ORIGINAL RESEARCH

Migration of artisanal fishers targeting small pelagics in West Africa: current trends and development

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ABSTRACT. This study sought to present the evolutions and new trends of migrant fishing targeting small pelagics in West Africa from fishing to consumption stage. The work involved the characterization of migrant fishers targeting small pelagics in West Africa (country of origin, fishing gear and target species), modalities of access to resources, estimation of their catches and finally the assessment of the impact in the host countries. This work was useful to analyse changes in terms of the actors involved, the volumes and values of catches, and forms of valorisation and marketing of products from the migrant sectors over the period 2008-2018. Overall, the quantities of pelagic fish caught by migrant fishermen were increasing. The production of small pelagic by migrant fisheries has almost doubled over a decade, from an estimated of 180,000 t over the period 2008-2012, to a current estimated production of almost 324,500 t. More than 50% of this production was sold on the market in fresh or frozen form. More than 75,000 t (22%) and 94,000 t (28%) were destined for artisanal and industrial processing, respectively. Migrant fisheries thus supply more to industrial processing than to artisanal processing. Indeed, migrant fisheries have contributed over the last ten years to the emergence of fishmeal factories in West Africa. However, despite their significant evolution in terms of catch volumes and values, migrant fisheries still operate outside of legislative frameworks and without being explicitly accounted for in national statistics. Moreover, conflicts are increasingly important given the current tensions and issues surrounding the exploitation of small pelagic fish in West Africa. This work recommends the development of a common management plan for migrant fishers in the countries of the Sub-Regional Fisheries Commission (SRFC) and the West Central Gulf of Guinea Fisheries Committees (WCGC).

Key words: Fisheries, impact, management, politics, added value.

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Migración de pescadores artesanales en la pesquería de pequeños peces pelágicos en África Occidental: tendencias actuales y desarrollo

RESUMEN. Este estudio buscó presentar las evoluciones y las nuevas tendencias de la pesca migratoria dirigida a los pequeños peces pelágicos en África Occidental desde los caladeros de pesca hasta los centros de consumo. El trabajo consistió en caracterizar a los pescadores migrantes que se dirigen a estas pesquerías en África Occidental (país de origen, artes de pesca y especies objetivo), presentando las modalidades de acceso a los recursos, estimando sus capturas y evaluando

el impacto en los países anfitriones. Este trabajo permitió analizar los cambios en cuanto a los actores involucrados, los volúmenes y valores de las capturas, así como las formas de valorización y comercialización de los productos de los sectores migrantes durante el período 2008-2018. En general, las cantidades de peces pelágicos capturados por los pescadores migrantes están aumentando. La producción de las pesquerías migratorias de estos pequeños peces pelágicos casi se ha duplicado en una década, desde un promedio de 180.000 t durante el período 2008-2012, a una producción promedio actual de casi 324.500 t. Más de 50% de esta producción se vende en el mercado en forma fresca o congelada. Más de 75.000 t (23%) y 94.000 t (28%) se destinaron al procesamiento artesanal e industrial, respectivamente. Así, las pesquerías migratorias suministran más al procesamiento industrial que al procesamiento artesanal. Consecuentemente, las pesquerías migratorias han contribuido en los últimos diez años al surgimiento de fábricas de harina de pescado en África Occidental. Además, su contribución a las economías locales es cada vez más importante. Sin embargo, a pesar de su importante evolución en términos de volúmenes y valores de captura, las pesquerías migratorias todavía operan fuera de los marcos legislativos y no son contabilizadas explícitamente en las estadísticas nacionales. Además, los conflictos son cada vez más profundos dadas las tensiones actuales y los problemas que rodean la explotación de pequeños peces pelágicos en África Occidental. Este trabajo recomienda el desarrollo de un plan de gestión común para los pescadores migrantes en los países de la Comisión Subregional de Pesca (SRFC) y los Comités de Pesca del Golfo de Guinea Centro-Occidental (WCGC).

Palabras clave: Pesquerías, impacto, manejo, política, valor agregado.

INTRODUCTION

Migratory fisheries in West Africa are increasingly intensifying without this being explicitly being accounted for in national statistics and in the design of regional fisheries management policies (Failler and Binet 2010; Binet et al. 2013; Failler et al. 2020). This intensification is more pronounced in the capture of small pelagics. Thus, the production of migrant fishers targeting small pelagics is increasingly important. Production has nearly doubled over a decade, rising from an estimated 180,200 t between 2008-2012 to more than 324,000 t between 2014-2018, justified by the multi-use nature of small pelagics (Dème et al. 2022a). Indeed, they constitute the raw material for artisanal and industrial processing, and largely dominate the consumption and export market. As such, more than 48% of production is destined for fish trade, 30% for industrial processing and less than 22% for artisanal processing (Corten et al. 2017). The share allocated to the fishmeal industry is increasingly significant given the progressive establishment of fishmeal industries in Mauritania, Senegal and the Gambia (Corten et al. 2017). At the same time, the demand for fishmeal has increased in Ghana, Nigeria, Asian and European countries (Corten et al. 2017; Belhabib et al. 2018; Asiedu et al. 2022a, 2022b). Consequently, migrant fishers would contribute significantly to the emergence of fishmeal factories in West Africa. In addition, consumer demand continues to increase in line with the rapid population growth in West African countries. All these factors result into the growth in catches of migrant small pelagic fish. Despite their importance, catches are not considered either in the fishing countries or in the countries of repatriation of the fish. Moreover, despite the important work that has been carried out in recent decades, there are still no specific policies and measures for the management of migratory fisheries at the country level, let alone at the regional level.

The objective of this study was to present the evolution of migrant fishermen targeting small pelagics in West Africa from fishing to consumption stage. This perspective of evolution and comparison was made possible by synthesizing previous work on migrant fishing in West Africa (Seck 2014; Failler et al. 2020; Dème et al. 2021a; Failler and Ferraro 2021; Sall et al. 2021; Wanyonyi et al. 2021; Asiedu et al. 2022a). The present work thus offers a much more consistent set of data than previous work on migratory fisheries (Dème et al. 2021b; Ly and David 2021; Nunan

2021). It also provides a much clearer overview and a wider geographical coverage (countries) in order to understand the evolution of migrants' fishers in West Africa in terms of volume, product marketing and the actor's incentives. The article also addresses the urgent need to develop specific management policies for migrant fisheries in a context of growing demand, fishing overcapacity, rife IUU fishing and the vulnerability of small pelagics to climate change.

Background to the research

Synthesis of knowledge on migrant fisheries in West Africa

First of all, it is important to precise that this work refers to the regional migration of artisanal fishers. Several factors influence this migration of fishers (Asiedu et al. 2022a). Scientific literature shows that artisanal fishers migrate in search of abundant fish and for the development of their economic network (Ba et al. 2017; Dème et al. 2021a; Failler and Ferraro 2021; Nunan 2021; Wanyonyi et al. 2021; Sall et al. 2021). According to several studies on migrant fishers, this activity can be defined as the voluntary movement of fishermen from one country to another or from one Economic Exclusive Zone (EEZ) to another for ecological (abundant resources) and economic (profitability of fishing) reasons (Binet et al. 2013; Asiedu et al. 2022b; Dème et al. 2022b). Characterizing and analysing migratory fishing is not a systematic work in the various countries of the West African coast. This shows the opacity that characterizes migrant fishing, with its non-inclusion in fisheries statistics and public policies at national and regional level, despite important research carried out on the issue.

Since the 1980s, studies on the migratory dynamics of West African artisanal fishermen have followed one another with added value aimed at producing a sustained and exhaustive scientific knowledge of the issue (Binet et al., 2010). Scientific literature shows that the migratory movements of West African artisanal fishermen have, since the end of the 19th century, been driven by the Saint Louisians, *Lebous* and Nyominkas of Senegal, the *Temnes* of Sierra Leone and the Fantis of Ghana (Bethemont 2000; Chauveau et al. 2000). Indeed, the seaway played an important role in the development of the West African informal economy in the 1980s and 1920s (Binet et al. 2010). This new economic boom allowed artisanal fishermen to identify suitable fishing grounds and to intensify shipping along the West African coast. As a result, artisanal fisheries landings boomed at the end of the 19th century and the beginning of the 20th (Bethemont, 2000). They supplied national (especially the expanding urban centres) and regional markets (in the coastal areas where economic activity is concentrated). Artisanal fishing, which until then had been practiced in the 'historic' maritime centres (*Wolofs*[1] and *Lebous*[2] of northern Senegal, Nyominkas of the Saloum), was partially relocated to these new economic zones along the coast. These ethnic groups thus ensured the bulk of the pirogue fisheries of Mauritania, Senegal and the Gambia, and were part of the fishing migrations along the entire African Atlantic coastline (Binet et al. 2010; Chauveau et al. 2000). Gradually (in the middle of the 20th century), the existing diverse ethnic migrants' fishers' groups were enriched by those of the Soussou of Guinea, the *Diolas*[3] of Casamance and the indigenous fishermen of the Gambia River as well as the *Wolofs* of *N'Diago* in Mauritania

[1]The *Wolof's* are a typical Senegambian ethnic group. They are the majority in Senegal where there represent almost half of the population and are the third place in Gambia with 15% of the inhabitants.
[2]The *Lebous* are part of the Wolof community in Senegal. Traditionally fishers but also farmers, they are concentrated in the Cape Verde peninsula (Dakar) which they occupied when the first settlers arrived in the region.
[3]The *Diolas* are a Senegalese ethnic group located mostly in the south of the country in Casamance.

(Failler et al. 2020; Dème et al. 2021b; Failler and Ferraro 2021). Chauveau et al. (2000) has shown that the development of the exchange economy from 1920 to 1940 was decisive in the development of migrant fishing. In this regard, the study underscores that migration intensified with the development of the exchange economy on the coasts and the arrival of new fishermen in the sector, influenced by migrant fishermen working in their traditional fishing area. This period was marked by a complexification and intensification of migrations leading to the constitution of real migrant fishing hubs in the West African space as a place of settlement, but also of transit and departure (Binet et al. 2010; Seck 2014; Ly and David 2021). It also led to the enlargement of the migratory spaces for the most experienced fishermen (Senegalese and Leoneans) (Wanyonyi et al. 2021). Then, the industrialization of production, the attainment of independence and the emergence of national economies marked years 1940-1980 (Chauveau et al. 2000; Binet et al. 2010; Failler and Ferraro 2021). The events of West African history and the main milestones in the history of fisheries exploitation have shaped the migration processes and their distribution areas (Cinner et al. 2012; Dème et al. 2019, 2021a).

At the beginning of the 21st century, work began to identify these migratory movements and to quantify for the first time the volumes and values of catches (Failler et al. 2020). It was found that West African migrants fishers accounted for more than 20% of catches in the EEZs of coastal countries without this being explicitly considered in national statistics (Failler et al. 2020; Dème et al. 2021a). From this point of view, migrant fishing is similar to illegal, unreported and unregulated (IUU) fishing (Failler et al. 2020; Failler and Ferraro 2021). Most of the work concludes with policy recommendations to integrate migrant fishing into regional fisheries management policies. However, no progress has been made in this direction, despite the fact that the new uses of pelagic fish, particularly for industrial processing, have intensified these migratory movements and the quantities caught. While this has led States to develop measures to provide access to resources for migrant fishermen, nothing has been done to take them into account in national statistics, or to develop specific policies and measures for migrant fisheries (Failler et al. 2020).

Exploitation dynamics of small pelagic resources in West Africa: fishing units, actors and market, legislation

Small pelagic fish are the most exploited species in West African coastal areas in terms of tonnage (Asiedu et al. 2022a, 2022b; Failler 2014). The main pelagic stocks exploited on a regional scale are sardines (*Sardinella aurita* and *S. maderensis*), mackerel (*Scomber scombrus*) and Ethmalosa (*Ethmalosa fimbriata*) (Chouvelon et al. 2015; Ba et al. 2017; Corten et al. 2017; Brochier et al. 2018; Dème et al. 2021c, 2022a; Asiedu et al. 2022b). These species are mainly exploited in West Africa by an artisanal fleet (purse seine and encircling gillnet) and an industrial fleet (pelagic sardine and trawlers, seiners) (Belhabib et al. 2018). Policies for the exploitation of small pelagics vary from country to country. While Senegal[4] has opted for the exclusive exploitation of small pelagic resources by nationals, this is not the case in other coastal countries which have signed agreements with foreign fleets (Dème et al. 2021b).

Beyond fishing units, several actors are involved in the distribution of pelagic fish in West Africa. Fishermen (artisanal or industrial/national, migrant or foreign) catch resources. The fishmongers ensure wholesale sales and supply the countries' export markets. On a smaller scale, there may also be micro fishmongers who take over and make the fish available to households, often within the country. Pelagic fish is the raw

[4]Senegal has not granted any fishing opportunities to foreign fleets since 2012 (Dème et al. 2021a).

material for artisanal and industrial processing and is the main source of protein for West African populations. In frozen form, small pelagic fish are exported to African, European and Asian countries (Dème et al. 2021c; Soumah et al. 2021; Asiedu et al. 2022b; Touron-Gardic et al. 2022). With the transfer of technology, artisanal processing techniques are similar and are done with smoking ovens (Moity-Maïzi 2006; Diouf et al. 2022). The processing sector is largely dominated by women (Durand 1981; Moity-Maïzi 2006). All these actors use a large unskilled workforce to support them (Ba et al. 2017).

In terms of legislation, although some countries such as Mauritania, Senegal and the Gambia have initiated specific management plans for small pelagics, their implementation is confronted with financial and technical constraints (Dème and Thiao 2021). Overall, in coastal West African countries, management measures are based mainly on zoning, minimum landing sizes for certain species, mesh size regulations, protection of certain species, licensing systems and closed seasons. Current legislation prohibits certain types of fishing that are harmful to resources and natural habitats (Binet et al. 2013).

Framework of the study

This study covers eight West African countries that are members of the two sub-regional fisheries commissions, namely the Sub-Regional Fisheries Commission (SRFC) and the Fisheries Committee for the West Central Gulf of Guinea (FCWC) (Figure 1). In the SRFC area, the study included Senegal, Gambia, Guinea, Guinea-Bissau and Mauritania, while in the FCWC region, it covers Benin, Côte d'Ivoire (Ivory Coast) and Ghana. The undeniable weight of these countries in the West African fishing economy makes them a relevant scale of study for the analysis of migratory movements of fishers in West Africa (Figure 1). Moreover, the scientific literature has shown that movements of great importance in terms of volume and value of fish caught take place between these countries (Dème et al. 2021a; Failler et al. 2021).

Furthermore, the focus of this study on small pelagics is explained by the importance of this resource in West Africa (Chouvelon et al. 2015; Ba et al. 2017; Dème et al. 2021c, 2022b; Asiedu et al. 2022b). The only available statistics of small pelagics from West Africa indicates that landings reached 1.7 million t in 2014, which represented 70% of the total declared catch (Failler 2014). The upwelling and cold-water upwelling zones of the Canary Current and the Benguela Current explain the abundance and wide distribution of pelagic fish on the West African coast (Failler 2014; Dème and Failler 2022; March and Failler 2022; Touron-Gardic et al. 2022) (Figure 1). Several observations, such as those in FAO Area 34, show causal links between upwelling and the abundance of small pelagic species (Thiaw et al. 2017). Scientific literature has shown that upwelling is positive for the development of small pelagics, supporting particularly productive areas in West Africa (Auger et al. 2016; Pincinato et al. 2020). For example, off Ghana and Ivory Coast, sardines catches are higher during the cold season and are correlated with the intensity of the upwelling at that time (Thiaw et al. 2017). At the scale of SRFC countries, the catch per unit effort of Sardine is also related to an upwelling index. Small pelagics thus seek optimal conditions of temperature and food availability (Brehmer et al. 2019). In other words, an intensification of the upwelling increases the quantity of plankton, which improves the feeding and survival conditions of the larvae, and therefore their recruitment (Diankha et al. 2015; Brochier et al. 2018; Mouget et al. 2022). This leads them to make significant migrations on a regional scale. Thus, because of their migratory nature, these resources are generally shared by many countries. Fishermen also seem to follow this migration of small pelagic fish by moving into various Exclusive Economic Zones (EEZs) to catch them.

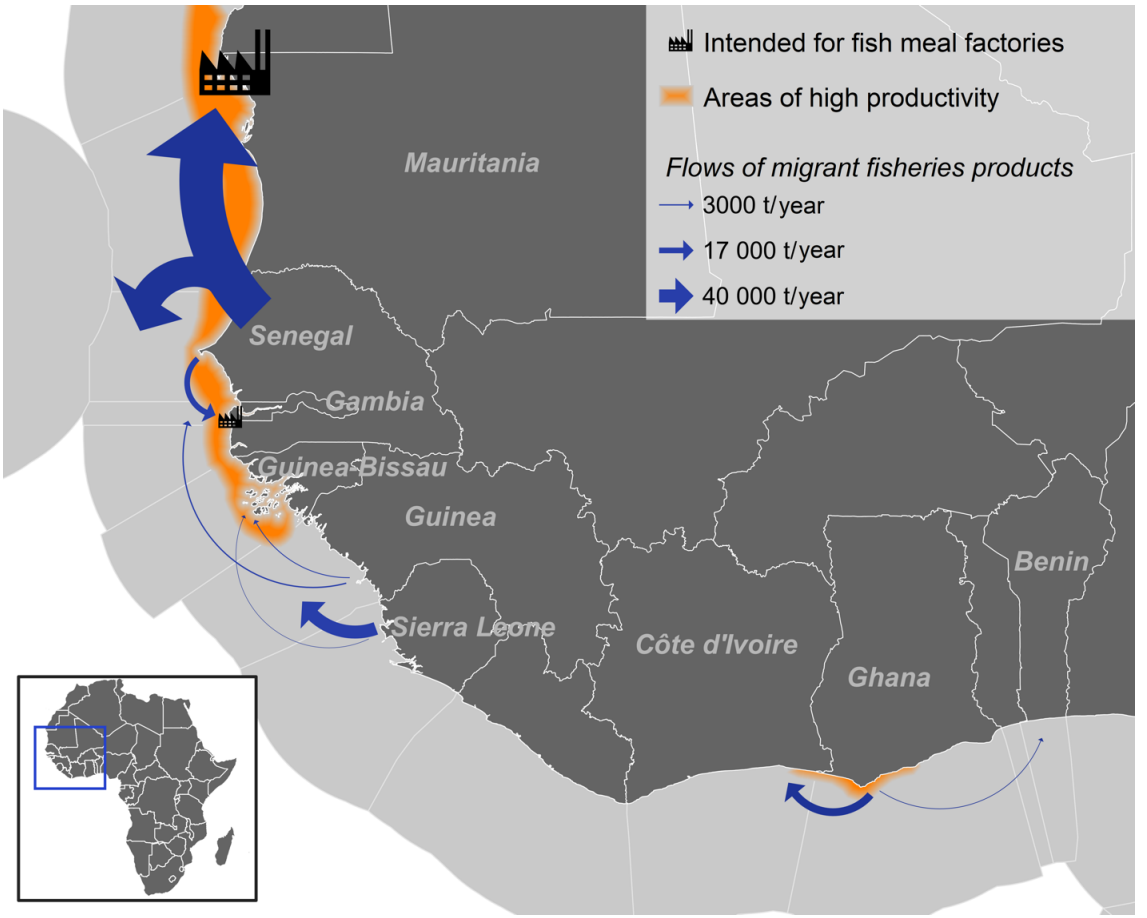

Figure 1. Framework of the study, identification of particularly productive areas and migratory small pelagic fisheries in West Africa, as well as estimation of catch volumes based on literature and field surveys.

MATERIALS AND METHODS

Study area

This study covers eight West African countries that are members of the two sub-regional fisheries commissions, namely the Sub-Regional Fisheries Commission (SRFC) and the Fisheries Committee for the West Central Gulf of Guinea (FCWC) (Figure 1). In the SRFC area, the study included Senegal, Gambia, Guinea, Guinea-Bissau and Mauritania, while in the FCWC region, it covers Benin, Côte d'Ivoire (Ivory Coast) and Ghana. Fishermen from Sierra Leone were interviewed at their area of activity, e.g. Guinea and Guinea-Bissau. So, it was not necessary to cover Sierra Leone, especially as it has not hosted migrant fishers in their waters since the civil war.

Field surveys

Latest data on migrant fisheries date back to 2012 (Failler et al. 2020). Thus, updating this data necessitated conducting field activities in the various countries of departure and reception of fishermen, more precisely in the various fishing cen-

tres of West Africa coastal countries. Research institutions[5] from different countries covered by the study facilitated the data collection process. The data collection activity was carried out over two years (September 2019-September 2021). Nearly 300 people were interviewed for this work in fishing ports in the migrant fishers' home and host countries. Criteria used to select the fishermen were that respondents should be migrant or national fishers and have good experience of migration. Fishermen who participated in the in-depth interviews were selected using random sampling techniques that met the above criteria (Figure 2). For key information, such as national data on migrant fisheries, respondents were selected using the choice sampling method. In addition, once at the survey sites, the identification of other fishermen was made possible by the snowball method and the assistance of local fisheries officers. Contact with local agents was facilitated by our partnership with national research institutes. A questionnaire was submitted to the fishermen (migrants and nationals) in order to collect the following information:

- Characterisation of migrant fishers (country of origin, ethnic group, fishing gear used, geographical area of fishing, target species).
- Modalities of access to resources in the host countries, local management measures, costs of access (payment, licence or fishing permit).
- Estimation of pelagic fish caught between 2014 and 2018 by migrant fishers (see approach above).
- Conflicts related to the presence of migrant fishers (nature and extent of conflicts, permanent or occasional frequency).
- Impacts of migrant fishing in host countries (socio-cultural, economic and technological).

A pre-survey was carried out in September 2019 to identify the countries and ports of departure and reception of migrant fishers with fishing administrations. This initial fieldwork also enabled contacts to be made in the field and the questionnaire to be tested and validated. The survey itself started in January 2020 and ended in September 2021. It was interrupted between March 2020 and January 2021 due to the Covid-19 pandemic. The collection of qualitative data, including the profile of migrant fishers, access modalities, conflicts and impacts, was satisfactory with individual and group interviews. However, the quantification of small pelagic catches by migrant fishers required the development of a specific methodology and was particularly time-consuming.

To estimate volumes of catches by migrant's fishers, a direct and indirect estimation method was used. The direct method consisted in seeking data from national fisheries administrations. This work made it possible to obtain information on migrant fishing units and catches officially declared in the countries of reception and departure of migrant fishers. Documents relating fishing agreements between countries (e.g. Senegal and Mauritania, Guinea), licences and fishing permits issued were also direct sources for obtaining data. However, it became apparent during the fieldwork with administrations that fishermen can bias the data collection because they did often declare the origin of catches. This led us to carry out an indirect evaluation with fishermen for comparison purposes. The indirect assessment consisted in interviewing migrant fishers of different origins and from different fishing areas. They were asked to provide an estimate of the number of annual trips and the estimated catch per trip. By multiplying the number of trips with

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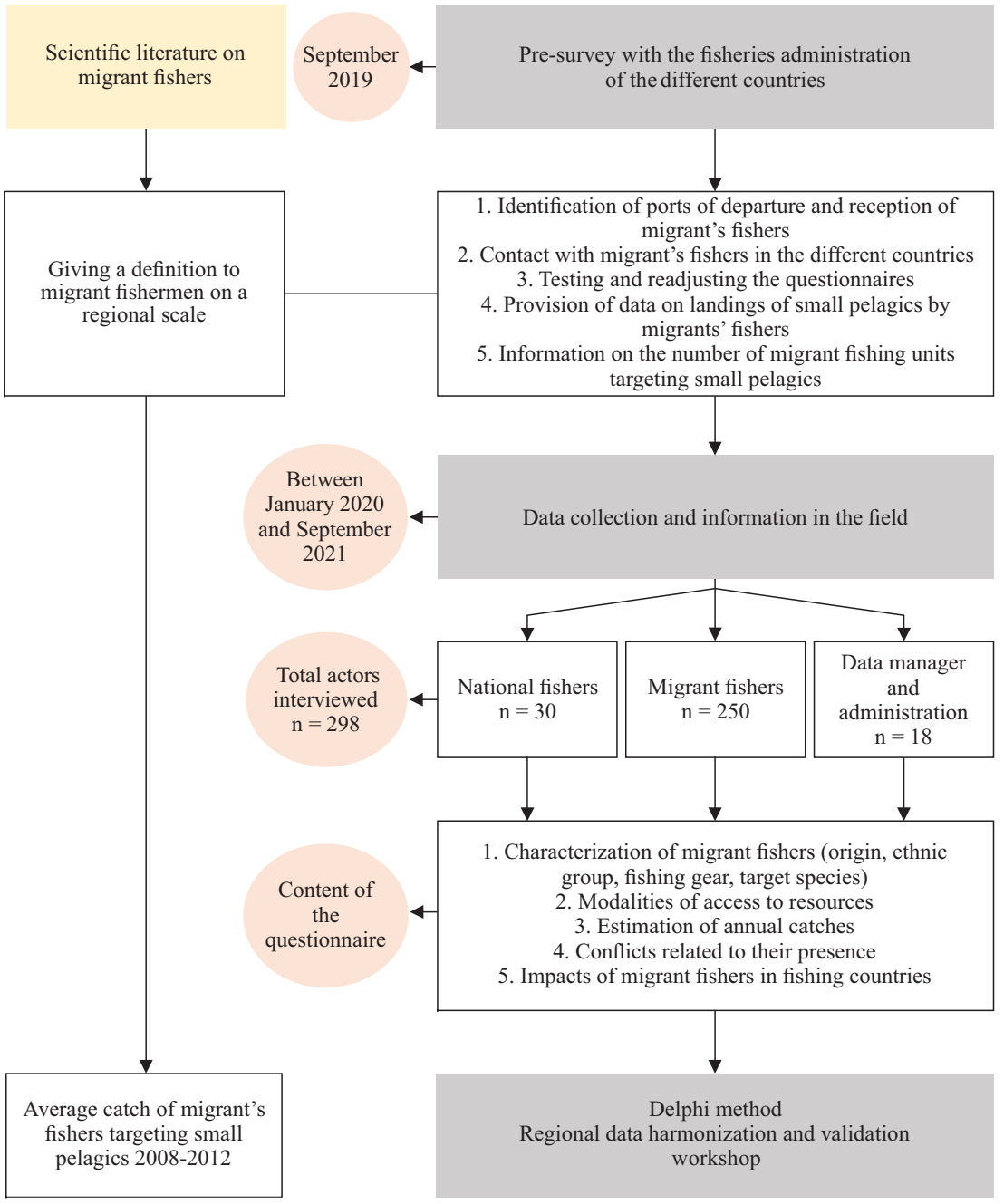

Figure 2. Methodological approach, data collection and validation process.

the estimated catch, it enabled us to calculate the annual catch per fishing unit. This figure was then multiplied by the number of migrant fishing units from different host countries (provided by the administrations) to obtain the total estimated catch of small pelagic fish. In making these cal-

culations, account was taken of the seasonality of migrant fishing activity and the changing annual contexts, including the termination of fishing agreements (e.g. in Senegal and Mauritania in 2017), and the significant fluctuation in fishing authorisations (number of fishing licences and permits) issued annually.

Cross-checking direct and indirect assessment data revealed inconsistencies in national catch statistics for migrant fisheries. These inconsistencies led us to use the Delphi method (Table 1). Thus, a regional workshop on migrant fisher's data was organised, bringing together all the experts involved in data collection. This framework allowed all inconsistencies to be removed and data on catches of small pelagic fish by migrant fishers to be validated.

Review of the literature

This research required an extensive review of the literature on migrant fishers in West Africa. The main objective of this literature review was to highlight the achievements and to make a comparison. The work of Failler et al. (2020) provided volumes of small pelagic fish caught by migrant fishers in West Africa over the period 2008-2012. These data were compared to the data we collected in the field for the period 2014-2018. This comparison allowed to assess the evolution of the production of migrant fisheries. In addition, the special issue from Failler and Ferraro (2021) helped identifying migration patterns along the West African coast. Beyond migration patterns, this special issue has been an important source of the main migrants fishers' situations currently observed in the EEZs of West African countries (Dème et al. 2021a; Failler and Ferraro 2021; Ly and David 2021; Nunan 2021; Sall et al. 2021). Given the limited scientific literature on migrant fishers, the literature searches minimized publication bias by including unpublished study reports. The study reports of the RECARGAO project[6] 'Study on the state of play and recent evolution of migrations of artisanal fishermen in the SRFC countries' were mobilized in the framework of this research. Indeed, these reports provide case studies of different countries of departure or reception migrants' fishers in West Africa. The information from the reports allowed for the validation and confirmation of information obtained in the field.

Overall, these secondary data produced by national and regional researchers and institutions have helped to reinforce our primary data from the field surveys. The scientific literature combined with field surveys provided us with a time of data on migratory fisheries over a decade. This was followed by a comparison of volumes of pelagic fish landed and ways in which resources were exploited and marketed. References cited above have made it possible to retrace the history of movements of migrant fishermen in West Africa and to give an initial definition of migratory fishing.

Data analysis

Data analysis combined information of migratory fishing obtained over the period 2008-2012 from the literature and that obtained over the period 2014-2018 from surveys. The database follows a nomenclature established according to needs, including volume and value of catches of small pelagics, ethnic groups involved, fishing gears used and migrant fishing areas. Similarly, the quantities paid into the various segments (production, fish trade, artisanal and industrial processing) were entered into the database. Estimates of the two five-year periods were used to assess the evolution or regression of the volumes of various migrant small pelagic fishing sectors. The value was obtained by multiplying the estimate price per tonne by the estimated quantity

[6]https://www.cofish.org/www.cofish.org/knowledge-base/projects/wa-ngo-recargao/index.html.

Table 1. Access modality of migrant fishermen to pelagic resources in host countries. Information collected in the field from September 2019 to September 2021.

	Country of departure			
Host country	Senegal	Ghana	Guinea	Sierra Leone
Mauritania	The artisanal fishing license is in place[1]. The cost of the fishing license was 116 EUR for pirogues of less than 13 m and 150,000 EUR for pirogues of more than 1 m. For the so-called artisanal pelagic fishing concession, access fees are 22 EUR year^{-1} artisanal boat^{-1} in Mauritania[2].			
Gambia	Access to small pelagic fish resources, like all other marine resources, is free for Senegalese migrant's fishers and is based on a reciprocal agreement between Senegal and The Gambia[3].		Registration fee and fishing license.	
Guinea-Bissau			Purchase of an annual fishing license varying between 152 and 2,455 EUR depending on the power of the engine (15, 40 and 60 HP).	Purchase of an annual fishing license varying between 152 and 2,455 EUR depending on the power of the engine (15, 40 and 60 HP).
Benin		Landing fee[4].		

Table 1. Continued.

	Country of departure			
Host country	Senegal	Ghana	Guinea	Sierra Leone
Ivory Cost		Ghanaian fishing units pay the same annual license at the same price as national artisanal units (46 EUR for one year).		

[1]Mauritania has opted to sign a convention on artisanal fishing with Senegal. The first convention was signed on 25 February 2001 and is renewed every year.

[2]Sidibeh 2019; Avadi et al. 2020.

3Senegalese purse seine units operating on behalf of fishmeal factories and assimilated to a Mauritanian fleet were concerned by this concession.

[4]Line fishermen with 4 box boats (about 25 kg case^{-1}) paid 0.23 EUR and the fishmonger paid 0.13 EUR per case. If the fisherman uses Avion dô and lands mackerel, tuna, trevally, Atlantic bumper and sardinella, he pays 1.53 EUR per 60 kg bucket if the catch reaches 4 buckets. Users of Tohounga and Soovi paid 0.31 EUR per 10 kg bucket if the catch reaches 4 buckets.

[5]The cost of fishing permits is dynamic and varies from year to year. It averages around 765 EUR for longline encircling gillnets, and can go up to 1,630 EUR for bottom encircling gillnets.

produced. The database also allowed the mapping of the fishing grounds to the consumption grounds. The percentage per segment was established using the Delphi method. The application of this percentage to the total production made it possible to obtain the trade flows.

RESULTS

Main migrations of fishermen targeting small pelagics in West Africa

Senegalese, Ghanaian, Sierra Leoneans and Guinean fishing units largely dominated the migratory fishery targeting small pelagics in West Africa. With more than 350 fishing units present in neighbouring coastal countries, three Senegalese migratory small pelagic fisheries were identified between Mauritania and the Gambia. Ghanaian fishermen were mainly present in the EEZ of Benin and Côte d'Ivoire. Guinea appeared to be a special case in that it was both a host and a departure point. Thus, its hosted fishermen from Sierra Leone targeting flat sardines, Ethmalosa and jacks, and spread them out into the maritime space of Guinea Bissau and the Gambia. In addition, Guinean fishermen shared Guinea-Bissau waters with Sierra Leone fishermen (Figure 3).

Looking at the host countries and ethnic groups, only the *Wolofs* (Guet Ndar) and the *Lebous* (Bargny, Mbour and Saloum Island) from Senegal exploited small pelagics in Mauritania. Mauritania only received Senegalese fishermen. In Benin and Côte d'Ivoire, only *Fanti* fishermen from Ghana were present. Gambia and Guinea-Bissau received two nationalities targeting small

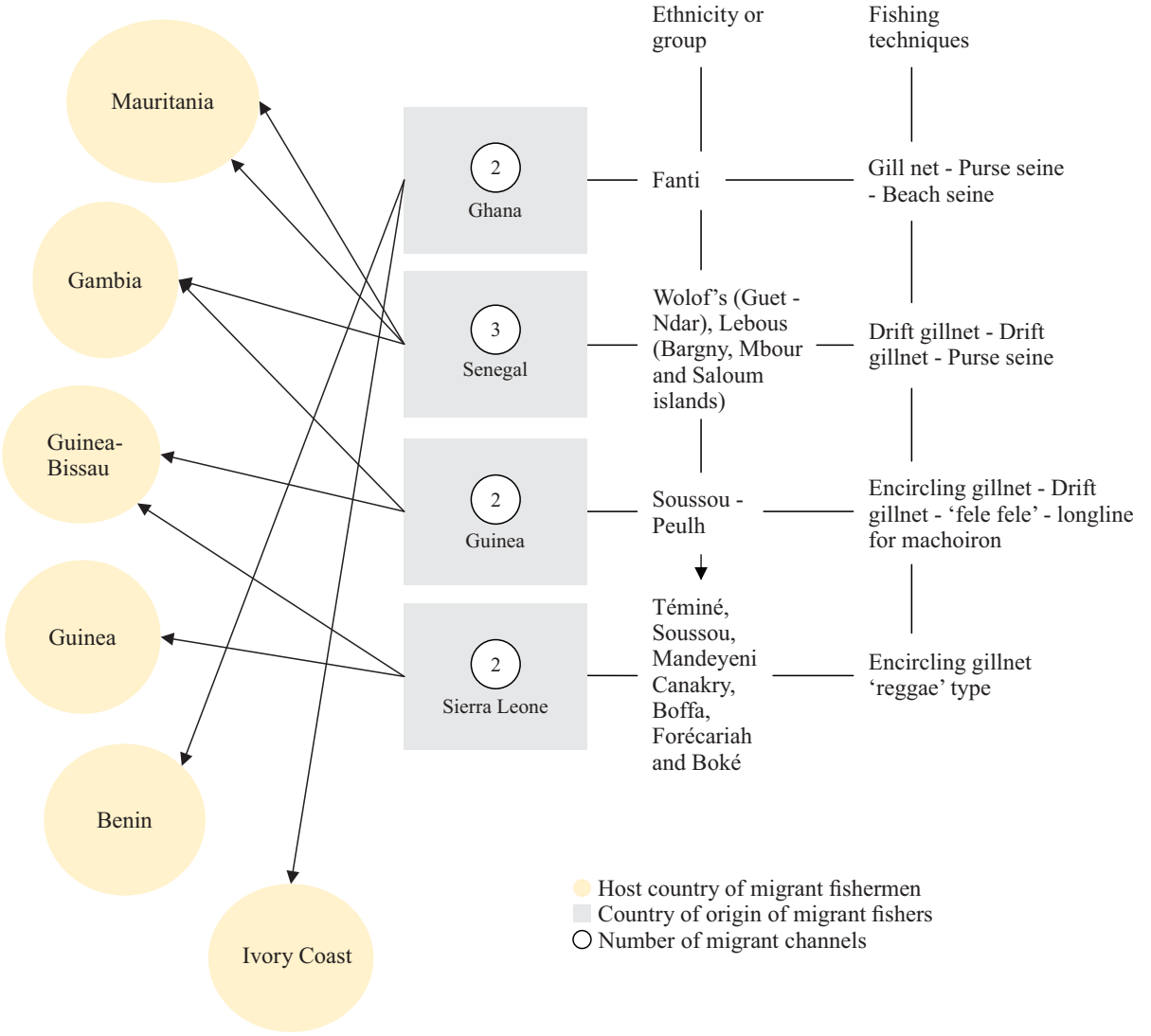

Figure 3. Main migratory channels targeting small pelagics in West Africa, characterization of ethnic groups and fishing techniques.

pelagics, namely the *Soussous* and *Peuls* from Guinea and the *Téminé*, *Bofa*, *Boké*, *Canakry* from Sierra Leone. Thus, nine migratory movements characterized the migratory fishery targeting small pelagics in West Africa (Figure 3).

Main species of small pelagic fish targeted by West African migrant fishers were flat and round sardine, Ethmalosa, herring (*Clupea harengus*) and jawfish, with a smaller proportion of mackerel, mullet (*Mugil cephalus*) and barracuda (*Sphyraena barracuda*).

For the capture of these species, Senegalese and Ghanaian fishermen mainly used drift nets and purse seines. Very few Ghanaians used beach seines in Benin and Côte d'Ivoire. Guinean and Sierra Leonean fishermen targeted small pelagics with encircling gillnets and they used longlines for the specific capture of jawfish (Figure 3).

Migrant fishers were established in different fishing areas in the host countries. For example, in Mauritania, Senegalese fishermen were located in the south of Nouakchott and in Nouadhibou. In the Gambia, Senegalese and Gambian fishermen frequented the same fishing grounds, notably at the Northern border of Casamance and on the Gambia River. In Guinea-Bissau, migrants casted their nets in the Bijagos Archipelago, in Cacine and in the southern regions. In Guinea, Sierra Leoneans were present along the entire coastline with the main fishing areas being *Kalé bama* in *Matakang* (Salatougou, Khounyi and Souri nènè) in the south, in the prefecture of *Forécariah*, (Koba bama, Bokhi nènè and Koukoudé Yatagui) in the north, in *Boffa*, *Kamsar bama* as far as Alcatraz in *Boké* in the north-west, passing through the *Cap Verga* area. They were also found in the fishing areas around the city of Conakry and the islands of Loos. In Côte d'Ivoire, Ghanaian fishermen were located in *San Pedro*, at the level of the *Grands Ponts*, in *Gbôklè*, in *Sud Comoé* and in the autonomous district of Abidjan. Finally, in Benin, Ghanaian fishermen targeted pelagic fish in *Seme-Kpodji*, Cotonou, *Ouidah* and *Grand Popo*.

Access modality and seasonality of production of migrant fishers targeting small pelagics

The establishment of EEZs in the 1980s[7] has put an end to the regime of free access to resources. In terms of fishing, this translates into the appropriation of fishing by the coastal state. Migrant and foreign fishermen must now comply with regulations of the country in question by paying fishing fees and respecting the quotas imposed. The host country can take all necessary measures to ensure compliance with its laws (boarding, fines and imprisonment). Thus, modalities of access differ according to the host country of the migrant fishers (Table 1).

Access to resources in the host countries of migrant fishers is subject to payment, except for the presence of Senegalese in Gambia, where access is free under a reciprocal agreement. For Ghanaian fishermen, their access to Beninese and Ivorian waters is conditioned by very low fees that do not exceed 50 EUR[8]. The same applies to the Senegalese license to fish in Mauritanian waters for only 115 EUR. Compared to other countries, the license for access to Mauritanian waters is particularly high at between 150 and 2,305 EUR for powerful engines of 60 HP or more.

Catch volumes and values of the main migratory small pelagic fisheries in West Africa

Overall, catches by migratory fisheries targeting small pelagics doubled over the decade 2008-2018, from an estimated of 136,500 t over the five-year period 2008-2012 to an estimated of more than 324,500 t over the period 2014-2018 (Table 2).

In contrast, there has been a decline in the estimates catch of the Guinean migrant fisheries. Thus, Guinean catches in the Gambian EEZ fell by 10,000 t from 13,000 t over the period 2008-2012 to 3,000 t over the five-year period 2014-2018. The same applies to the Guinean migrant sector established in Guinea-Bissau (Table 2).

As well as volumes, the value of catches from the migratory small pelagic fisheries has risen considerably, from an estimated of 34,125,000 EUR over the period 2008-2012 to an estimated value of over 97,350,000 EUR over the period 2014-2018. In addition to quantities, this increase is also linked to an increase in the price per tonnes in recent years (Table 2).

[7]An international convention on the Law of the Sea met in Montego Bay to recognize the sovereign rights of each coastal State over a 200-mile EEZ that it is responsible for managing (Article 56).
[8]1 EUR = 655,957 FCFA (XOF).

Table 2. Average catches and values of small pelagic (SP) migratory chains in West Africa over the five-year periods of 2008-2012 and 2014-2018. N/A: data not available.

		Average 2008-2012		Average 2014-2018		Average price per tonnes 2008-2012 (EUR)	Average price per tonnes 2014-2018 (EUR)
Nº	Name of the migrant SP pathway	Production (t)	Value (EUR)	Production (t)	Value (EUR)		
1	Guinean SP migrant channel in the Gambia	13,000	3,250,000	3,000	900,000	250	300
2	Senegalese SP migrant channel in the Gambia	3,000	750,000	17,000	5,100,000	250	300
3	Senegalese SP migrant channel in Mauritania	77,000	19,250,000	150,000	45,000,000	250	300
4	Senegalese SP migrant channel in Mauritania	30,000	7,500,000	90,000	27,000,000	250	300
5	Guinean SP migrant channel in Guinea-Bissau	10,000	2,500,000	2,000	600,000	250	300
6	Ghanaian SP migrant channel in Benin	N/A	N/A	1,500	450,000	N/A	300
7	Ghanaian SP migrant channel in Ivory Cost	N/A	N/A	20,000	6,000,000	N/A	300
8	Leonean SP migrant channel in Guinea	500	125,000	40,000	12,000,000	250	300
9	Leonean SP migrant channel in Guinea-Bissau	3,000	750,000	1,000	300,000	250	300
Total		136,500	34,125,000	324,500	97,350,000		

Estimated catches from grey literature 2008-2012 (Failler 2020). Estimated catches between 2014-2018 from field surveys.

Forms of valorization and marketing of catches from the migrant small pelagic sector in West Africa

As indicated earlier, migrant fisheries targeting small pelagics landed an estimated of 324,500 t year^{-1} over the period 2014-2018. After this primary production, coastal pelagics were valorized in different forms: fresh distribution (fishmonger), artisanal processing, freezing, and industrial processing into fishmeal and fish oil (Figure 4).

The largest production share to the local fish trade was estimated over 155,700 t. Artisanal and industrial processing share the remaining half. The industrial processing market, established mainly in Mauritania, Gambia and Senegal, absorbs more than 28% of the production of the migrant small pelagics sector, i.e. nearly 94,000 t. The artisanal processing segment received an estimated of 74,800 t annually over the period under consideration (Figure 4).

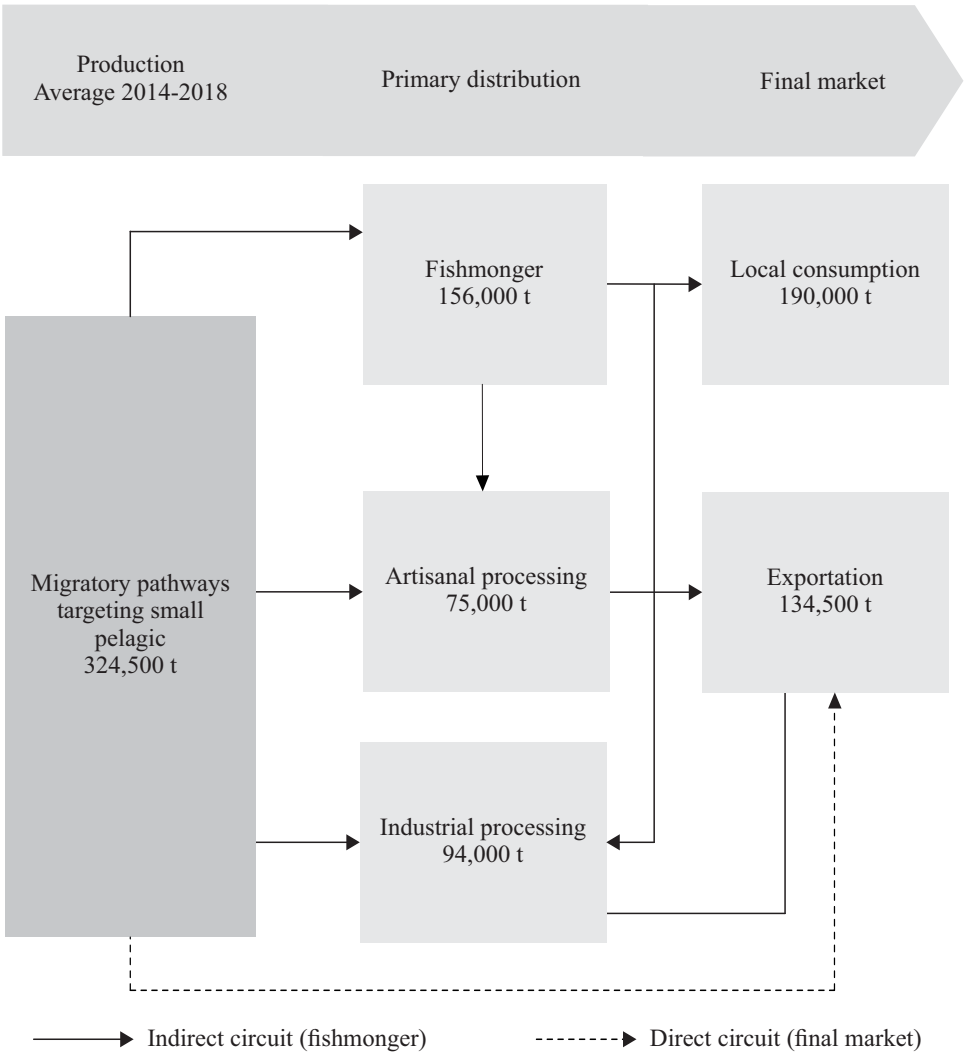

Figure 4. Marketing of catches from migrant small pelagic fisheries in West Africa. Source: information collected in the field.

DISCUSSION

Increasing catch volumes of migrant fishers in West Africa and the emergence of fishmeal industries

The migratory fishery targeting small pelagics is increasingly important in West Africa in terms of volume and value of catches. As shown in the results, production has doubled in less than a decade. This growth is justified by the large quantities of fish used in the fishmeal industries (Péron et al. 2010; Corten et al. 2017; Malcorps et al. 2019). This high demand for small pelagic fish by the milling industry is linked to the growing international demand for fishmeal by African countries such as Nigeria and Ghana, European and Asian countries (Asiedu et al. 2017; Malcorps et al. 2019). Thus, migrant fishing is an important supply mechanism for the fishmeal industries. A Greenpeace study estimated the amount of small pelagics processed in the fishmeal industries of the Gambia, Senegal, and Mauritania at 500,000 t (Belhabib et al. 2018; Thiaw and Stuart, 2022). The study revealed that migrant fishers supplied more than half of this amount. Thus, migrant fishing is the main supply of raw materials for the West African fish milling industry. Migrant fishers insist that sale of their product to the fishmeal industry has a double advantage. Firstly, the fishmeal market is much more remunerative than the fish consumer market, and secondly, fishmeal factories ensure that the entire catch is sold because they are not very demanding on the quality of the product (Tacon and Metian 2018; Touron-Gardic et al. 2022). This is so because the main reason for migration is economic profit, which justifies the fact that the Senegalese small pelagic sector supplying the fishmeal industries in Nouadhibou and Nouakchott is the most important in the sub-region in terms of volume and value of production (Tacon and Metian 2018). The Mauritanian state seems to be satisfied with the relatively small number of artisanal and industrial units, but the nationalization of Senegalese rotary seines and the signing of agreements with foreign industrialists has led to a tenfold increase in fish flour production (Touron-Gardic et al. 2022). It has increased from 10,000 t in 2009 to more than 119,000 t in 2020 (op. cit.).

Senegalese and Ghanaian fishermen: main actors in migrant fishing in West Africa

The analysis of results showed that Senegal is the giant of the migrant fishery in the SRFC countries, and Ghanaian fishermen are the main actors of this migration of artisanal fishermen in the Gulf of Guinea (March and Failler 2022). Their supremacy is undeniable in Côte d'Ivoire, with catches of small pelagic fish almost equal to those taken by national artisanal fishers. Of the estimated 40,000 t of small pelagic fish landed annually by artisanal fishermen in Côte d'Ivoire over the period 2014-2018, Ghanaian fishermen accounted for half. Ghanaian catches of small pelagics mainly supply the Ivorian artisanal processing market. Field observations show that, by repatriating their families to Côte d'Ivoire, Ghanaians are an essential component of the artisanal processing segment. They are active in fish smoking and receive on estimated of more than half of the production of Ghanaian fishermen in Côte d'Ivoire (Failler 2014). There is a vertical integration of the Ghanaian community in Côte d'Ivoire, starting from production to marketing and passing through different forms of valorization (Asiedu et al. 2022a). Thus, landings of the Ghanaian migrant fishery complement the very low national artisanal production to fill the gap of an ever-growing national demand. Had it not been for the landings of Ghanaian migrant's fishers, Côte d'Ivoire's recourse to pelagic fish imports from Mauritania and Senegal would have been much more important than it is at present (Dème et al. 2020). As a result, the trade deficit in

fishery products would be much higher. Ghanaian fishermen are also present in Benin, with a much lower production than in Côte d'Ivoire, estimating 1,000 t of small pelagics over the five-year period 2014-2018.

Impacts of migrant fishers on the local economics of countries

Interviews with fisheries administrations showed that the two major migrant fisheries in West Africa have positive impacts on the fisheries economy of the host countries because of their significant and decisive contribution to the supply of fresh fish to the processing and consumption markets. Beyond these contributions, they have mechanized the activity of artisanal fisheries in the countries through the transfer of technology (Dème et al. 2021b). Indeed, the arrival of Ghanaian fishermen with large dugout canoes equipped with engines of 40 HP and more has revolutionized artisanal fishing in Côte d'Ivoire (Chavance et al. 2016). Gradually, natives have abandoned their small pirogues made from a single tree trunk to adopt the Ghanaian model, which is more robust and more widely adopted, especially with the remoteness of the fishing areas noted in recent years (Asiedu et al. 2017, 2022a). If the Senegalese purse seine has spread in West Africa, especially in Mauritania and Gambia, it was due to Senegalese migrant's fishers (Dème et al. 2021a). Impacts are also to be appreciated from the point of view of their contribution to local economies. Indeed, access to fisheries is most often subject to the purchase of a fishing license or permit. Field surveys have shown that this cost is higher for migrant's fishers and, in some countries, falls in a distinctive category between foreign fishermen. This local economic contribution is however difficult to quantify due to the lack of control over the migrant fishing fleet and variable costs of license payments. If today the significant added value generated by the small pelagic economy in Mauritania is estimated at more than 116 million EUR, it has been deduced that more than a third of this is contributed by Senegalese migrant fishers (Touron-Gardic et al. 2022). Overall, migrant fisheries in West Africa have positive impacts to be appreciated in terms of their contribution to the food security of countries, to local economies and to the supply of the artisanal and industrial processing segment. Such an important supply makes it possible to create and maintain millions of jobs in the various West African coastal countries. The supply of raw material to the artisanal processing segment by migrant fishers, particularly from Ghana, Guinea and Senegal, keeps this segment alive in the face of competition from the fishmeal industry and the export market (frozen) (Moity-Maïzi 2006; Diouf et al. 2022). Thus, migrant fishers constitute an important lever for the supply of women processors. Migrant fishers thus contribute to the development of policies for the financial empowerment of women, initiated in recent years in West African countries.

Migrant fishers facing conflicts and ecological changes: how to manage migrant fisheries in West Africa?

Despite these positive impacts, field surveys have uncovered about the existence of frequent conflicts between migrant and indigenous fishermen in the exploitation of fisheries resources. The efficiency of the fishing gear used by migrants, their greater autonomy at sea and access to fishing areas, their incursion into certain protected areas (MPAs), and their dominant position in the village are often put forward as the main source of these conflicts. Conflicts of use between Ghanaian and Ivorian fishermen are a typical example. Indeed, Ivorian artisanal fishing was rather lagoon-based and was not practiced much in the maritime area. Ghanaian migrant fishers have made the maritime area the main fishing zone and in view of the large quantities fished, the locals accuse them of being the

cause of the scarcity of resources in the various fishing areas. These same conflicts are also noted in the Senegalese migratory channels of small pelagics in Mauritania. Indeed, Mauritanian purse seine fishermen try to regulate fishing trips to adjust the supply of fish for a better landing price. Information on the ground shows that, the Senegalese (St. Louisian) community disassociated itself from the measure, arguing that no clause regulating fishing effort is mentioned in the fishing licenses granted to them. In order to ensure a steady supply of fish products to the Mauritanian market, the Mauritanian public authorities in charge of fisheries supported the argument of the Senegalese fishermen. These same conflicts between natives and migrants are extended to the protected areas. Thus, fishermen from Sierra Leone and Guinea are accused of violating the rules of the Orango National Park (located in the south of the Bijagos archipelago in Guinea-Bissau) (Failler et al. 2019). In the same way, violations of Mauritania's MPAs by Senegalese fishermen are emphasized by Mauritanian fishermen (Failler et al. 2019; Failler 2020). Thus, these conflicts are likely to be exacerbated in the coming years in view of the frantic race for pelagic fish and the tensions surrounding availability and marketing. They are also likely to be exacerbated by the overexploitation of small pelagics in West Africa and their vulnerability to climate change (Failler 2014, 2020; Thiaw et al. 2017). According to Hannesson et al. (2006) and Pincinato et al. (2020), decadal climate change is occurring in West Africa and is affecting the fish population, particularly the distribution and abundance of small pelagics. Since 2012, a downward trend in small pelagic production has been observed; however, migrant fishers have so far shown a strong capacity to adapt to the changing natural, institutional and economic environment (Binet et al. 2013). Notwithstanding, this current resource situation and threats of climate change call into question the basic logic of migrant fishers based on increasing quantities alone. Changes in migratory routes may occur in the coming years as a measure of resilience (Dème et al. 2021a). All these socio-economic, biological and political issues discussed here must necessarily inform the regional fisheries commissions the design of regional management policies for migratory fisheries.

CONCLUSIONS

The coastal countries of the West African region must engage collectively in the management of migrant fisheries. Thus, the two entities in charge of fisheries management in West Africa, the Sub-Regional Fisheries Commission (SRFC) and the Fisheries Committee of the Central West African Gulf of Guinea (FCWC), could serve as a framework for the implementation of common policies for the management of migrant fishermen. The objective of these policies will be to reduce the opacity that exists around migrant fishing.

The first step towards this should be to ensure that catches of migrant fisheries are clearly specified in the national statistics of the countries receiving the migrants and repatriating the fish. This would allow countries to avoid the scientific gaps noted in the indirect assessment of fisheries potential. Secondly, there is a need to integrate migrant fisheries into fisheries policies. Third, the harmonization of the country management plans of the two regional commissions would facilitate this. To enhance this, the development of a regional management plan for small pelagic species integrating migratory fisheries could serve as a pilot before being extended to other fisheries. Fourth, such policies should also integrate mechanisms for the social integration of migrants and conflict management. Fifth and final point, surveillance at regional level must be strengthened. The prospect of developing a migrant fishing license and harmonizing prices

and access conditions to resources could be envisaged. All of this would make it possible to regulate migrant fishing and to monitor the marketing of products for greater efficiency.

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