E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2020; 8(2): 112-119

www.fisheriesjournal.com
Received: 12-01-2020
Accepted: 14-02-2020

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Aquatic and avian biodiversity at the level of the marine protected area of saint-louis du Senegal: inventory, threats and indicators of governance and steady

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Abstract
The Saint-Louis Marine Protected Area (MPA), located between the former mouth of the Senegalese River and the district of Guet-Ndar, i.e. between longitudes 15 ° 50'.0 N and 15 ° 58'.5 N and latitudes 016 ° 48'.5 W and 016 ° 31'.5 W, is the largest of the 5 MPAs created in Senegal (West Africa) in 2004. It covers an area of 49,600 hectares. Its biodiversity, studied by crossing various sources of data (scientific campaigns, field surveys, reference state, etc.), reveals 443 halieutic species and 80 avian species whose viability faces natural, anthropogenic, institutional and political threats. The inventory is, however, to be deepened for incompleted zoological groups such as cetaceans. Prerequisites are specified, followed by the proposal of 8 indicators of good governance and monitoring of biodiversity so that the MPA meets the expectations placed in it during its creation.

Keywords: MPA, Saint-Louis, Senegal, biodiversity, threats, indicators

1. Introduction
Biodiversity, in the etymological sense of the term, means the diversity of living things, whether they are of plant or animal type. An MPA or marine protected area corresponds to "any intertidal or infra tidal space as well as its overlying waters, its flora, its fauna and its historical and cultural resources that the law or other effective means have put in reserve to protect in all or part of the environment thus defined " (IUCN, 1994). Senegal, going in the direction of the international movement which has been taking shape since the beginning of this millennium, has set up, by presidential decree n ° 2004-1408 of 04/11/2004, the MPAs of Saint-Louis, Kayar, Joal - Fadiouth, Abéné and Bamboung. The creation of these areas, spread over a total area of 103,000 ha, is the fruit of a partnership between local coastal communities, the State and organizations working in the field of conservation, research and management of marine resources.
The major objective pursued is the protection of important spawning and nursery areas present in these MPAs with a view to sustainable management of fisheries (Niang, 2012) [11]. Concerned in contributing to a better knowledge and to the viability of the MPA of Saint-Louis, we are here carrying out an inventory of its halieutic and avian biodiversity by a diagnosis of the main threats to it before proposing indicators of good governance and monitoring of biodiversity in this important marine area. The total length (TL) was measured in centimeters (to the nearest 0.01 cm) with the help of digital caliper (Mitutoyo) and body weight was recorded in grams (to the nearest 0.01g) with a digital balance.

2. Materials and Methods
2.1. Presentation of the MPA
The MPA of Saint-Louis is located in the city of the same name, on the north coast of Senegal (West Africa), precisely off the Langue de Barbaric strip (Figure 1A) which is a strip of land separating the Senegal River from the Atlantic Ocean covering an area of 49,600 ha, mean 48% of the total area of all MPAs in the country's created in 2004.
Its maritime and terrestrial geographic coordinates are illustrated in Figure 1B.
The MPA, between the isobaths - 10 m and - 81 m, is an integral part of the Saint-Louis

continental shelf going up to the 200 m isobath over almost 30 km wide.
The muddy sands cover its entire lower part and surround the mud flats of Saint-Louis, where the second stock of coastal shrimp in the country was established, after that of Ziguinchor in the south.
The coast is uniformly sandy and flat, bordered by high cords of present and sub-current dunes (Bonnardel, 1967) [5].
Near the mouth, especially in the area of influence of the MPA, the rare rocky shoals are overtaken by muddy or sandy sediments, witnesses of old shoreline (Domain, 1976) [7].
These last shorelines mixed with "joxoor" shell, are suitable for fishing. Indeed, the various natural habitats, in particular rocks, are places of refuge, spawning and growth of fry, mainly demersal species.

(A) (B)

Fig 1: Aerial view of Saint-Louis (A) and geographical coordinates of its MPA (B)

2.2. Source of data
The data relating to the study of fishery and avian biodiversity have, for the most part, been extracted on the basis of the geographical limits of the MPA, from the 6 sources below (i) demersal fishing campaigns carried out by the Dakar - Thiaroye Oceanographic Research Center (CRODT), on board the N / O Itaf Dème, using standard fish trawls, from 2001 to 2008 for coastal cruises (bottoms from 10 to 200 m) and between 2002 and 2008 for deep cruises (bottoms from 150 to 800 m) (ii) CRODT artisanal fishery surveys carried out in Saint-Louis from 1980 to 2006 (iii) baseline state of the MPA made in the cold season in 2009, using a beach seine (Figure 2) (iv) MPA management plan finalized following a data collection made from 2006 to 2010 (v) avian count from January 2009 to November 2011 at the level of the Parc National de la Langue de Barbarie (PNLB) and from January to November 2011 at the MPA of St-Louis, contiguous to the PNLB (vi) followed by the laying of turtles and the stranding of cetaceans at the PNLB and / or MPA beach (Fall, 2009 - Niang, 2012 - WWF, 2009) [9, 11, 17].

2.3. Nature and processing of data
Scientific (coastal and deep demersal) and commercial (surveys) fishing data as well as those from the reference state were aggregated in a single file containing the scientific names of the species online and the 4 variables below in column: surname, zoological group, data source and observations.
The presence of a taxon is indicated by 1, its absence by 0 depending on the source. Scientific names have been verified via reference works in the Senegalese context (Blache, Cadenat et Stauch, 1970 – Bellemans, Sagna, Fischer et Scilabba, 1988) [4, 3].
Data obtained as part of the management plan and inventories of avifauna, turtles and cetaceans stranded have, for the most part, been treated according to the same approach except that they are clearly less informed and that each file has was taken and analyzed in isolation (no aggregation).
When it comes to threats to a given ecosystem, they can be multifaceted. In the specific context of the Saint-Louis MPA, we first listed them in bulk on the basis of personal observations, literature data and interviews (specialized local technicians and populations) before classifying them as natural and anthropogenic threats (communicational, institutional and political).
Finally, for lack of being able to act on all types of threats, it seemed to us at least useful to propose indicators of good governance and monitoring of biodiversity on the basis of their relevance, clarity, validity, applicability and reliability.
Such indicators could facilitate the assessment of the results produced by conservation strategies at the local level. (Niang, 2012) [11].

3. Results
3.1. Biodiversity
There were 437 taxa grouped into 166 families and 6 taxonomic groups as follows:

1. 76% bony or osteichthy fish (groupers, sea bream, pagres, mullet, etc.)
2. 10% cartilaginous or chondrichthyan fish (rays, sharks and chimeras)
3. 7% crustaceans (shrimps, crabs, langoustines, squilli, etc.)
4. 4% cephalopods (octopus, cuttlefish and squid)
5. 1% of gastropods, mainly volutes ("yeet") and murex ("touffa")
6. 2% echinoderms (sea urchins and sea cucumbers) (Figure 2).

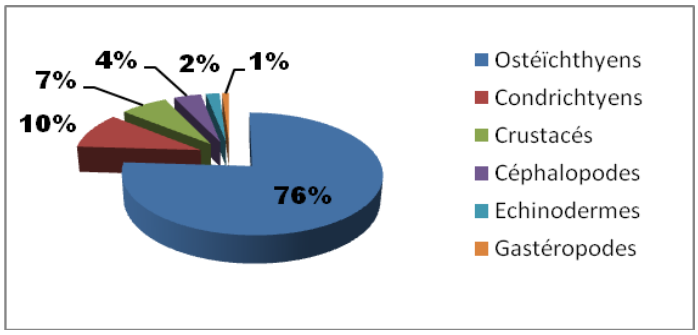

Fig 2: Composition by group of fish species in the MPA of Saint-Louis

However, only 325 taxa have been formally identified in genus and species, the recognition of the 112 others not exceeding the genus or even the family. The families most mentioned (40%) by the different sources are the following: Carangidae, Sparidae, Sciaenidae, Serranidae, Clupeidae, Haemulidae, Macrouridae, Scombridae, Soleidae, Rajidae, Scorpenidae, Tetraodontidae, Portunidae, Octopodidae and Ophidiidae (Annexe I). Only 7 species are mentioned at the same time by scientific campaigns, artisanal fishing surveys, the reference state and the management plan, i.e. 4 sources (maximum noted): These are *Pagellus bellottii, Raja miraletus, Sardinella aurita, Sepia officinalis hierredda, Selene dorsalis, Stromateus fiatola and Trichiurus lepturus* (Figure 3).

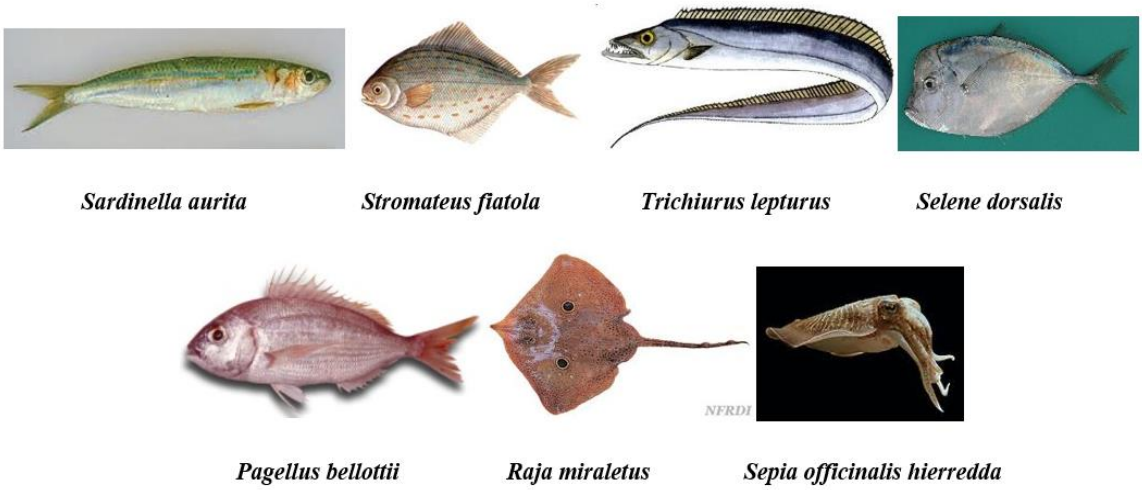

Fig 3: Taxa cited by campaigns, surveys, baseline and the management plan

The main sources of information are deep campaigns (38%), coastal campaigns (21%), artisanal fisheries surveys (30%), management plan (7%) and baseline (4%). Molluscs are poorly represented (3% of the species identified). Crustaceans, the second largest group after bony fish, have 22 species divided into 11 families, mainly Pandalidae and Peneidae. The rare sightings of cetacean strandings indicate the presence of the blowing dolphin (*Tursiops truncatus*) and, in 2006 at the level of the PNLB, of the monk seal (*Monachus monachus*), species classified as vulnerable by IUCN and threatened with extinction. For reptiles, there is the green turtle (*Chelonia mydas*) and the hawksbill one *(Erethmochelis imbricata).* The results of the avifaum counts mention 80 species in the MPA area (Appendix II) of which 65% are reported by the 2 sources (PNLB and AMP) while the gray-headed gull, the royal tern and the Hansel terns make up the largest numbers.

3.2. Threats

3.2.1. Natural threats

The MPA of Saint-Louis, as a natural receptacle of the waters of the Senegal river, is undergoing strong and progressive erosion on both shores of the Langue de Barbarie from where, ruptures of the strip, the creation of a new mouth constantly in movement with visible damage on the flora and fauna (Figure 4) and the total upheaval and not yet mastered of the hydrodynamic conditions.

Fig 4: Remaining strain of the filao strip (August 2009)

The latter, due to the alternation of salt water from the tide (7 to 8 months) and fresh water from the flood of the river, reaches its peak in October - November.

The evolution of the physico-chemical parameters of the waters in the MPA mimics, synchronously, that of the fluvial dynamics at the level of the estuary : turbid fluvial waters and salinity decreasing during floods, reduced turbidity and estuarine salinity close to that sea water during periods of rising tides and closed gates of the dam from Diama.

3.2.2. Anthropogenic threats

The construction of the Diama dam has contributed to a destabilization of the ecosystem of the Senegal River delta as a whole with negative consequences for the ichtyo fauna (Diouf, 1999 cited by Kane 2005) [10]. Indeed, his works oppose the migration of fish, destroy their habitats while periodic reservoirs and releases of water cause an abrupt variation in hydrodynamic conditions harmful to fish.

In the balance sheet, we are witnessing a significant decrease or even the disappearance of species with marine and estuarine affinity such as *Ethmalosa fimbriata, Elops lacerta, Mugil cephalus, Liza falcipinis, Tilapia guineensis, Dicentrarchus punctatus, Polydactylus quadrifilis* (Figure 5).

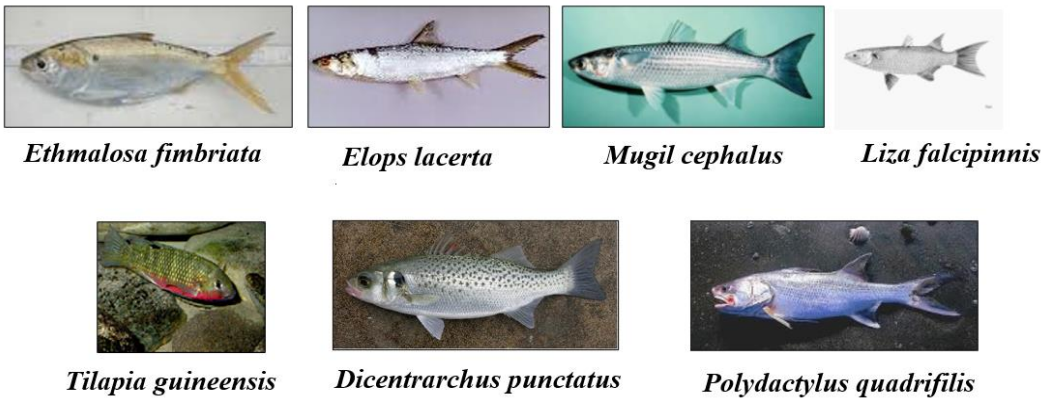

Fig 5: Illustration of the species whose abundance has greatly decreased due to the dam

The breach, opened in October 2003 (Sy 2006 - Dieng 2010) [15, 6] to stave off the floods that periodically affected the city of Saint-Louis during floods, is, paradoxically also an anthropogenic threat. Its size increased from 4 m at the start to 800 m in less than a year then to 1.4 km in 2006 (Barry, 2004 - Durand, Anselme and Thomas, 2010) [8]. It has increased fishing pressure in the MPA in the sense that boardings and landings are now done on the river side, saving time and fuel. Fish landings have thus increased since 2003 with peaks of 50,000 t in 2004 and 60,000 t in 2008 (Niang, 2012) [11].

Then (i) the breach directly threatens the surrounding islets and will destroy the mangrove which serves as a refuge and a place of reproduction for fish, turtles and several species of birds[1]; (ii) it will not be easy to stabilize it because of the configuration of the middle soil (fine sand which does not resist the assault of the waves)[2]; (iii) the opening of this breach allows the frontal arrival of ocean waves, which causes mechanical erosion of langue de Barbarie and causes a modification of the mangrove[3]; (iv) the MPA, which is supposed to promote the biological rest of the species, to be an a priori "quiet and undisturbed" area, connects to the breach, which has become the favored passageway for fishermen from Guet-Ndar.

In terms of pollution, the Saint-Louis MPA receives directly, on the river side (drainage) as on the sea side (sea currents), all kinds of household garbage dumped into the waters by the populations living near the sea coast (from Nouakchott to Saint-Louis) or the Senegal River (Figure 6).

In addition, there is the direct dumping of wastewater into the sea by the populations of the Langue de Barbarie neighborhoods (Guet-Ndar, Ndar - Toute and Goxumbaac). All of this is amplified by the connection with the river of waste water evacuation pipes collected by the Office National Assainissement du Senegal (ONAS) and arriving directly in the MPA via the breach. Pollution of the agroindustrial type results, overall, from the waters of the river, natural outlet of the drainage waters of the irrigated perimeters located along the valley; which are loaded with pesticides, fertilizers and other agricultural residues that can contribute to the eutrophication of the environment. Other risks, this time of an enlarged dimension, could also come from the future exploitation of gas or even oil, after the recent discoveries of fairly large deposits offshore of Saint-Louis and Kayar.

However, this great anthropic threat could be avoided in the context of the proper application of the environmental and social management plan (PGES) of the oil and gas companies in Saint- Louis and Kayar's areas.

Fig 6: Elements of domestic pollution visible at the Saint-Louis MPA

[1] Mr. Mané, Professor at the university of Gaston Berger Saint-Louis (Cf. MPA Action and Management Plan)

[2] Mr. Niane, researcher at the university of Gaston Berger Saint-Louis (Cf. MPA Action and Management Plan)

[3] Mr. Soumaré, program officer at the World Wilde Fund of the West African region (WWF - WAMER)

3.2.3. Communication threats

They are linked to the negative perception of MPA by local actors. For example, the interviews conducted at the level of the 3 sub-districts of Guet-Ndar (Lodo, Dack and Pondokholé) show that the MPA, known certainly by more than 90% of the respondents, is also rejected in a certain way. It is accused, in particular, of the disruption of fishing habits and the loss of income due to various restrictions. In this regard, Diallo[4] reports that for 54% of respondents, an MPA is simply a park, a place where all exploitation is prohibited. In Lodo, where the discharge is more nuanced, the populations no longer attach importance to the MPA area, which is severely degraded and no longer serves as a fishing area according to them.

On the balance sheet, we note that even if the gap is reduced between fishermen and managers grouped in the management committee (CG), as for their perceptions on the MPA, the latter constitute, therefore, a constraint for better management of AMP.

3.2.4. Political and institutional threats

This type of threat refers above all to the nagging question of supervision between the ministries in charge of fisheries on the one hand, and of the environment and nature protection on the other, MPAs having a double grip (marine and terrestrial) and giving rise to conflicts of interest (conservation and / or exploitation?). The vagueness persists, to this day, despite the creation of a Technical Committee supposed to resolve the problems but, never met until now.

Then, even if the annual operating budget of 9,900,000 FCFA allocated by the State (Anonymous, 2020) gives a ratio of 160 FCFA / ha / year in 2020, which certainly exceeds the national average in this area which is of 33 FCFA / ha / year[5] (Ndiaye and Diop, 2001), the fact remains that this ration of MPA (i) is below international standards (<0.01 $ US / ha / year to> 10 000 $ US / ha / year) (ii) only finances the operating costs of the State agents assigned on the spot. It therefore does not concern the activities specific to the development and ecological monitoring of the site. The consequences of such a state of affairs are numerous: MPA management process highly dependent on the support of external partners, lack of MPA monitoring, lack of an adequate ecological monitoring system, absence of internal initiative for the execution of development works, timid functioning of the management bodies of the MPA.

On another level, the AMP co-management bodies have so far been largely ineffective, like the General Assembly (GA) faced with a glaring lack of dynamism from its stakeholders[6]. In addition, the Management Committee, the main decision-making body of the MPA, is criticized for its inertia.

3.3. Indicators

There are 8 bioecological monitoring (IBE) and good governance (IBG) indicators, a description of which is given in detail in Niang (2012) [11] and succinct below:

- Biannual inventory of new fishery species (IBE-1) intended to note the number of new taxa reported at the level of the MPA compared to those mentioned in this work (cf. Appendices). To be entrusted to CRODT.
- Bi-annual inventory of new avian species (IBE-2), identical to the previous except that these are seabirds and that expertise is expected from the DPN[7] and DEFCCS[8]
- Increase in catches (IBE-3) following the non-MPA distribution of resources. We can limit ourselves to global catches (all commercial species combined) or targeted catches (ex: Sparidae, Serranidae, cephalopods, etc.)
- Increase in the average size of key species (IBE-4), work to be entrusted to CRODT. The size parameter could be the total length (fish), the cephalothoracic length (crustaceans) or the ventral length of the mantle (cephalopods).

Target species could be *Epinephelus aeneus, Pomadasys jubelini, Sepia officinalis hierredda, Pseudotolithus senegalensis, Sphyraena guachancho, Arius heudeloti, Galeoides decadactylus, Pentanemus quinquarius* and *Cynoglossus senegalensis*.

The notable return of these taxa, which have become rare according to the actors and coupled with interesting sizes, would be a plus for the promotion of tourism and fishing.

- Number of meetings of the Management Committee (IBG-I), an indication of the annual good functioning of this body, provided that the meetings are productive and followed by effects, being mainly acts going in the direction of preservation biodiversity.
- Number of outings at sea by the Management Committee (IBG-II), an indicator operating directly on biodiversity as aiming, at sea, to report, correct or punish prohibited fishing practices, beaconing faults, pollution risks, etc.
- Number and type of gear seized (IBG-III), subject to the participatory definition of prohibited fishing gear. It is a good indicator for preserving biodiversity: the more it increases, the more it will be threatened and the more it will be necessary to strengthen surveillance, trips at sea, communication, etc. As an indication and with the exclusion of traps and single lines, the fishing gear and techniques to be prohibited could be the following: beach seines, dead nets, purse seines, longlines, surface and bottom drift nets, net monofilament, explosive fishing, spear fishing
- Amount of offenses in FCFA (IBG-IV), very related to the precedent which it is, somewhat, a financial reflection. One of its great advantages is that, subject to the tacit agreement of the various parties, it can constitute a significant addition to the operating budget of the MPA, in order to contribute to the disinterestedness of the intervention teams.

It is proposed in Table 1 a rating system for the 8 indicators with, implicitly, a concern for objectivity in assessing the performance expected from the establishment of an MPA like that of Saint-Louis. For each indicator, there are 4 modalities marked from 0 to 3 points; or a minimum total of 0 to 12 points for each. On this basis and depending on the total number of points obtained, the following classifications could be retained:

a) For bioecological indicators

- Total ≤ 3 points: unsatisfactory bioecological monitoring
- 4 ≤ total ≤ 6 points: bioecological monitoring fairly good

[4] WWF Program Officer – WAMER

[5] Average budgets noted in certain countries of Central Africa (Angola) and Asia (Cambodia, Laos)

[6] Local elected officials, technical service agents, customary and religious authorities, local NGOs, educational and private tourism establishments, etc.

[7] National Parks Directorate of Senegal

[8] Department of Water, Forests, Hunting and Soil Conservation of Senegal

- 7 ≤ total ≤ 9 points: good bioecological monitoring, positive impact of the MPA on resources
- 10 ≤ total ≤ 12 points: very good bioecological monitoring, very positive impact of the MPA on resources

b) For good governance indicators

- Total ≤ 3 points: the governance of the MPA is not good
- 4 ≤ total ≤ 6 points: the governance of the MPA is quite good
- 7 ≤ total ≤ 9 points: the governance of the MPA is good
- 10 ≤ total ≤ 12 points: the governance of the MPA is very good

Table 1: Rating system proposed for bioecological and good indicators

1. Inventory of new fish species		Fact		
modalities	Not done	No new sp	1 to 5 species noted	> 5 species noted
Number of points	0	1	2	3
2. Inventory of new avian species		Fact		
modalities	Not done	No new sp	1 to 5 species noted	> 5 species noted
Number of points	0	1	2	3
3. Increase in non-MPA catches		Increase in catches		
modalities	No increase	1 to 4%	5 to 10%	> 10%
Number of points	0	1	2	3
4. Increase in the average size of key species		Increase in average size of catches		
	No increase	1 - 2 cm (or mm)		> 5 cm (or mm)
Number of points	0	1	2	3
5. Number of Management Committee meetings	No meeting	Annual meetings		
		1 to 2 meetings	3 meetings	4 meetings
Notes	0	1	2	3
6. Number of trips by sea to the Management Committee		Sea trips		
modalities	No sea trip	<6 outings	6 to 12 outputs	> 12 outings
Notes	0	1	2	3
7. Number and type of gear seized		Effective seizure of gear		
modalities	No gear seized	<6 machines	6 to 12 machines	> 12 machines
Notes	0	1	2	3
8. Amount of infringements		Effective seizure of gear		
modalities	No gear seized	<250,000 FCFA	250,000 to 600,000 FCFA	> FCFA 600,000
Notes	0	1	2	3

4. Discussions

The bioecological study made it possible to count 437 species of fish, crustaceans, molluscs and echinoderms, 325 of which are formally identified. Such an inventory level does not yet exist in other MPAs except that of Kayar where similar work was carried out 2 years ago (WWF, 2009) [17].

More specifically, on ichthyological biodiversity, similar studies (Sarr *et al*., 2018; Sarré *et al*., 2009) [13, 14] were made in the MPA of Joal-Fadiouth, created the same year as the MPA of Saint-Louis, with a much less specific diversity, i.e. 67 and 56 fish species respectively in 2018 and 2009 for AMP Joal-Fadiouth, against 375 fish species for AMP Saint-Louis. The results can be explained by the living conditions for organisms close to the coasts (Rivierre, 2007) [12], but also by a biological diversity which would also partly depend on the level of exploitation of resources (Sarr *et al*., 2018) [13].

The importance of the results obtained is explained by the availability and cross-referencing of several sources of information which are complementary, some being more precise than the others. For example, the reference state made in the bottoms less than 10 m of depth supports coastal (10 to 200 m) and deep (150 to 700 m) campaigns; the latter also provide exceptional data due to the less accessible (targeted) nature of deep stocks.

Likewise, data from coastal (scientific) cruises complete and validate surveys on small-scale fishing. Thus, the approach adopted in the study of halieutic and avian biodiversity of the Saint-Louis and Kayar MPAs, both innovative and effective, could be extended to the remaining MPAs. However, we must be a little careful with the data recently obtained from surveys of small-scale fisheries. Indeed, the fishermen of Saint-Louis, with the scarcity of fish in local waters, exercise more and more their activities in the neighboring waters of Mauritania. Fortunately, 45% of the 190 species identified in these surveys are confirmed by other sources.

Poorly defined taxa (25%, such as Dentex sp, squid, etc.) reflect the difficulty experienced by technicians in determining the species exactly for various reasons: too short time and / or too much work (campaigns at sea), ignorance of certain species, etc. Finally, data on cetaceans and sea turtles are quite scarce, certainly due to the ban on their capture (cf. Maritime Fishing Code in force) and let us also say, relatively unknown in terms of systematics, that is to say, the recognition of species. Hence, the need to conduct local studies on these groups and even other molluscs (bivalves, gastropods, etc.) and the flora with, beforehand, strengthening the capacities of the actors (research, local technicians, members of the 'AMP, etc.) in relation to their respective systematics. This, would provide a more comprehensive view of the biodiversity of the MPA.

To be fully functional, the Saint-Louis MPA, like the 4 others, must see a certain number of minimum conditions fulfilled, in particular markup, the availability of regulatory texts, the existence of a CG and d " a dynamic GA, the availability of a good operating budget and the implementation of an effective communication policy.

From then on, it becomes possible to tackle threats to its biodiversity. The resolution of those relating to natural and human causes (breach, pollution, Diama dam, etc.) challenges both the authorities, the technical services and the local

populations in terms of project management (ex: breach), impact studies (Diama dam, breach), application of regulatory texts (pollution), laxity harmful to the environment (pollution), etc. Communication, political and institutional threats can be resolved through the unequivocal designation of the supervisory authority, the establishment of appropriate operating budgets, the improvement of the functionality of the management bodies (effective involvement of all actors, participative modification of the internal regulations, implementation of information systems facilitating dialogue and decision-making, ecological monitoring, monitoring and alerting on the state of biodiversity and the environment, etc.). The monitoring and good governance indicators proposed were aimed at preserving biodiversity within the Saint-Louis MPA. Existing in a limited number (8), they are also quite easy to collect, relevant, clear, valid, applicable and reliable. They presuppose the involvement and above all the expertise of specialists in biodiversity issues (CRODT, DPN, DEFCCS, etc.) and governance (lawyers) with a view to achieving the self-assessment objectives assigned to them.

The voluntary omission of socio-economic indicators is explained by a certain degree of caution, since their validity and applicability require a lot of investigation and time. They could be taken into account in the future; the present list and its method of scoring are not limiting but suggestive.

5. Appendices

Annex 1: Listing and importance of taxa grouped mainly into families

Family	%	Family	%	Family	%	Family	%
Acanthuridae	0,16%	*Cariidae*	0,16%	*Drepanidae*	0,48%	*Macrouridae*	2,07%
Acropomatidae	0,48%	*Centracanthidae*	0,48%	*Diodontidae*	0,16%	*Majidae*	0,48%
Albulidae	0,48%	*Centrolophidae*	0,64%	*Elopidae*	0,16%	*Malacosteidae*	0,16%
Alepocephalidae	0,48%	*Centrophoridae*	0,79%	*Emmlichthyidae*	0,32%	*Melanostomiatidae*	0,16%
Antennariidae	0,32%	*Cepolidae*	0,16%	*Engraulididae*	0,32%	*Merlucciidae*	0,95%
Apogonidae	0,32%	*Ceratiidae*	0,16%	*Etmopteridae*	0,16%	*Mobulidae*	0,64%
Ariidae	0,95%	*Chaetodontidae*	0,16%	*Exocoetidae*	0,16%	*Monacanthidae*	0,16%
Ariommatidae	0,32%	*Chaunacidae*	0,32%	*Fistulariidae*	0,32%	*Moridae*	0,79%
Aristeidae	0,32%	*Chlorophthalmidae*	0,64%	*Gempylidae*	0,32%	*Moronidae*	0,32%
Ateleopodidae	0,32%	*Cichlidae*	0,32%	*Gerreidae*	0,48%	*Mugilidae*	0,95%
Aulopodidae	0,48%	*Citharidae*	0,32%	*Geryonidae*	0,16%	*Mullidae*	0,48%
Balistidae	0,32%	*Clupeidae*	2,70%	*Gobiidae*	0,32%	*Munidae*	0,48%
Belonidae	0,48%	*Clupeidae*	0,16%	*Guentheridae*	0,16%	*Muraenesocidae*	0,16%
Berycidae	0,32%	*Colocongridae*	0,16%	*Gymnuridae*	0,32%	*Muraenidae*	0,32%
Blenniidae	0,32%	*Congridae*	0,64%	*Haemulidae*	2,70%	*Muraenosocidae*	0,32%
Bothidae	1,11%	*Coryphaenidae*	0,16%	*Halosauridae*	0,32%	*Muricidae*	0,32%
Branchiostegidae	0,48%	*Cottunculidae*	0,16%	*Hemiramphidae*	0,32%	*Myctophidae*	0,32%
Calappidae	0,32%	*Cymatiidae*	0,16%	*Istiophoridae*	0,32%	*Myliobatidae*	0,16%
Callionymidae	0,48%	*Cynoglossidae*	0,64%	*Labridae*	0,16%	*Nematocarcinidae*	0,16%
Caproïdae	0,64%	*Dactylopteridae*	0,48%	*Lethrinidae*	0,16%	*Nemichthyidae*	0,32%
Carangidae	6,20%	*Dalatiidae*	0,32%	*Loliginidae*	0,48%	*Nettastomidae*	0,16%
Carangidae	0,16%	*Dasyatidae*	0,48%	*Lophiidae*	0,48%	*Octopodidae*	1,43%
Carapidae	0,16%	*Diceratidae*	0,16%	*Lutjanidae*	0,95%	*Ogcocephalidae*	0,16%
Carcharhinidae	0,32%	*Platycephalidae*	0,32%	*Scorpaenidae*	1,91%	*Ommastrephidae*	0,64%
Ophichthidae	0,48%	*Platytroctidae*	0,16%	*Scyliorhinidae*	1,27%	*Synodontidae*	0,48%
Ophichthiidae	0,16%	*Polychelidae*	0,16%	*Sepiidae*	0,95%	*Tetraodontidae*	1,75%
Ophichtidae	0,16%	*Polynemidae*	1,11%	*Serranidae*	3,66%	*Torpedinidae*	0,48%
Ophidiidae	1,27%	*Pomatomidae*	0,48%	*Soleidae*	2,07%	*Trachichthyidae*	0,64%
Oxynotidae	0,32%	*Portunidae*	1,59%	*Solenoceridae*	0,32%	*Trachipteridae*	0,16%
Palinuridae	0,32%	*Priacanthidae*	0,32%	*Sparidae*	5,09%	*Triakidae*	0,79%
Pandalidae	0,95%	*Psettodidae*	0,16%	*Sphyraenidae*	1,11%	*Trichiuridae*	0,79%
Paralepididae	0,16%	*Psychrolutidae*	0,16%	*Sphyrnidae*	0,32%	*Triglidae*	0,95%
Paralichthyidae	0,16%	*Rachycentridae*	0,16%	*Squalidae*	1,27%	*Uranoscopidae*	0,48%
Pasiphaeidae	0,32%	*Rajidae*	1,91%	*Squatinidae*	0,16%	*Volutidae*	0,32%
Penaeidae	1,27%	*Rhinobatidae*	0,32%	*Squillidae*	0,32%	*Xiphiidae*	0,32%
Percichthyidae	0,32%	*Rhinochimaeridae*	0,16%	*Sternoptychidae*	0,16%	*Zeidae*	1,11%
Percophidae	0,32%	*Rhyncobatidae*	0,16%	*Stomiidae*	0,48%	*Zenionidae*	0,16%
Peristediidae	0,32%	*Sciaenidae*	3,82%	*Stromateidae*	0,64%	*	*
Phothichtyidae	0,16%	*Scombridae*	2,07%	*Syngnathidae*	0,16%	*	*

Annex 2: List of bird species counted at the MPA of Saint-Louis

N°	Species	N°	Species	N°	Species
1	*Haliaeetus vocifer*	29	*Phalacrocorax africanus*	57	*Larus cirrocephalus*
2	*Egretta ardesiaca*	30	*Numenius arquata*	58	*Larus ridibundus*
3	*Egretta dimorpha*	31	*Numenius phaeopus*	59	*Burhinus senegalensis*
4	*Egretta garzetta*	32	*Tachybaptus ruficollis*	60	*Plectropterus gambensis*
5	*Ardea intermedia*	33	*Dendrocygna viduata*	61	*Alopochen aegyptiaca*
6	*Anhinga rufa*	34	*Himantopus himantopus*	62	*Pelecanus anocrotalus*

7	*Recurvirostra avosetta*	35	*Falco tinnunculus*	63	*Pelecanus rufescens*
8	*Pandion haliaetus*	36	*Falco peregrinus*	64	*Charadrius dubius*
9	*Limosa limosa*	37	*Phoeniconaias minor*	65	*Halcyon senegalensis*
10	*Limosa lapponica*	38	*Phoenicopterus roseus*	66	*Pluvialis squatorola*
11	*Calidris ferruginea*	39	*Larus fuscus*	67	*Charadrius pecuarius*
12	*Calidris temminckii*	40	*Larus audouinii*	68	*Gallinula chloropus*
13	*Calidris canutus*	41	*Larus genei*	69	*Coracias abyssinicus*
14	*Calidris minuta*	42	*Phalacrocorax carbo*	70	*Platalea leucorodia*
15	*Calidris alba*	43	*Charadrius hiaticula*	71	*Sterna caspia*
16	*Calidris alpina*	44	*Egretta alba*	72	*Sterna sandvicensis*
17	*Galllinago gallinago*	45	*Charadrius alexandrinus*	73	*Gelochelidon nilotica*
18	*Motacilla alba*	46	*Chlidonias leucopterus*	74	*Sterna albifrons*
19	*Motacilla flava*	47	*Chlidonias hybrida*	75	*Sterna hirundo*
20	*Circus aeruginosus*	48	*Butorides virescens*	76	*Sterna maxima*
21	*Tringa nebularia*	49	*Nycticorax nycticorax*	77	*Arenaria interpres*
22	*Philomachus pugnax*	50	*Ardea cinerea*	78	*Vanellus tectus*
23	*Tringa ochropus*	51	*Ardeola ralloides*	79	*Vanellus spinosus*
24	*Tringa totanus*	52	*Bubulcus ibis*	80	*Gyps fulvus*
25	*Actitis hypoleucos*	53	*Ardea purpurea*		
26	*Tringa stagnatilis*	54	*Haematopus ostralegus*		
27	*Tringa glareola*	55	*Ceryle rudis*		
28	*Corvus albus*	56	*Milvus migrans*		

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