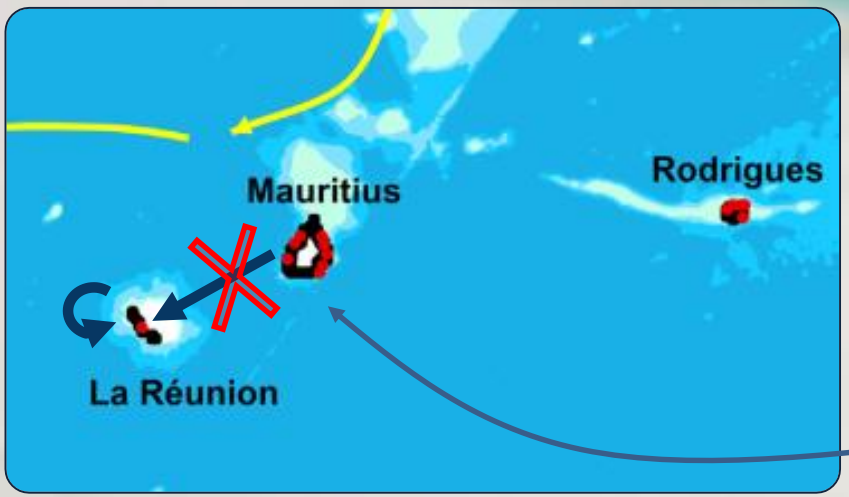


- Similar clusters for degradation indices = 20, 50%
- From 70%, Mascarene archipelago islands begin to be completely isolated from the other islands/reefs.

IMPLICATIONS IN TERMS OF MANAGEMENT

→ Large scale connectivity : not only self-recruitment, ecosystems are linked

➔ Conservation efforts have to be designed relatively to connectivity patterns (distinguishing sink/source sites)



Thank you