
ORIGINALARTICLE

Are there any Sound reasons Accounting for sustainably managing pelagic Fishes? A case Study on Sardinella resources in Côte d'Ivoire, West Africa

Laurent BAHOU*

Department of Research on the Biology, Ecology and Population Dynamics of Aquatic Living Resources, Centre for Oceanographic Research, Fishers Road, Treichville, Tel : (225) 21 35 58 80, BP V18 Abidjan, Côte d'Ivoire.

Email address*: lbahoucrothon@yahoo.fr

ABSTRACT

Worldwide, some pelagic fishes, if not many, play key roles in marine ecosystems, serving as food for predatory fishes, besides their heavy occurrence in landings. Sardinellas are suchlike fishes, being among species known as small pelagics that account for the principal coastal fishery resources of Côte d'Ivoire. With permanent fish supply intended for the Ivoirian people as a result of increasing fish-consumption, local stocks of Sardinellas are being made use of in prominent and steady ways. Yet, immoderate use of Sardinellas stocks cannot be sparing of some effect on fisheries viability, not alone overall ecosystem state. Some few years ago, people even foretold about Sardinellas stocks in Côte d'Ivoire that reaching collapse was at hand. We aim to raise local awareness over the urges to establish a sustainable management strategy for Sardinellas stocks. Therefore, this research was carried out in February-March and August-September 2021, based on surveys and individual interviews made at Sassandra (southwestern Côte d'Ivoire), using a questionnaire. The main results indicated undeniable economic and social returns derived from the use of Sardinellas stocks, the roles of these species within the ecosystem, and a reputation of fishers that turned sullied by unfair and irresponsible practices that in time may cast a slur on the production process. Therefore, the study calls on local fisheries Managers to set new objectives in line with Sustainable Goal (SG12) for managing Sardinellas stocks, which the fisher flock and consumers may certainly benefit from.

KEYWORDS: Fisheries viability, Light-fishing, Pelagic fishes, Sardinellas stocks, Sustainable management.

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INTRODUCTION

Worldwide, almost all fishes are useful to humans as regards consumption; but the fish that heavily occur in the landings certainly deserve a greater importance. The reason is their role is generally not limited to solely serve as food for humans. They would also play key roles within the ecosystems, being either planktonic-organisms consumers or even prone to serve as food for predatory fishes, of which apex predators. Sardinellas (the round sardinella *Sardinella aurita* Valenciennes, 1847 and flat sardinella *Sardinella maderensis* (Lowé, 1839)) are suchlike fishes. According to several authors [1]; [2], the geographic distribution of round sardinella is widespread, covering vast coastal zones of Tropical Atlantic Ocean, from Gibraltar to South Africa (Saldanha Bay), as well as the Mediterranean and Black Seas; in addition to Western Atlantic Ocean, from the Gulf of Mexico to Brazil and the Indo-Pacific. In contrast, [3] indicated that flat sardinella occur in areas not that widespread as round sardinella do, being distributed within Mediterranean Sea and Eastern Atlantic Ocean, and from Gibraltar to Angola; yet, not across the American coasts [3]. Both species occur throughout the Gulf of Guinea (West Africa), especially in Côte d'Ivoire, where they represent a large part of fishes accounting for the principal coastal fishery resources [4]. According to [5], coastal pelagic fish contribute substantially to food security in the world. As an important component of coastal pelagic fishes, Sardinellas would heavily be caught in fishing gears

deployed by artisanal fisheries. Those fisheries generally are coastal because the canoes they use as fishing fleets, though equipped with 40-hp motors, are not powerful enough to enable fishers embark for fishing trips any further than the coastal areas. Yet in terms of species richness, both *Sardinella* species prominently occur in the catches [6], favoured by cooling conditions that take place in continental shelf waters of Côte d'Ivoire, from July to September. Unfortunately, though, the scarceness of fishery resources, shaped as it is by poor landings at times, low-sized fish, occurrence of juveniles within the catch, etc..., often adds to the competitive spirit between fisheries opposed to each other (i.e. artisanal fishery and industrial fishery). The overall objective of the current study was to show that *Sardinella* resources deserve special attention accounting for the stocks be managed sustainably. A specific goal was to shed light on the production process, searching for ways to improve the harvest conditions with regard for the observance of responsible fishing practices.

MATERIAL AND METHODS

Carrying out surveys

Our main focus was to ask questions to a considerable number of people from the fisher flock and other people working for the benefit of the marine artisanal fishing sector of Sassandra, southwestern Côte d'Ivoire. Therefore, a questionnaire was designed to enable us carry out individual interviews in which people were asked questions about their fishery-related activities. Conversations were engaged with respondents as an informal discussion, in a manner that showed we have a deep respect for them and regard for their job; while answers were taken in note form on duly-designed sheets of paper serving for enquiry sheets. Questions that were asked throughout conversations read this way: 1. Hello! Are *Sardinella*s of any importance to you? 2. Do fishers target *Sardinella*s? Do *Sardinella*s constitute a part of the fish you sell to customers or process with wood smoke? 3. Do *Sardinella*s account for a large part of your fishing business? 4. When do *Sardinella*s abound within the catches? 5. Is there any other fishery that fishes for *Sardinella*s as you artisanal fishers do? 6. Do artisanal fishers get on well with the industrial fishery? Can you tell us about your relationship? 7. Some people say both artisanal and industrial fishers perform light-fishing. Can you confirm that? 8. Some other people say that artisanal fishers' nets are frequently torn apart by boats of the industrial fishery that also fishes for *Sardinella*s. Can you confirm the case? 9. Why does such a conflicting situation generally occur? 10. Are the fishing Licences issued by fisheries Managers species-specific? 11. Would you welcome a fishing-closure decision, effective when the reproductive season of *Sardinella*s is approaching, in order to avoid capture for juvenile fish shortly thereafter? 12. Do you have any extra activities that could be a substitute for the one you are carrying out, if the law on fishing closure were to come into effect? 13. Do you believe that *Sardinella*s play any particular role as regards their importance within the ecosystem they live in?

The survey dealt with 172 people in totals, including fishers (31), wholesalers (29), smoke-curing agents (41), and retailers (71). We saw to it that the respondents varied considerably in age and experience, to maximize our chances to getting a large array of opinions.

Data analysis

All the data we collected were registered in an Excel file to facilitate expressing them as percentages. Simple counts were also used to illustrate some data; but for some other data, salient points were brought out using figures.

RESULTS AND DISCUSSION

The marine artisanal fishery located at Sassandra, south-western Côte d'Ivoire, targets various species, of which *Sardinella aurita* and *S. maderensis*. Figure 1 shows the extent to which these small-pelagic species contribute to total landings (Fig. 1A) and overall earnings through fish trade (Fig. 1B). This really shows that contribution of *Sardinella*s to overall catch is outstanding. Contribution of round sardinella (39.75% of annual catch) and that of flat sardinella (27.47% of annual catch) perfectly illustrate what it stands for these species' prominent importance to fish landings at Sassandra, so much that both percentages combined (67.22%) largely exceeded the contribution of all other species combined (32.78%). In addition, Figure 1B shows how significant *Sardinella*s' contribution was to total revenue of fishers, as money earned from the sale of fish. Cumulative contribution derived from the two *Sardinella*s accounted for 58.20% of total revenue, though *Sardinella aurita* would contribute more (34.09%) than the other (24.11%).

Table 1 indicates the opinions and feelings of overall people working for the benefit of the artisanal fishery located at Sassandra, southwestern Côte d'Ivoire. The present state of the views held by most people or by a large number of people varied from the lowest (0%) to the highest (12.50%) percentages deduced using responses obtained from 172 people. Cumulatively, 32.28% of positive responses ($Q_1 + Q_2$

+ Q₃) show the importance of Sardinellas as a part of fishers’ targeted-fish and their role in the fishing business, increasing the portion of the fish purchased and that processed with wood smoke. Yet, Sardinellas are of no importance to wholesalers (5.22% of cumulative negative opinions on Q₁ + Q₂ + Q₃), mainly because they would sell to customers the portion of the production made up of species known as “noble fish”. Furthermore, behaviours of fishers from the industrial fishery towards artisanal fishers as regards the way both fisheries should restrict fishing operations to specific areas depict a conflicting issue. A conclusion drawn from observation of the facts indicates that both fisheries do not put up with each other, as illustrated by 12.50% of positive and 12.50% of negative responses obtained from the interviewees concerning questions Q₈ and Q₆, respectively. In addition, although light-fishing is not a widely-held practice among artisanal fishers (10.76% of negative opinion on Q₇), it does exist, not alone among industrial fishers (1.74% of positive opinions on Q₇). Almost all people from the fishers’ community and others engaged in fishery-related activities have extended a cautious welcome to the proposals for a fishing-closure decision, as illustrated by the 5.74% of cumulative positive responses on questions Q₁₁ + Q₁₂. The majority of them have no extra activities that could be a substitute for the ones they are currently carrying out, as judged on the 19.26% of cumulative negative responses on questions Q₁₁ + Q₁₂.

Artisanal fishers know from experience that Sardinellas abound from July to September (Q₄). Unfortunately, during that period of time, the larger boats the industrial fishery uses to fish for Sardinellas too (Q₅) frequently tear apart the nets of the artisanal fishers, when the boats sail quite closer to the coastal area (Q₉). In fact, the fishing Licences either fishery obtain from fisheries Managers are not species-specific (Q₁₀), which enables both artisanal and industrial fishers to fish or use fishing gears regardless of type of species. Additionally, artisanal fishers’ knowledge about Sardinellas’ role within the ecosystem is quite limited. They remained evasive at question Q₁₃, as a result. To enhance readers’ understanding of the subject, we set out an explanation based on gathered facts about stomach contents analysis carried out in previous research. Figure 2, which is a simplified illustration of the structure and functioning of an ecosystem, shows that Sardinellas are consumed at different levels of the food web. At the early stages of their life course, they would appear in stomach contents of pelagic fishes like Largehead hairtail (*Trichiurus lepturus* Linnaeus, 1758). At juvenile stage, and before they reach sexual maturity, Sardinellas are frequent in stomach contents of small tuna species such as frigate tuna (*Auxis thazard* (Lacépède, 1800)) and little tunny (*Euthynnus alletteratus* (Rafinesque, 1810)). They would however highly occur as prey in the stomach contents of major tuna species such as skipjack (*Katsuwonus pelamis* (Linnaeus, 1758)) and yellow fin tuna (*Thunnus albacores* (Bonnaterre,1788)), but to a lesser extent in stomach contents of related species. Adult Sardinellas are prone to serve as food for larger tunas and related species such as Atlantic sailfish (*Istiophorus albicans* (Latreille, 1804)) and Blue marlin (*Makaira nigricans* Lacépède, 1802). Moreover, Sardinellas themselves customarily feed on microscopic organisms known as phytoplankton and zooplankton (Fig. 2).

Table 1. Responses obtained following individual interviews that were carried out in 2021 within four corporations of people working for the benefit of the marine artisanal fishery of Sassadra, southwestern Côte d’Ivoire.

Positive or negative responses obtained from the different interviewees	Number of respondents	Initial percentages deduced using responses obtained within the four corporations	Final percentages deduced using overall responses obtained from 172 interviewees
Positive opinion on Q ₁	148	86.05	10.76
Positive opinion on Q ₂	148	86.05	10.76
Positive opinion on Q ₃	148	86.05	10.76
Positive opinion on Q ₆	0	0	0
Positive opinion on Q ₇	24	13.95	1.74
Positive opinion on Q ₈	172	100	12.50
Positive opinion on Q ₁₁	40	23.26	2.91
Positive opinion on Q ₁₂	39	22.67	2.83
Negative opinion on Q ₁	24	13.95	1.74
Negative opinion on Q ₂	24	13.95	1.74
Negative opinion on Q ₃	24	13.95	1.74
Negative opinion on Q ₆	172	100	12.50
Negative opinion on Q ₇	148	86.05	10.76
Negative opinion on Q ₈	0	0	0
Negative opinion on Q ₁₁	132	76.74	9.59
Negative opinion on Q ₁₂	133	77.33	9.67

Note: Q₁= Hello! Are Sardinellas of any importance to you? Q₂= Do fishers target Sardinellas? Do Sardinellas constitute a part of the fish you sell to customers or process with wood smoke? Q₃= Do Sardinellas account for a large part of your fishing business? Q₆= Do artisanal fishers get on well with the industrial fishery? Can you tell us about your relationship? Q₇= Some people say both artisanal and industrial fishers perform light-fishing. Can you confirm that? Q₈= Some other people say that artisanal fishers' nets are frequently torn apart by boats of the industrial fishery that also fishes for Sardinellas. Can you confirm the case? Q₁₁= Would you welcome a fishing-closure decision, effective when the reproductive season of Sardinellas is approaching, in order to avoid capture for juvenile fish shortly thereafter? Q₁₂= Do you have any extra activities that could be a substitute for the one you are carrying out, if the law on fishing closure were to come into effect?

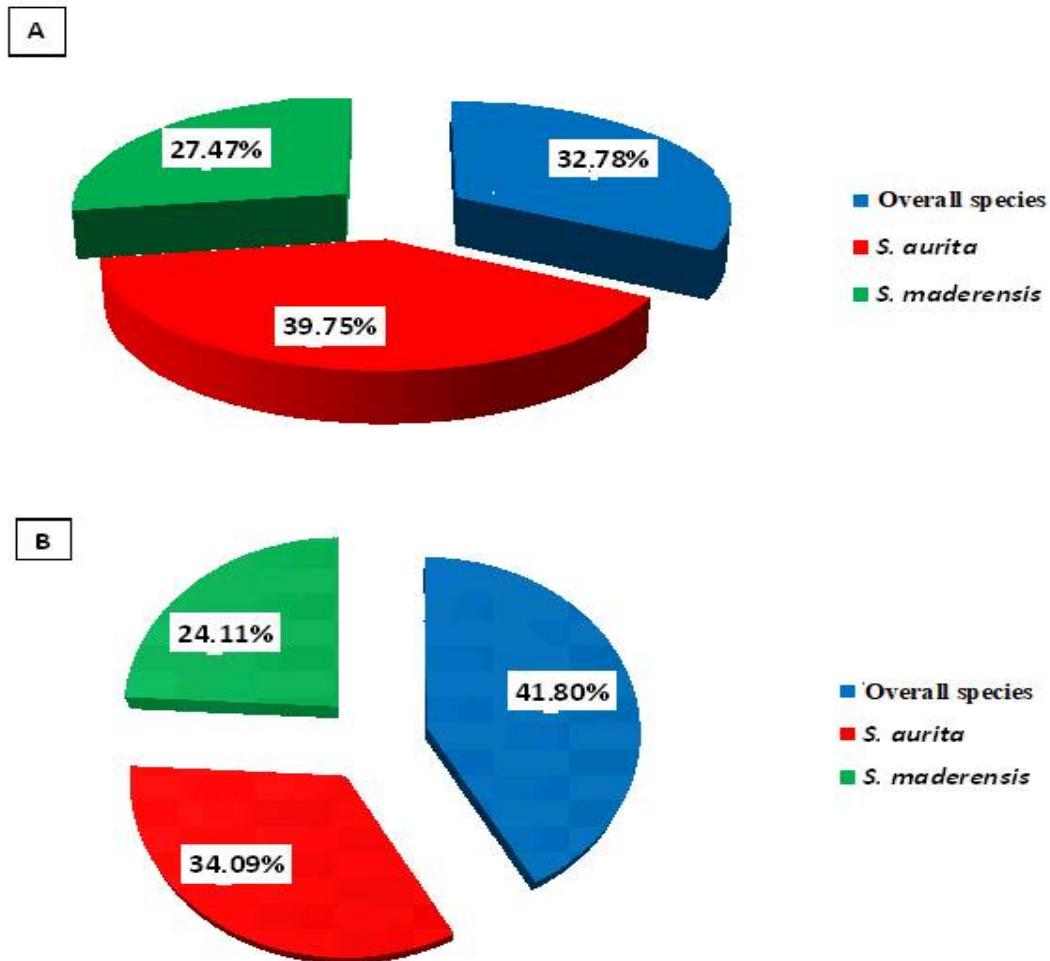


Figure 1: Contribution of Sardinellas to total catch as expressed in tons (A) and total money earned through fish trade (B, expressed in Millions of local currency) in 2020 at Sassandra, southwestern Côte d'Ivoire. Note: Courtesy to the local Office for Aquaculture and Fisheries Statistics ([7])

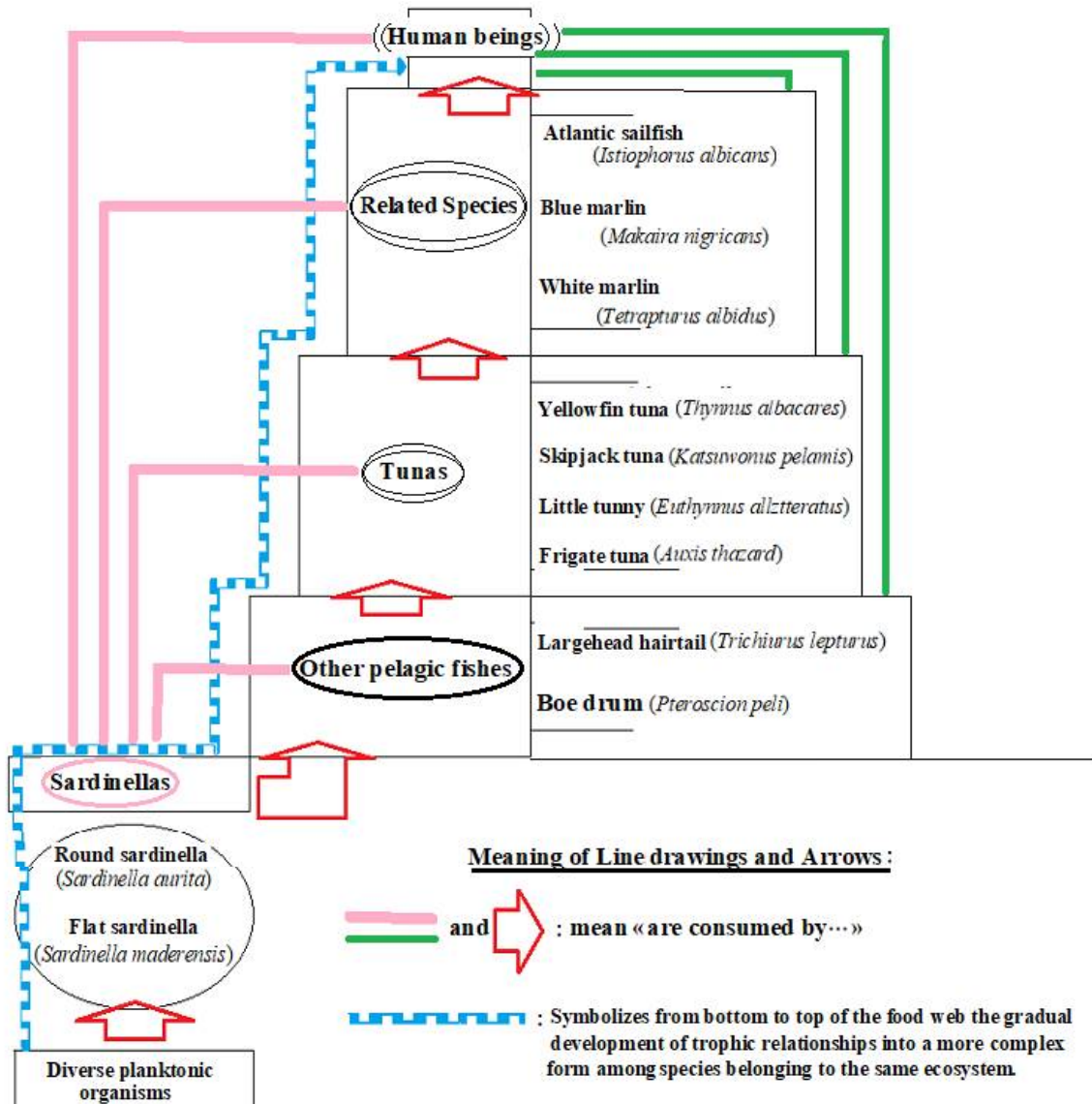


Figure 2 : Simplified representation of the food web showing the key-role of Sardinellas within the marine ecosystems, especially as prey consumed by predators from various trophic levels.

DISCUSSION

Contributions of Sardinellas to total landing and revenue are conspicuous. Fishers undoubtedly draw a large part of their annual revenue from the sale of Sardinellas, even though the other species would play undeniable part. With such impressive contributions, it is not surprising that the group made up of small pelagic species, to which Sardinellas belong, account for up to 80% of total landings ([8]). For all these reasons, both Sardinella species deserve to be referred to as principal species among overall fishes targeted by the marine artisanal fishery of Sassandra. The above-mentioned percentages would however reflect the outstanding abundance of the round sardinella (*Sardinella aurita*), compared with the flat sardinella (*Sardinella maderensis*). It seems that this later constative statement reflects consistency between now and past years. More recent data confirm this fact, showing that round sardinella account for about two-thirds of the catch by the semi-industrial fishery ([9]).

As fishery resources become scarce with the passing of years, new objectives are to be set in order to sustainably manage Sardinellas stocks. All fisheries are meant to abide by the Law, by promoting good fishing practices, and observing responsible fishing practices. For instance, both artisanal and industrial fishers well-know that fishing by using light to attract the fish during the night (i.e. light-fishing) is not lawful, since it is prohibited by the Law. Therefore, fisheries Managers should reinforce control over the fishing activities and verify them. They must also diversify their means of controlling the fishing sector

and reinforce regulations requiring that fisheries be fishing within the range of fixed limits and distance assigned by the Law. The fisheries authority should set limits and restrictions over the access to fishery resources by establishing a fishing-closure decision and making it applicable within a limited period during which fishing should be forbidden. But why should things turn out to working this way? Well, when fishing occurs while reproduction of the fish is under way, juveniles, low-sized and immature individuals, as well as reproductive fish are more likely to be taken. There is generally an increase in fish abundance and fishers increase their fishing efforts, as a result. Therefore, a fishing-closure decision may serve for a management measure intended for suchlike individuals. This undeniably could serve as a lesson from the reminder of the 1970s Sardinellas stocks depletion, especially of the catastrophic fishing from 1973 to 1975 [10]. Moreover, the utilization of multiple fishing gears should be encouraged to promote and establish a balanced exploitation of the water column and avoid creating stocks with different distributional characteristics [11]. Another point to take into consideration is about the licences issued fishers. These should be species-specific, that is, in accordance with a particular type of targeted-species, with the corresponding type of fishing gear to match. Such official permits will give permission to a specific vessel to fish only for Sardinellas or tunas, neither for both species at a time nor vice versa. By so doing, conflicting issues opposing fishers will certainly be avoided, as long as fishers will operate accordingly. Additionally, fishers will be constrained by the type of licence they own to conform to the way things should be by right. They will certainly avoid easy encroachment into the range and distance assigned by the Law to the other fishery.

Truthfully, various species inhabit a given ecosystem. The trophic interactions among species stand for a vital contribution to the ecosystem functioning. However, a specific species among many others may play key roles within the ecosystem in this regard; thereby contributing to the equilibrium state of the ecosystem, at least on the trophic level. This is certainly what Sardinellas do, being prone to serve for food for many other fishes [6]. For Sardinellas are consumed at almost all stages of their life history. This really testifies to the fact that consumption of the Sardinellas is not solely beneficial to humans, but it is also profitable to most of predatory species humans feed on. In addition, the round sardinella essentially feed on phytoplankton [1]; [12]. As for the flat sardinella, their feeding regime is similar to that of *S. aurita* [13]. Yet predominance of organic detritus generally occurs in stomach contents of *S. aurita*, whereas in stomach contents of *S. maderensis* the zooplankton abound [13]. Humans should therefore sustainably manage the ecosystems in general and particularly pelagic fishes, of which Sardinellas stocks; for their own opportunities to continue feeding on fish are at stake and seem to be linked to that. So, simply put, why should there be any reasons for sustainably managing Sardinellas stocks in Côte d'Ivoire or any suchlike pelagic fishes elsewhere? Well, just as Sardinellas do, some other pelagic fishes play key roles within marine ecosystems, making the diverse food webs function adequately. Their presence can be likened to a ring that connects with others to make up a chain. What would become of the perfect functioning of such a chain if the ring were removed?

The current study showed the usefulness of Sardinellas and the various roles they play economically as revenue sustainers and socially as cheaper animal-proteins providers. Interestingly, their outstanding role is not solely limited to mere service rendered to humans. It would expand to various trophic levels within the marine ecosystems, making the Sardinellas potential prey on which apex predators can rely to enhance their diets. The ability to produce the desired results as regards sustainable management of Sardinellas stocks rests on fisheries Managers. To achieve that, however, collaboration of the fishers and that of any other persons working for the benefit of the artisanal fishery of Sassandra are needed.

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CONFLICTS OF INTEREST

I the author, Laurent BAHOU, declare that I have no conflicts of interest to report.

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