

Fisheries management in data deficient industrial fisheries of Sierra Leone: Input controls and ecological risk assessment

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Abstract

Managing fisheries in data deficient situations could be challenging in developing countries such as Sierra Leone, where technical capacities are not yet fully developed. We present a diagnosis of industrial fisheries management planning based on input controls of licenses, inshore exclusion zone limitations, ecological risk assessment and bio-economic limit reference points. Existing industrial fisheries user rights in Sierra Leone based on license allocations relying on gross registered tonnages (GRT), mesh size regulations and area restrictions, do not account for allowable catches, and could be reactive to top-down approaches. Management decision making based on this system has often been characterized by weak evidence and minimum transparency. We have therefore used an Ecological Risk Screening (ERS) technique to gauge information on the effects of fishing on different ecological systems in order to assess impacts, prioritize issues and proffer advice on the risks associated with fisheries management units. The ecological risk assessment reveals associated fisheries management challenges including illegal, unreported and unregulated (IUU) fishing, seaweed and plastic pollutions, and degradation of mangrove habitats. The evidence of coastal erosions associated with climate change events, scanty knowledge on catch levels for inshore pelagics, shrimps and demersal resources, limited credit facilities for fishers, post-harvest losses, poor hygiene and fish trade limitations are critical risk areas to address. Over 100 fishing trawlers currently operate in the industrial fisheries of Sierra Leone without quota management restrictions for catches. Our empirical analysis reveals that revenues at maximum economic yield (REV MEY) can be maximized at levels of 1.5 (slightly over 60%) greater than the sustainable yield revenues for shrimps. A precautionary fleet limitation of 20 fishing vessels for shrimp fishery is proposed under a dual scheme of demersal fish, and shrimp licenses, with fishing, restricted to night hours, from 6 pm to 6 am, to minimize bycatch.

1. INTRODUCTION

1.1 Description of the Industrial Fishery of Sierra Leone

The industrial fishery of Sierra Leone is conducted within 6 to 200 nautical miles (nm) in the continental shelf and the exclusive economic zone (EEZ). Sierra Leone is located in West Africa, bordered in the North by the Republic of Guinea, in the South by the Republic of Liberia and in the West by the Atlantic Ocean (Figure 1). The country lies within latitudes ($6^{\circ}55'$ - $10^{\circ}0'$ N) and longitudes ($10^{\circ}14'$ - $13^{\circ}17'$ W), with a coastline extending up to 560 kilometres (km) and a continental shelf area of 300,000 km². The coastline is wider in the North and narrower in the South. The fishing areas are located in the continental shelf, including offshore waters and waters superjacent to the sea bed and subsoil of the Atlantic Ocean, which lies within national jurisdictions. Common fishing grounds can be found in coastal waters, river estuaries, creeks, bays and the open ocean.

The country's continental shelf is favored by two current systems, the Guinea current that flows from the North-West and the Canary current that flows from the South-East, creating the Guinea Current and the

Canary Current Large Marine ecosystems (GCLME & CCLME) that are associated with estuaries, mangroves and upwelling areas that support large quantities of fish resources. These ecosystems host small pelagic fish, tuna, billfish, shrimps and demersal fish resources, with a biomass of around 124,00 to 600,00 mt, and potential yields around 150,000 mt. These ecosystems also support other rich biodiversity of migratory birds, threatened manatees, seals, monks, marine mammals, sea turtles, porpoises, sawfish and crocodiles.

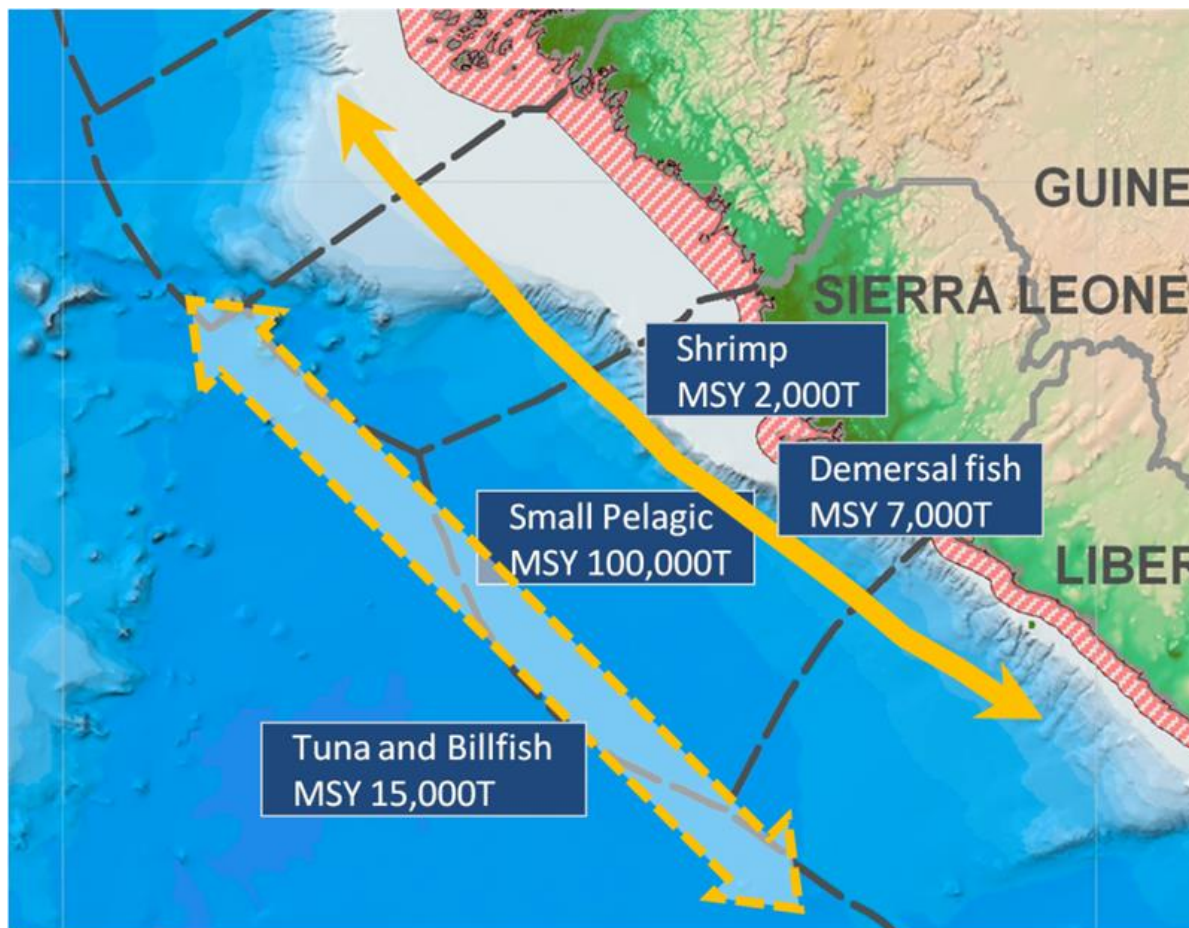


Figure 1. Sierra Leone Exclusive Economic Zone.

Source: MFMR, (2016). Fisheries and Aquaculture Bill. MFMR, 7th Floor, Youyi Building, Freetown, Sierra Leone.

The fishing grounds in Sierra Leone are supported by nutrient inputs from river systems in the Western Area, Northern and Southern Provincial Districts around Freetown, Portloko, Kambia, Moyamba, Bonthe and Pujehun, which empties into the Atlantic Ocean. The major river systems include the Scarcies river estuary in the North which has rich mangrove forests around Yeliboya and Kortimaw Islands, serving as fish breeding grounds and the Sierra Leone River estuary in the North Western region which receives nutrient-rich waters from tributaries and creeks. The Sherbro River estuary and the Yawri Bay are other river systems that host rich fishing grounds around the Sherbro Island and Cape Saint Ann in the south, which are influenced by strong tidal ranges, with the peak of the rainy seasons (July and August) favouring increased nutrient inputs from runoff water discharges. There are fishing grounds around the Southern coastal borders of Liberia, which has rivers that extend into a lagoon that contain nutrient-rich waters.

Popular fishing grounds within the continental shelf of Sierra Leone are presented in Figure 2. The South Western Coast in the Moyamba District and part of the Western Area are favoured by a bay and creek – the Yawri Bay and Kagboro Creek, which contain wetlands of intertidal mudflats and 14 percent of the country's mangrove cover and other rich biodiversity and fish resources.

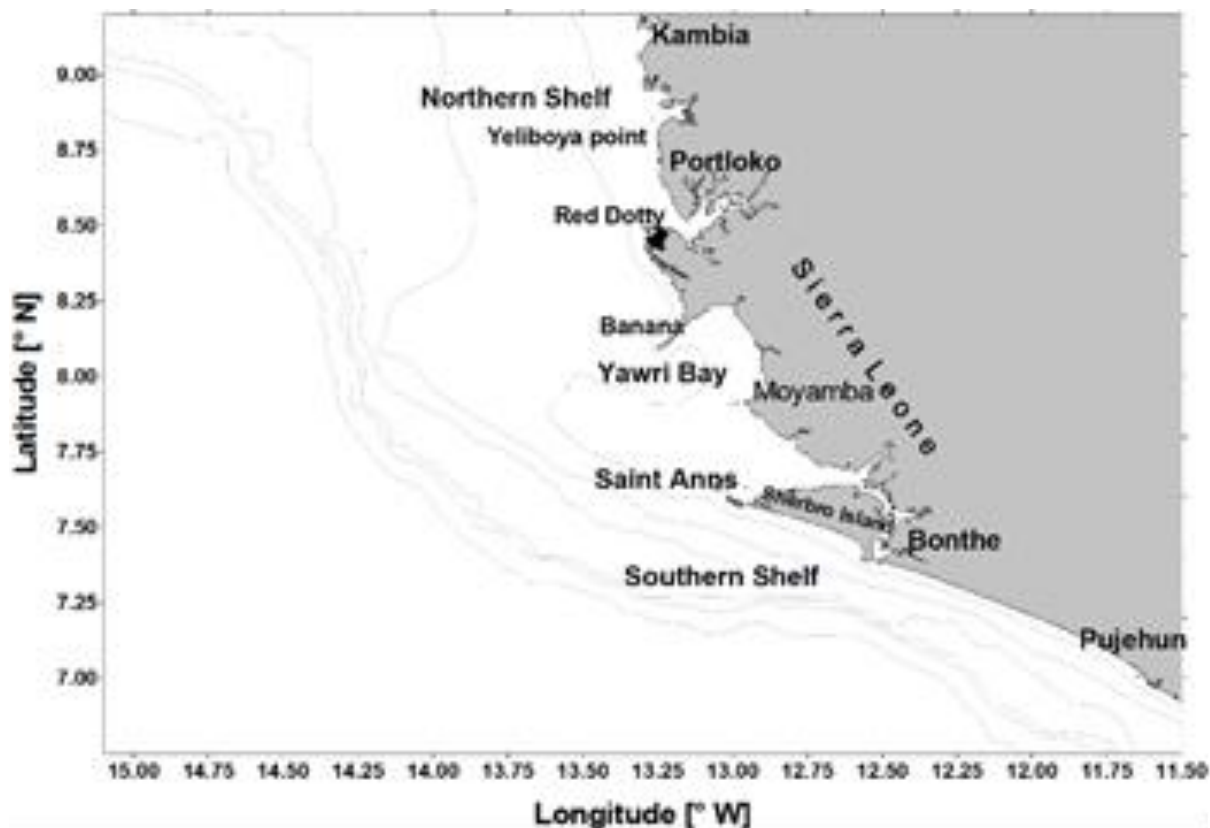


Figure 2. Major Fishing grounds in the Continental Shelf of Sierra Leone¹.

Source: MFMR, (2016). Fisheries and Aquaculture Bill. MFMR, 7th Floor, Youyi Building, Freetown, Sierra Leone.

About 188 species of fish were identified in the continental shelf during the 2009 fishery abundance survey and they include commercially important pelagic, shrimp and demersal fish resources². These fish stocks are targeted by both industrial and artisanal fishing gears and have been categorized as: Penaeid shrimps (Penaeidae), Croakers (Scaenidae), Seabreams and Dentex (Sparidae), Groupers (Serranidae), Snappers (Lutjanidae), Threadfins (Polynemidae), Grunts (Haemulidae), Sardinella, Bonga Shad, West African Ilisha and Anchovy (Clupeidae), Scads, Jacks, Horse Mackerels and Pompanos (Carangidae), Barracudas (Sphyraenidae), Tuna, Tuna Like and Mackerels (Scombridae), Sole (Cynoglossidae), Cuttlefish, Squid, Snail, Crab (Portunidae), (Sharks (Carcharhinidae) and Rays (Rajidae)³. Royal Spiny Lobsters (*Panulirus regius*) are also caught, but the Lobster fisheries are currently not developed. The pelagic fish resources are shared stocks among the Eastern Central Atlantic. These stocks have been defined as:

¹ Khan, A., and Sei, S. (2015). The Co-Governance of Fisheries in Post- Conflict Sierra Leone: Is the Transition for Better or for Worse? In S. Jentoft, and R. Chuenpagdee (eds.) *Interactive Governance for Small Scale Fisheries*. Springer.

² Turay, I., O'Donnell, C., Schaber, M., Corten, A., Sarre, A., Sei, S., Seisay L.D., Mustapha C., Kamara, M., Lamin P., and Lahai M. (2009). Sierra Leone Fisheries Resource Survey, Third Survey, 24 May to 13 June 2009. Cruise Report, EU funded Institutional Support to Fisheries Management Project (ISFM), 9ACP SL 19. Ministry of Fisheries and Marine Resources

³ Longhurst, A.R., and Pauly, D. (1987). *Ecology of Tropical Oceans*. Academic Press, Inc., Harcourt Brace Jovanovich Publishers, Sandiago, 407p.

- 1) Northern Stock, shared by Guinea Bissau, Guinea, Sierra Leone and Liberia;
- 2) Western Stock, shared by Cote d'Ivoire, Togo, Ghana and Benin;
- 3) Central Stock, shared by Nigeria, and Cameroon; and
- 4) Southern Stock, shared by Congo and Angola.

The most common shared pelagic fish stock, the Sardinellas (herring), is targeted by both artisanal and industrial fishing fleet and has potential yields around 2.5 million metric tons in the Eastern Central Atlantic region. Other important target species in the industrial fishery include: *Penaeus notialis* (Pink shrimp), *Dentex Congoensis* (Congo Dentex), Bobo Croaker (*Pseudolithus elongatus*) (Gwangwa), false Scad (Pollock) (*Decapterus rhoncus*), Sompat Grunt (*Pomadasys jubelini*). Some fish categories including the Penaeid shrimps, the Seabreams and Dentex are usually not separated during data collection and reporting and are commonly mislabeled as Snappers. This causes mislabeling of species of the sparidae family as snappers of the Lutjanidae family. The snappers are also wrongly labelled as groupers. This introduces errors in the commercial fishery statistics reporting. In addition to this, the fishery stock assessment has not been regular due to funding bottlenecks. Comprehensive fishery- dependent data has been collected for commercial fish production since 2009; industrial catch data was collected by fisheries observers from 2010 until today. No fisheries independent data (scientific surveys) is available for 2011-2018. Available assessments reveal that some of the demersal fish species are either fully exploited or at the point of being harvested unsustainably⁴. Some species of the Sparidae, Grunts, Croakers, Sardinella, and Pink shrimps are fully exploited⁵. The Northern pelagic fish stock of Bonga Shad is considered overexploited, with yield potential below current biomasses and high fish mortality⁶. The offshore pelagic fish stocks of carangidae, mainly Pollock and Atlantic Bumper, are underexploited. Biomasses reported for major fish stocks show that pelagic fisheries account for about 65 percent of the total biomass⁷ of around 600,000 mt. Transshipment for offloading of industrial vessel catches take place at designated ports in Kingtom, Muray Town Wharf, Government Wharf and other designated areas of the Port of Freetown, following each fishing trip that took place over one to three months. There are also several other ancillary fish landing ports in the Western Rural coastal communities that aid fish discharges into Cold storage facilities –these ports are operated by about 25 fishing Companies in the Country. Rights granted under licenses are based on vessel types, and fishing gear characteristics, gross registered tonnages, vessel ownerships and establishments, and have been regulated into the following categories:

- 1) Demersal Fish Trawlers
- 2) Shrimp and Cephalopod Trawlers
- 3) Pelagic and Mid-Water Trawlers
- 4) Tuna Purse Seiners
- 5) Tuna Long Liners
- 6) Purse Seiners for Small Pelagic
- 7) Mothership with canoe support, pots, traps or lines
- 8) Fish processing vessels, carriers for transshipments and fish
- 9) Motherships for fish processing
- 10) Transhipping vessels with local licences
- 11) Transhipping vessels with foreign licences

⁴ FAO (2008/2009). FAO CECAF Working group reports on assessment of demersal fish resources

⁵ Andrew Baio and Sheku Sei (2017). Management plan for small pelagic, shrimp and demersal fisheries of Sierra Leone. Consultancy report, NEPAD/PAF West Africa Pilot Project (WAPP)

⁶ FAO/CECAF Working group reports on Assessment of pelagic fish resources (2010)

⁷ Mehl, S., Lundsør, E., Turay, I., Sei, S., & Lamptey, E. (2007). 2007 Surveys of the fish resources of the western gulf of Guinea. Auinea Bissau, Guinea, Sierra Leone and Libera. Survey of pelagic and demersal resources. 5 May-29 May 2007.

- 12) Local fish carriers/supply vessels
- 13) Processing plants and establishments

There are non-refundable fees charged for letters of intent for authorization of newly registered fishing companies, entry clearance authorizations, applications for licenses, transshipments, canoe support operations and processing authorizations. Additional post-fishing right levies apply for catch origin certification, fish import and export, and local fish discharge. Major fishing right restrictions for industrial fishing vessels include their exclusion from fishing within the inshore exclusion zone (IEZ) and mesh size restrictions. The IEZ is solely reserved for artisanal fishing boats. However, industrial vessels often flout the IEZ regulation, which results in conflicts with artisanal boats for fishing grounds, often leading to the destruction of artisanal fishing nets, crafts and sometimes loss of life. Conflicts also exist for fishing grounds outside the IEZ as some larger artisanal fishing boats share fishing grounds with industrial vessels. There is a barter relationship between industrial fishing companies that target the Bobo Croakers (Gwangwa) and the artisanal fishermen. The latter sells the Gwangwa fish caught in the artisanal fishery to industrial fishing companies, while the former provides the artisanal fishers with fishing nets in exchange. Direct sales of artisanal fish catches of croakers to industrial vessels have increased competition for fishing grounds among artisanal fishers who strive to reap the high returns from Gwangwa, a fish species in high demand in Asian markets. The vulnerability of industrial fishing operations to climate change and pollution is increasingly felt in Sierra Leone. The impact of global climate change on fisheries can include coastal erosions, floods that inundate jetties, and severe weather that reduces fishing time. In relation to severe weather events at sea, trawling often has to be interrupted, usually during the months of July and August. Other detrimental impacts include pollution due to oil discharges, high nutrient loading from runoffs during rainy seasons and uncontrolled sewage disposal including plastics at sea.

1.2 Economic contribution and social implications of the fishing activity

The fisheries sector of Sierra Leone contributes about 10 percent to the gross domestic products (GDP) of Sierra Leone. The industrial fishery accounts for over 90 percent of sector revenue earnings. Sierra Leone industrial fish and fishery products are traded in local, regional and international markets, including within the sub-regional African countries of Guinea, Ghana, Senegal, Nigeria and international markets of Asia, Europe and the USA. Annual revenues of about USD 6 million are generated from the industrial fishing operations and related services. Fish is traded in the local markets in frozen, chilled or smoked forms. All species of industrial fish caught in Sierra Leone including bycatch are traded for human consumption. Local direct sales of fish for household consumption occur at ports of landing and in local markets nearby landing ports. Fish caught can be delivered to fishing companies and fish processing establishments operating cold storage facilities, including ice producing and fish processing factories. Fish and shrimps caught are usually in frozen form and wrapped in cartons on fishing vessels before being transhipped for export via fish carriers or containers. Refrigerated trucks are used to distribute fishery products to market outlets in the country, including the provinces. The Bobo Croakers (*Pseudotolithus elongatus*) caught by artisanal fishers are usually battered and sold to industrial fishing companies in exchange for fishing gears. In most cases, the Asian fishing companies pre-finance artisanal fishermen to purchase fishing boats and nets, to encourage them to sell their catches to them. This barter trade has increased the demand for Croaker fish stocks, attracting the establishment of several fish processing factories (establishments) in coastal communities. This serves as an incentive for overexploitation of the croaker fish stocks. The croaker fishery products are considered very valuable in Asian markets as their consumption is assumed to increase human life longevity. Major Asian markets include China and Korea. Sierra Leone is currently not listed among countries allowed to export fish and fishery products to the European Union Markets due to the inability of the country to meet minimum EU hygiene and sanitary requirements. However, fish caught and processed by foreign fishing vessels, including tuna vessels, which are listed among compliance

vessels, are exported to EU markets. There are also indications that illegal fish caught in Sierra Leone waters ends up in EU markets under the so-called port of convenience window. About 5,000 fishermen are currently involved in industrial fishing operations, and 100 percent of the fishermen are male. An additional 250,000 people are involved in post-industrial fishing operations in the country, mainly as retailers and fish processors.

Most industrial fishermen work full time throughout the whole year, with their entire income earned from fishing. Both foreign and local crew are allowed under fishing license rights to participate in fishing operations, either as engineers, captains, Coxswains, fishermen, cooks, navigators or first aid service delivery. Women only participate in post-fishing operations including fish processing and fish marketing, and serve as Agents and fishing company owners or representatives.

2. MANAGEMENT OF THE FISHERY

The Ministry of Fisheries and Marine Resources (MFMR) is the sole government authority in charge of the management of the industrial fisheries of Sierra Leone, under the sale of fishing rights through licenses, royalties and associated levies. There are input controls on fishing gear types and mesh sizes based on the 1994 fisheries Management and Development Act and the fisheries regulations of 2010, which stipulates a minimum mesh size of 60 mm at cod end for demersal trawl nets and pelagic trawl nets respectively. A 45 mm cod end mesh size is stipulated for shrimp trawl nets, and the minimum requirement for seine nets is 30 mm. In all cases, it is required that the mesh sizes on the sides of trawl nets must be below those at the cod end⁸. There are also local landing obligations where licensed fishing trawlers are required to land 40 percent of their total catch for sale in the local markets while the licensed shrimp trawlers must land 70 percent of bycatch and 5 percent of shrimps caught during each fishing trip. Conservation measures imposed on fishing rights under the current license regime include:

- 1) Designation of local person (Sierra Leonean Agent) to represent foreign companies is a requirement for license;
- 2) No fishing without fisheries observers on board or without a logbook;
- 3) Observers must be allowed onboard without hindrance, to collect and report daily catch data and other scientific information to MFMR;
- 4) Observers must be allowed to collect samples from catches of licensed fishing vessels anywhere in the fishery waters for Scientific purposes;
- 5) Vessel operators are required to pay travel costs and salaries for Authorized Fisheries Observers while Government is required to arrange insurance for Observers and other authorized officers;
- 6) Illegal catches on board and illegal fishing gears can be confiscated for violations;
- 7) Poaching vessels (vessels fishing without valid license) can be immobilized or damaged;
- 8) Authorized officers must be allowed without hindrance to stop and board vessels during fishing operations at sea at any time;
- 9) The use of VMS transponders and payment for air time is a requirement for license;
- 10) Infractions can be enforced using VMS or other devices such as AIS;
- 11) No unauthorized transshipment of catch or offloading;
- 12) No transshipment or offloading of catch at sea except at authorized areas;
- 13) No fishing by vessels in marine protected areas;
- 14) Access agreement is required for foreign companies prior to fishing;

⁸ Government of Sierra Leone. (1994). The Fisheries Management and Development Act of 1994, Section 39(a-d), Supplement to the Sierra Leone Gazette Vol. CXXV No.58. Forestry Division, Ministry of Agriculture and Natural Resources

- 15) Certificate of competency is required for captains or Coxswains operating motorized vessels above 60GRT;
- 16) Licenses granted for fishing are not transferable or inherited;
- 17) Prohibition for catching marine mammals, young and gravid crustaceans including lobsters during fishing;
- 18) Prohibition from using drift nets, explosives, poisons or other devices or chemicals that render fish to be easily caught;
- 19) No destruction of artisanal fishing gears in the IEZ by industrial vessels;
- 20) Compensation for destruction of artisanal fishing gears in cash or kind and compensation for loss of fishing time;
- 21) No stowage of illegal nets onboard trawl vessels or other fishing boats;
- 22) No use of seine nets in rivers;
- 23) Right holders are required to clearly place markings or call signs and vessel names on both sides of their vessel;
- 24) No export of live fish from Sierra Leone and no import of live fish into Sierra Leone;
- 25) Clearance required for entry and exit of industrial vessels in and out of Sierra Leone fishing waters;
- 26) Fishing right holders are required to adhere to the provisions of the Fisheries Act in force;
- 27) Fines stipulated for contravention of all offences must be paid or court actions can be sought;
- 28) Bonds can be placed for release of seized fish or fishing gears;
- 29) Fish and other perishable goods seized for infractions can be sold and the proceeds lodged with the court, pending the outcome of court action for infractions, where applicable.

Despite all the above conservation measures, the Government objective for managing fish resources remains largely focused on revenue generation through licenses, without setting allowable catches for target fishery. This makes the current management regime ineffective and is rendering some commercial fish stocks to be exploited unsustainably⁹. Placing fisheries management emphasis on revenue generation can promote fishing fleet overcapacity, as was evidenced by the 1976 bilateral fishing agreement between the Government of Sierra Leone and the former Soviet Union (now Russian Federation), which lasted for fifteen years until 1990. This arrangement saw an increase in the number of fishing vessels from 183 in 1981 to 327 in 1987 (Table 1). There were inadequate surveillance activities during this period and the collaborative surveillance arrangements between the Department of Fisheries and the Naval Wing of the Republic of Sierra Leone Armed Forces was not effective. Drawing the dichotomy between fisheries surveillance patrols and security patrols in resource mobilization on the part of the Navy was also a challenge. The surveillance system under the bilateral arrangement was, therefore, malleable and associated with the challenges of understanding and clearly defining maritime enforcement collaboration and Departmental conflicts of interest.

⁹ Andrew Baio and Sheku Sei (2017). The management plan for pelagics, shrimps and demersal fish resources of Sierra Leone

Table 1. Licensed industrial fishing vessels of Sierra Leone, 1981-1993.

Year	Shrimp Trawler	Demersal Trawler	Purse Seiner	Canoe Support Vessel	Liner	Netter	Processing Carrier	Total
1981	60	96	15	3	3	0	6	183
1982	27	70	30	7	5	0	1	140
1983	27	60	24	11	3	0	1	126
1984	52	82	29	9	7	0	1	180
1985	31	78	44	13	10	1	5	182
1986	27	93	54	11	8	0	6	199
1987	84	144	59	13	8	0	19	327
1988	63	72	52	11	3	0	27	228
1989	84	98	35	10	3	0	27	257
1990	66	83	16	6	0	0	13	184
1991	49	19	19	1	5	0	5	98
1992	65	34	15	5	1	0	6	126
1993	51	29	5	1	0	0	6	192

In order to improve benefits from the industrial fisheries and sustain the artisanal fisheries, the Sierra Leone Government conceived the idea of a public-private partnership (PPP) arrangement through a joint venture with a private sector company. Accordingly, the Government amended the fisheries Act in 1990 (The fisheries amendment Act of 1990) that could allow licensing of industrial vessels and delivery of MCS services by a private enterprise. In 1991, the Government of Sierra Leone introduced the idea of privatizing some of the fisheries management activities, including industrial fishing licensing and monitoring control and surveillance. This privatization was rolled out through a Joint Venture Company, the Maritime Protection Service (Sierra Leone) Limited (MPSSL), a partnership between the Sierra Leone Government and the Marine Protection Services (MPS) of the United Kingdom. Under this PPP arrangement, 51 percent of the shares were owned by the Government and 49 percent of the shares owned by the MPS. The MPS provided the initial costs for setting up the joint venture company and played a very key role in the decision making of the MPSSL. A major conflict area was that the 51 percent share allocated to the Government made the MPSSL a Government parastatal, which was also seen to be supervised by the then Ministry of State Enterprises of Sierra Leone, thus making the control by the Department of Fisheries (DOF) over the MPSSL weak. The idea of this PPP arrangement was to improve on revenue generation from the fisheries and to ensure the sustainability of the resource. This arrangement was faced with several challenges as early as the second year of operation and was discontinued in 1993, allegedly due to political interference from top-level Government ranks and files. Although the arrangement led to the improvement of fishing access controls, reduction of artisanal-industrial fishing conflicts, and the collection of access license fees, the revenues that were meant for the government nevertheless dissipated through unaccounted means. Artisanal catch productions also declined during the period of operation of the MPSSL arrangement, which indicated that the Joint Venture had failed to meet one of its key objectives of enhancing food security through improved artisanal fishing. Additionally, during the operations of the MPSSL, fishing companies were not able to maximize profit from their activities, as license fees set under the MPSSL were considered very high. The annual transshipment costs imposed on fishing companies were considered very high as well and could have funded the entire yearly MCS activity

of the MPSSL¹⁰. The surveillance activities of the MPSSL, during the first year of operations, nonetheless apprehended an increasing number of illegal fishing vessels in the IEZ¹¹. But given that the MPS was a private sector investor within the MPSSL framework, their main motive was profit-making. This objective conflicted with those of the government, which were focused on creating employment for the people, while simultaneously preserving the fishery resource base. Another key limitation that contributed to the ineffectiveness of this arrangement was that the MPSSL largely monopolized fishery management functions and did so by taking advantage of the limited legal framework in place at the time of privatization¹². Consequently, the activity of the MPSSL made industrial fishing a less attractive activity for the local fishing companies, who withdrew their operations once profit-making staggered. Several efforts by the parties to introduce new scopes of management to generate increased financial benefits through strict management measures were not attainable for contract renewal. It has been suggested that an improvement to the PPP arrangements could have been to limit the activities of the MPSSL to the mere role of delivering surveillance operations. In this case, the MPSSL would be contracted by the Government of Sierra Leone, which would retain the generated revenue in order to continue funding the MPSSL¹³.

A new form of co-management arrangement now exists between the MFMR and other key institutions under a Joint Maritime Committee (JMC), established through a memorandum of understanding (MOU) for improving monitoring control and surveillance and maritime security in Sierra Leone. The JMC is comprised of the MFMR, the Maritime Wing of the Republic of Sierra Leone Armed Forces (RSSLAF), the Sierra Leone Maritime Administration (SLMA), the Office of National Security (ONS), the National Revenue Authority (NRA), the Foods Unit of the Ministry of Health and Sanitation (MOHS) and the Labor Ministry. The Sierra Leone Industrial Fishing Agency Association (SIFCA) and Fisher Organizations including the Sierra Leone Artisanal Fishermen's Union (SLAFU) and the Sierra Leone Amalgamated Artisanal Fishermen's Union (SLAAFU) and the Sierra Leone Indigenous Artisanal Fishermen's Union (SLIAFU) also collaborate with the MFMR in fisheries policy development and decision-making processes. Although some consultations are made with the SLIFCA and artisanal Fishermen's Organizations, fisheries management decision-making is largely made by the MFMR with scientific advice from the Scientific and Technical Committee, which comprises of experts in fisheries matters including retired Directors of fisheries, University Researchers and Policy Analysts. An arrangement is proposed in the new fisheries bill of 2016 to adopt a quota management system for the industrial fisheries based on total allowable catches (TACs), relying on advice from an inclusive Fisheries Advisory Board that will take into consideration the views of local traditional stakeholders on the status of the fish resources and management issues. If the new bill is enacted, this fisheries advisory board will consist of an expansion of the technical and scientific committee to include artisanal fishermen's association and the newly constituted community management associations (CMAs). The CMAs or artisanal fishermen's organization will proffer advice on artisanal fisheries' interactions with the industrial fishery. The new arrangement is sought in order to address the numerous concerns of the artisanal fishery sector, arising from the impacts of trawl fishing on food security in poor fishing communities. The ongoing fisheries management initiative of introducing territorial use rights in fisheries (TURFs) in the artisanal fisheries through co-managed marine protected areas will contribute towards sustaining the resources. This initiative which is supported through the West African Regional Fisheries Program in Sierra Leone (WARFP-SL), with funding support from the Global Environment Facility (GEF), through the World Bank, will rebuild declining fish stocks in the artisanal sector, with spillover effects on the industrial fishery sector through recruitment. Community

¹⁰ Fadlu-Deen, T. (1994). *The economics of enforcement in fisheries management* (Unpublished Masters Dissertation). University of Portsmouth, United Kingdom

¹¹ MPSSL (1991) Brief on MPSSL Freetown Mimeo MPSSL

¹² *Ibid*

¹³ Golley-Morgan, E.T.A. (1991). Background paper: fisheries subsector group report. Paper presented at the National Seminar on Fishery Industry Development, 25-29 November 1991, Freetown, Sierra Leone.

management associations (CMAs) are now enforcing fisheries management regulations on the use of illegal fishing nets in their communities. Stewardship responsibilities among local stakeholders are developing in some fishing communities. However, this effort must be expanded to include a robust alternative livelihood scheme. Additionally, surveillance operations, including community surveillance, must be strengthened. Without effective surveillance efforts, the successful efforts to rebuild the declining fish stocks, through the management of MPAs and later TURFs, will be overturned due to the continued incursion of fishing trawlers into the IEZ.

2.1 Rights-based approach: allocation and characteristics

The allocation of fishing rights-based on the sale of licenses is legally recognized in Sierra Leone, and it is regulated through the Fisheries Management and Development Act of 1994 and the Fisheries Regulations of 2010, currently in force. Fishing licenses are issued for specific periods of time, usually for three months, six months and one-year maximum, for any given time and they cannot be sold, transferred or inherited. Licenses can be renewed once a port inspection has taken place to ensure that gear characteristics have remained unchanged over time, and after paying the requisite license fees for renewal. Every license has specifications on restrictions by the Director of Fisheries, and these restrictions can be modified as the Director deems fit, as long as it is for the conservation and sustainability of the fish stocks. Since both the modification of mesh sizes and the incursion of fishing vessels into the IEZ in order to increase catchability are the most common offences committed by licensed fishing vessels, these restrictions are always included on the licenses issued. The allocation of licenses is made to local and foreign fishing vessels operating under fishing companies owned by individual Sierra Leoneans serving as Agents. Sierra Leoneans serve as Agents to represent the interest of foreign partners who own fishing vessels or are associated with foreign fishing companies. It is required by law that foreign fishing companies or foreign cooperation cannot be allocated fishing rights except after the designation of a local Agent to represent their company in Sierra Leone. It is further required that all local fishing companies owned by local agents must have onshore cold storage facilities and audited bank accounts. Agents designated by foreign partners must be Sierra Leoneans with continuous resident history in Sierra Leone over five years, and without a history of conviction, to administer fishing operations and represent their interest in Sierra Leone. Fishing rights allocated through licenses recognize the food security needs of local fishing communities. The licenses that are issued largely prohibit fishing in the IEZ in order to prevent the destruction of fishing nets owned by fishermen and to protect juvenile fish populations that breed in the IEZ. Licenses are issued based on categories of fishing vessels, types of fishing gears and target species. The category of fishing vessels currently operating in Sierra Leone includes Demersal fish trawlers, shrimp and cephalopod trawlers, pelagic and mid-water trawlers, tuna purse seiners, purse seiners for small pelagics, mothership with canoe support, pots, traps or lines, fish processing vessels and carriers for transshipments. A new policy has been introduced that restricts the establishment of new fishing companies. This policy was adopted by the MFMR in 2016 in order to cap the number of fishing vessels operating in the industrial fishery. Under this moratorium, only existing fishing companies can operate fishing vessels based on the history of their previous fleet capacity. This arrangement may not hold in the long run since most Sierra Leoneans do not currently own a fishing vessel. The reduction of fleet numbers under this arrangement may only be temporal, as Agents are highly incentivized to scramble for foreign partners in order to bring new vessels under their allowed capacity. Coupled with the current priority of the Government of Sierra Leone to increase revenue, fishing fleet numbers are expected to increase in the future. The inshore exclusion zone (IEZ) limitation has defined coordinates within five nautical miles from which industrial trawling is prohibited. If fully enforced, this control measure alone can improve on fish stock sustainability. Additionally, the fishing right allocation requirement of access agreement is a control measure to reduce over-capacity of the industrial fishery. It is provided by the 1994 Fisheries Act that licenses should not be granted to foreign vessels for the purpose of fishing in the fishery waters of Sierra Leone unless an access arrangement is in place, which shall be in the form of an Access Agreement

or Charter Agreement. This provision is however, not strictly implemented by the MFMR due to the urgent need from the Government to generate revenue. Fishing rights allocations also consider the status of fishing vessels with regards to their previous engagement in IUU fishing elsewhere. The Fisheries Act of Sierra Leone does not allow the issuance of licenses to vessels previously convicted for fishing crimes elsewhere and without settlement of the infraction, and where the license was withdrawn. It is also a condition that fishing vessels clearly display at all times, all vessel markings including international radio Call sign, on both sides of the vessel during fishing. Vessels granted fishing rights are also required to fly their national flag at all times.

2.2 Sustainable use of the resources

An industrial fisheries catch data collection and analysis scheme has been developed based on a fisheries observer scheme where logbooks for shrimps, demersal and pelagic fish data is reported on a daily basis. The observers also send daily radio catch reports to the Ministry of Fisheries and Marine Resources for monitoring. The industrial fisheries database system (IFDAS) has been developed for detailed analysis of production data. The production of accurate data for a total production including associated artisanal fisheries was stopped by the end of 2009 when the comprehensive data collection under the EU funded Institutional support for fisheries management ceased. Only industrial fish catch production data is available for 2010 through 2013 (Figure 3). An eleven-year civil war impacted industrial fishing as regulations were not effectively enforced between the years of 1996 to 2002. These periods witnessed a drastic decline in fish production, mainly due to a reduction in fishing vessel numbers as a result of reduced investment in the fishery. The earlier years of the 1980s to 1990 benefitted from increased fish production even when vessel numbers increased (Figure 4). This can be attributed to a situation of healthier resources, which maintained sustainable productions with consistent average fleet numbers around 200 vessels. Industrial fish productions returned sharply to pre-war levels by 2002 to 2010 when hostilities ceased, and fisheries management activities began to take shape. The increasing number of fleets in the late 1980s was believed to surpass the number of fleets that would adequately sustain fish resources¹⁴.

¹⁴ Garcia, S., and Poinard, F. (1989). The committee for the Eastern Central Atlantic Fisheries (CECAF) and the management of West African resources: critical review. In E.L. Miles (eds.) *Management of World Fisheries: Implications of Extended Coastal State Jurisdiction*. University of Washington Press, Seattle and London, 121-156

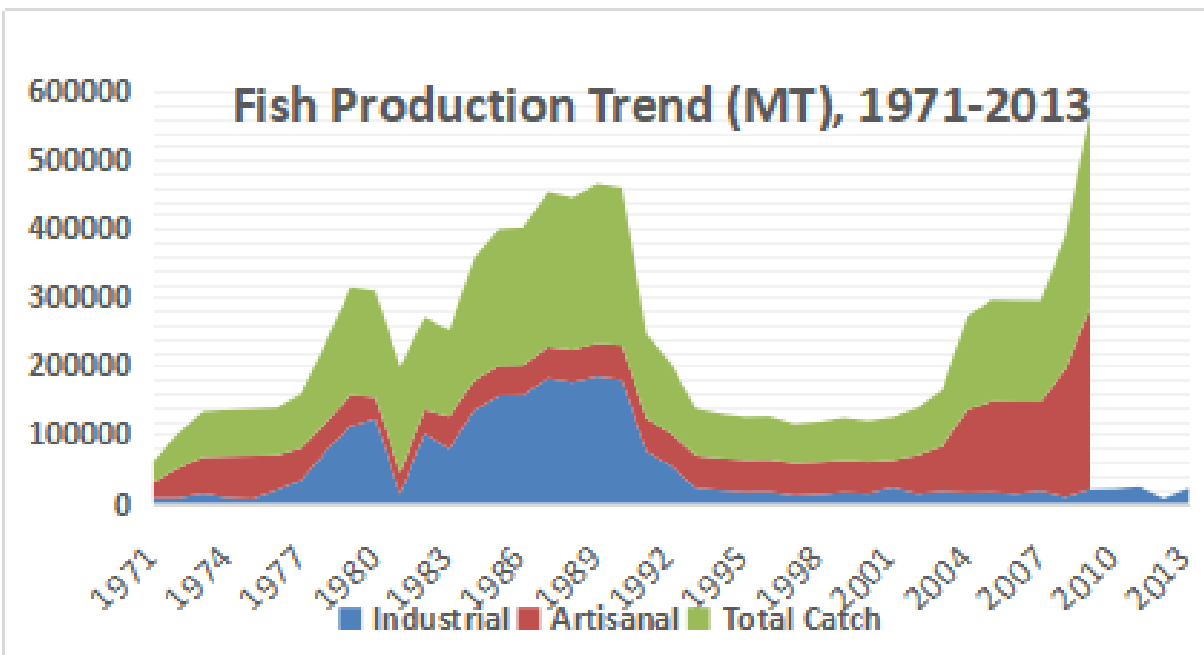
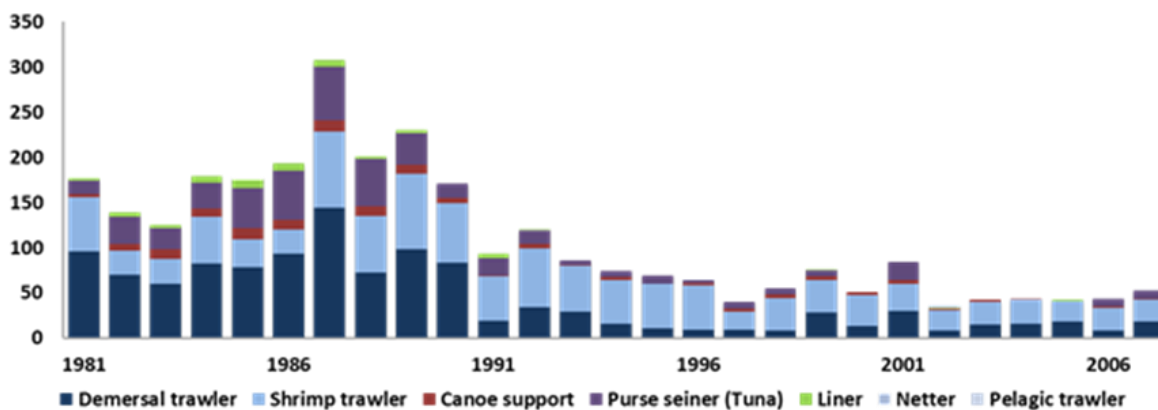


Figure 3. Fish production trends for industrial and artisanal fishery¹⁵.

The Industrial fishing rights through licenses allows the participation of both local and foreign fishing companies. Industrial fishery investment led to a greater number of fishing fleets; the period between 1981 and 1993 saw an additional 150 fleets in operation, with 308 vessels in 1987 alone. The peak of the civil war subsequently led to a decline in fleet numbers in the period from 1996 to 2002. Increased investment in tuna purse seine vessels in 2010 and 2011 contributed to a return to pre-war levels.



¹⁵ Baio, A., and Sei, S. (2017). Management plan for pelagic, shrimps and demersal resources of Sierra Leone

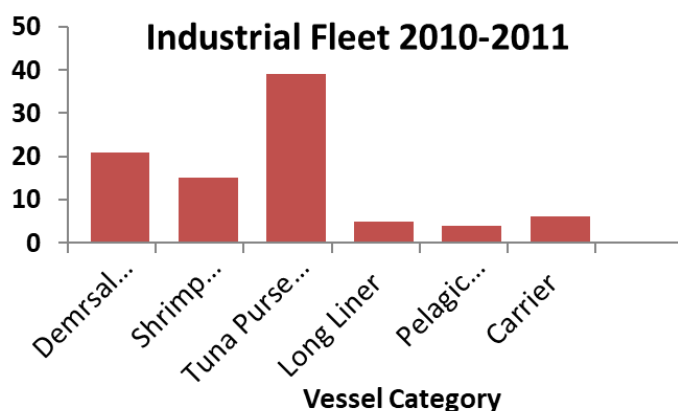


Figure 4. Industrial fishing fleet Composition, 1981-2006, 2010-2011¹⁶.

Over 100 foreign fishing vessels currently operate in the industrial fisheries of Sierra Leone. These fleets are primarily of European and Asian nationality, although African countries including Guinea, Senegal and Cape Verde also participate in the fishery as flag states of tuna vessels. An example of the list of fishing companies and their fleet composition in 2017 is presented in Table 2.

Table 2. Industrial Fishing Companies and fleet composition in 2017.

No.	Fishing Company/Locality	Category of Vessels	No. of Vessels	Flag State
1	Afric Fishing Company/Western Freetown	Tuna longliner	1	China
		Midwater trawler	8	China
		Demersal Trawler	18	chinese
2	Ann Senkal Fishing/Western Freetown	Tuna Purse Seiner	29	Guatemala, Spain, Belize, Cape Verde, panama, Curacao, Cote d'Ivoire, Senegal
		Cephalopod Trawler	4	Italy
		Supply Carrier	8	Spain, Panama
3	Okey Fishing Agency/Western Freetown	Shrimp trawler	8	China
		Demersal trawler	7	China
		Fish Carrier	2	China
4	Horse Fishing/Western Rural District		0	
5	Peninsula Fishing Agency Ltd.	Midwater trawler	2	Korea
		Demersal trawler	3	Spain, Korea
		Fish Carrier	1	Korea

¹⁶ MFMR. (2014). Sierra Leone Fisheries Investment opportunities

6	Sonit, Sierra Leone Ltd/Eastern Freetown	Midwater trawler	2	Korea
		Demersal trawler	3	Korea, Spain
		Fish carrier	1	Korea
7	Atlans Fishing/Western Freetown		0	
8	Aljan Fishing Company/western Freetown		0	
9	Africana Fishing Cooperation		0	
10	MDA Fishing Company/Western Freetown		0	
11	Coastal Fishing company/Western Freetown		0	
12	Africa Yuhai Fishing Co./Western Freetown	Demersal trawler	4	China
13	Sabco Fishing Company/western Freetown	Midwater Trawler	9	China
14	Senelone Company/Western Freetown	Tuna Purse Seiner	1	Spain
15	Sierra Fishing Company/Eastern Freetown	Midwater Trawler	2	China, France
	Western Freetown, Southern Province	Demersal trawler	19	China
		Fish Processing Carrier	2	China
		Fish carrier	3	China
16	Tima fishing Trading Ent./Western Freetown	Midwater Trawler	10	China
17	Korea Group	Semi-industrial	2	Sierra Leone
18	Hill Fishing Agency/Western Freetown	Shrimp Trawler	1	Guinea
19	Red Sea Fisheries	Semi Industrial	6	Sierra Leone
20	Kombra Fishing Company/Western, Southern	Midwater Trawler	3	St Kitts and nevis
21	Sierraquin Fishing Co. Ltd./West. F/Town		0	
22	Veeds Business & Beverages/West. F/Town		0	
23	White Pole Ltd./Western Freetown		0	
24	Monza Sierra Leone Ltd/West. F/Town		0	
25	F&I Solutions/Western Freetown	Demersal trawler	2	Korea

A regulatory system to monitor unreported catches has been instituted by the MFMR, where Dock Observers are deployed at major industrial fish landing ports to monitor catch landings and offloading activities of industrial fishing vessels. This data is collected in order to verify the daily catch reports sent by Scientific Observers and to enforce official controls for hygiene and sanitary standards, in collaboration with other stakeholders. A collaborative monitoring of transshipment and local fish discharges, where various institutions collaborate to implement port state measures, is proving productive for industrial fisheries regulation enforcement. Sampling for statistical data is continuous throughout the license period of every fishing vessel. Biological catch sampling is also done for some species. Data on size distribution and other growth parameters have been analysed to produce precautionary reference points which are used for management decision making based on fisheries management plans. Fishery independent data is also collected through scientific fishery abundance surveys including hydro-acoustic surveys for pelagic

fish resources and the swept area survey for demersal resources. The fishery dependent surveys have also been grossly irregular due to funding bottlenecks since such surveys are very expensive. Fishery abundance surveys have mainly been funded through development projects. Details of fishery independent surveys from 1991 to 2010 are presented in Table 3 and Figure 5.

Table 3. Fish stock abundance estimates for Sierra Leone.

Year	Pelagic (000 mt)	Demersal (000mt)	Total (000 mt)	Project/Organizations/ Research Vessel
1981-1991	513.40	105.00	618.40	GoSL/USSR/FAO
2000	360	110.00	470.00	IMBO, USL
2006	269	35.66	304.66	GCLME/EAF-Nansen/R/V Dr. Fridtjof Nansen
2007	100	24.04	124.04	GCLME/EAF-Nansen/R/V Dr. Fridtjof nansen
2008	241	109.54	351.04	ISFM/ R/V Itaf Deme
2009	282.10	170.32	452.40	ISFM/ R/V Itaf Deme
2010	231.40	84.00	315.40	ISFM/ R/V Itaf Deme
2017	Pending			EAF -Nansen Project

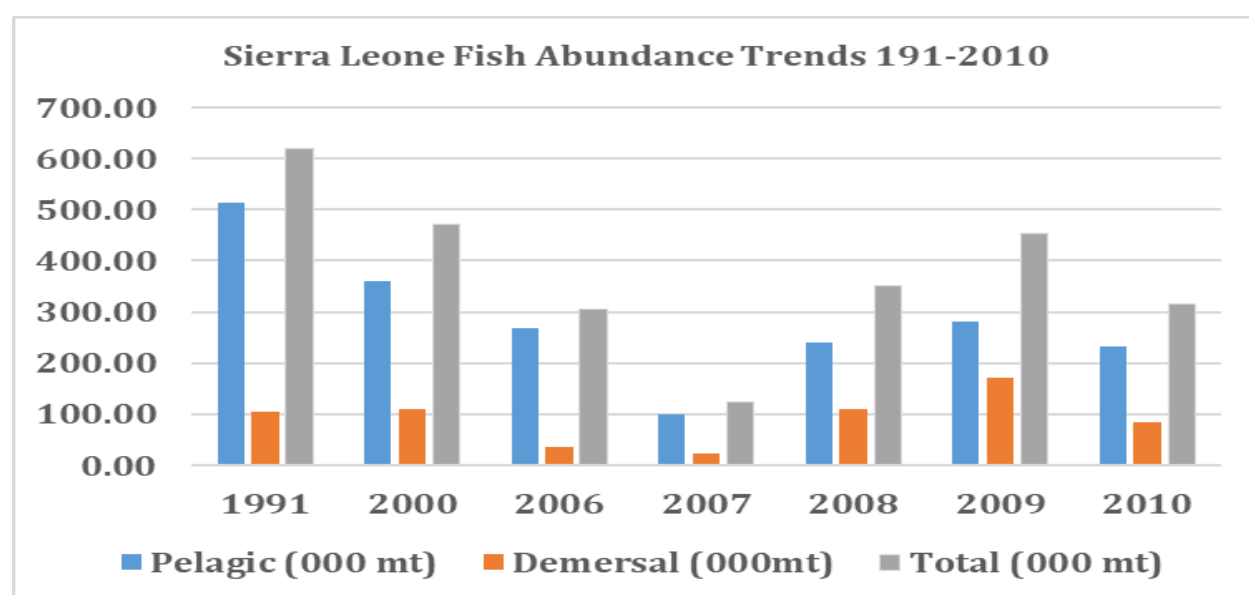


Figure 5. Fish abundance estimates for Sierra Leone, 1991-2010.

Fishery independent surveys for the estimation of resource abundances have been supported through research projects implemented through development cooperation with FAO, the European Union and the Norwegian Institute of Marine Research. The USSR/Sierra Leone had collaborated to carry out abundance surveys between 1976 and 1982, while the Norwegian Research Vessel R/V Dr. Fridtjof Nansen in collaboration with FAO conducts surveys in the continental shelves of countries in the Gulf of Guinea region. Given that most surveys were carried out on demersal resources, and the information on fish stocks in the Gulf of Guinea was scanty, the Fishery Committee for the Eastern Central Atlantic (CECAF) conceived the idea of carrying out fishery abundance survey in 1988, in order to improve the understanding on deeper water fish stocks in the Gulf of Guinea region between Sierra Leone and Ghana. The survey, referred to as the 'Guinea 90', was carried out in April 1990 in collaboration with the Spanish

Oceanographic Institute, in the continental shelves and slopes of Sierra Leone, Liberia, Cote D'Ivoire and Ghana, using commercial vessel. Several other survey efforts and stock assessment have been supported through the GCLME and EAF-Nansen project on board the R/V Dr Fridtjof Nansen in 2006 and 2007. Additionally, through the EU funded institutional support for fisheries management project, bi-annual surveys were conducted in the continental shelf of Sierra Leone from 2008 to 2010. A recent pelagic and environmental survey was conducted under the EAF-Nansen project from 21/07 /2017 to 20/09/2017 in the continental shelf of Cote d'Ivoire, Ghana, Guinea, Guinea Bissau and Liberia. The series of surveys up to 2010 documented total pelagic and demersal fish biomass around 124,000 mt to 618,00 mt with the pelagic biomass accounting for over 70 percent of the total fish biomass in the continental shelf of Sierra Leone. Stock assessments carried out through the FAO/CECAF working groups and experts hired through projects have shown that some demersal and pelagic fish resources in Sierra Leone, mostly the Mandarin Sardinnela (herring), the Gwangwa (Croakers) and the red snappers (Lutjanidae) are fully exploited, while the Bonga Shad is overexploited. Although estimated potential yields show a general picture of healthy fish resources for Sierra Leone (Figure 6), the potential yields for most of the pelagic clupeids and demersal fish stocks are nearing their biomasses.

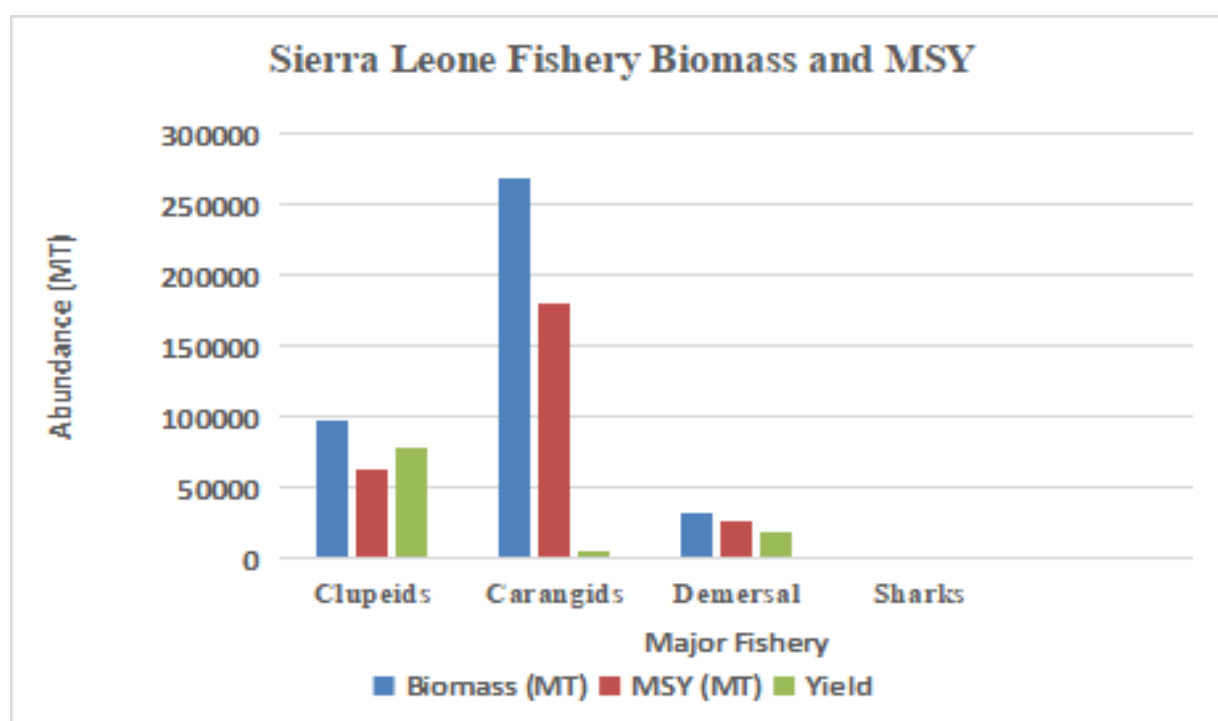


Figure 6. Fish stock abundance and potential yields for Sierra Leone.

The indications are that high fishing pressure is exerted on the demersal fish stocks. The status of the carangidae, mainly the Jacks, Mackerels, False Scads, Pompanos and Atlantic Bumpers, most of which are in offshore waters are underexploited and presents an opportunity for increased investment.

Shrimp fishing in Sierra Leone is more problematic as it is associated with about 70 percent of bycatch of finfish as a result of the utilization of undersized mesh nets by shrimp trawlers below the 45 mm cod end stipulations by law. Most of the pressure on demersal fish stocks is exerted by shrimp fishing gears, which take away a substantial amount of demersal fish species as bycatch. The bycatch of shrimp fishery can, therefore, be considered as a target catch in Sierra Leone. A bio-economic analysis of the Penaeid shrimp fishery (mainly *Penaeus notialis*) for fishing vessels from 1991 to 2008 with fleet numbers ranging from 20

to 65 vessels (Table 4) and unit cost of effort of USD 4,429,600, shows that economic benefits can be maximized more than double below the sustainable yields (MEY is 2.1 times <MSY). Revenues at maximum economic yield are about 1.5 times (over 60%) more than the revenues obtained at maximum sustainable yields (REVMY=1.5>REVMY).)

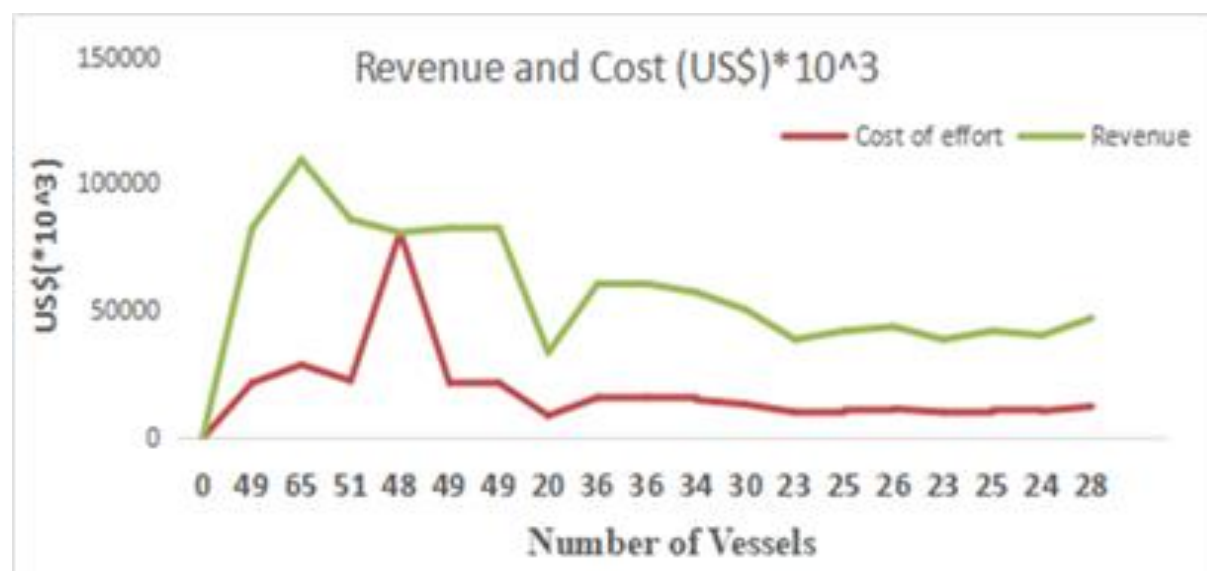
Table 4. Licensed Shrimp Trawlers of Sierra Leone, 1991-2008.

Year	No of vessels
1991	49
1992	65
1993	51
1994	48
1995	49
1996	49
1997	20
1998	36
1999	36
2000	34
2001	30
2002	23
2003	25
2004	26
2005	23
2006	25
2007	24
2008	28

The biological reference points and management implications for the Penaeid shrimps of Sierra Leone are presented in Table 5. The analysis results show that revenues increased during the earlier years of 1991-1996, even when the fishing effort increased. As shrimp trawl investments increased, the revenues fluctuated with a sharp decrease observed in 1997, followed by a further decrease from 1998 to 2008 (Figure 7). The earlier increases in the number of fishing vessels in the fishery were favoured by increases in revenues followed by a sharp decrease as investment continued. A further reduction in the cost of fishing effort resulted in increases in revenue.

Table 5. Bio-economic reference points for Penaeid shrimps of Sierra Leone.

BRP & ERP	Values	Management Implications
MSY	2 450	MSY is slightly more than 1,55mt previously estimated.
MEY	3765.8	Profit can be maximized at a level above the sustainable yield. Care must be taken in shrimp fishing investment.
Fmsy	1,225 fishing days	Fishing mortality at maximum sustainable yield is less than 2816 fishing days previously reported by ISFM project.
Fmey	903 fishing days	Maximum economic yield can be obtained at low efforts for shrimps.
Cost Fmsy	2,768,500,000	Cost of effort at MSY is higher than cost at Fmey.
Cost Fmey	2,039,926,592	Cost of Effort at MEY is lower than cost at MSY.
REV fMEY	15,846,600,000	Economic revenue can be maximized in the fishery about 1.5 times greater than revenues at maximum sustainable yields.
REV fMSY	10,309,600,000	Revenue at Maximum Sustainable yields.

**Figure 7. Cost and revenue profile for shrimp trawl investment in Sierra Leone¹⁷.**

Economic data collection and reporting by fishing companies in Sierra Leone is currently very irregular, as the companies are mostly not willing to report financial information on their investment for fear of increases of the license fee by the government. Using available information obtained from some fishing companies, the authors undertook an investment analysis based on net present value (NPV) discounting appraisal technique for shrimp trawl investment, over a period of 10 years (2009-2019), using 2009 as the base year and discounting bank charges of USD 37,800 (on the principal investment and interest rates). The analysis suggests that the current shrimp fishing in Sierra Leone is viable. The viability is partly due to the cash inflow for the bycatch of finfish species, which accounts for an average annual cash inflow of USD 132,140 (19%) of the cash inflow accounting for shrimp exports. A positive NPV of USD 739,700 is generated for the investment, with an Internal Rate of Return (IRR) of 37 percent for a loan amortization period of 15 years (Table 6).

¹⁷ Baio, A., and Sei, S. (2017). Management Plan for pelagic, shrimps and demersal fish resources of Sierra Leone

Table 6. NPV investment analysis profile for shrimp trawl fishing.

Investment Profile	Values
Period of investment (years)	10
Sales services for base year (%)	25
Sales services (other years) (%)	100
Loan amortization period (years)	15
Cash Inflow	
Export of Shrimps-Annual average (US\$)	562,750
Export and local sale of bycatch-Annual average (US\$)	132,140
Cash Outflows	
Fixed Asset Costs	
Lease purchase of trawler or agency arrangement cold storage Facility, office space, furniture bikes, vehicles and vans (USD)	581 000
Operational Costs	
Licenses, royalties, crew salaries, food and water, gear cost, spares for maintenance, repair costs, Bank service charges (Principal and interest) (USD)	113 400
Administrative costs including insurance, taxes and other levies	154 000
NPV (USD)	739 700
IRR(%)	37

In order to fully understand the performance of the fishery, an ecological risk screening (ERS) was done on target and non-target species. The management of declining fish stocks of demersal, pelagic and shrimp fisheries were screened based on their interactions within the ecosystem and the fishing gears. The objective was to design a management plan aiming to rebuild the declining fish stocks and enhancing food security, economic growth and resource conservation within a period of 5 years. The existing exploitation and management regime of the fish stocks were screened to determine the wellbeing of the ecosystem; the risk issues studied included the ecosystem structure, environmental impacts, external factors such as climate change effects and anthropogenic effects of pollution, coastal developments, mangrove harvesting, the use of illegal fishing nets, IEZ incursions etc. The screening relied on qualitative risk assessment methods based on likelihoods (L) and the consequence of the risk occurring, (C). Consequences were evaluated in the matrix against likelihoods. This was used to identify the critical risk areas that had to be addressed in order to implement an effective management plan for the pelagic, shrimp and demersal resources (Table 7 and Table 8). The following fish stocks were considered in the ERS:

Category 1: Demersal Croakers, Grunts and Threadfins.

Category 2: Pelagic Clupeids, mainly *Sardinella* and Bonga Shad.

Category 3: Penaeid shrimps, mainly *Penaeus notialis*, which is the main target shrimp associated with high bycatch.

Table 7. Qualitative Risk Screening Matrix.

Likelihood		Consequence Level			
		Minor	Moderate	Major	Extreme
		1	2	3	4
Remote	1	1	2	3	4
Unlikely	2	2	4	6	8
Possible	3	3	6	9	12
Likely	4	4	8	12	16

The consequence levels are considered minor, major or severe based on the duration it will take for declining fish stocks to recover, considering the available and future management opportunities. The ERS Screening combining likelihoods and consequence levels considers the ecosystem inhabited by fish stocks and the wellbeing of the investment community interactions, including fishing operations, compliance by fishing vessels, and enforcement of MCS activities. The impact of trawl fishing on the IEZ, including the MPAs and TURF activities, and natural environmental effects such as climate change were all discussed in a workshop with stakeholders. The advantage of the ERS process is that it presents an opportunity for all stakeholders, including fishermen, to interact and provide ideas on the status and management of fish stocks. The consequence levels were scored using the following criteria:

- 1- Minor**, meaning that the impact of activities on fish stocks is minimal and recovery of the fish stocks can take place within months after applying management measures
- 2- Moderate**, meaning that the fish stock is fished near the MSY and recovery can take between months to a maximum of one year, after applying management measures
- 3- Major**, meaning that the fish stock has been fished below the MSY and it would require years for recovery to take place. Robust management measures are needed
- 4- Extreme**, meaning that recruitment overfishing has occurred, where the ecosystem functions have been altered significantly. The fish stock (s) will require decades to recover.

The following likelihoods criteria were used for the risk screening:

- 1- Remote**, meaning that no one ever heard of the consequence of the risk. There is < 2% chance of the consequence happening within five years.
- 2- Unlikely**, means that consequence is not expected to occur. Chances of the consequence occurring are 2-10%
- 3- Possible**, means that consequence may occur, but not likely within five years
- 4- Likely**, means that the consequence level will occur within five years of the management plan

The screening matrix scores for major and extreme situations lie within 12 to 16 and moderate screening scores are between 6 and 8. The tree diagrams for the screening of ecosystem functioning and community wellbeing for assessment of the target industrial demersal, pelagic and shrimp fisheries are presented in Figure 8 and Figure 9. The assessment matrix scores are presented in Table 8 and Table 9.

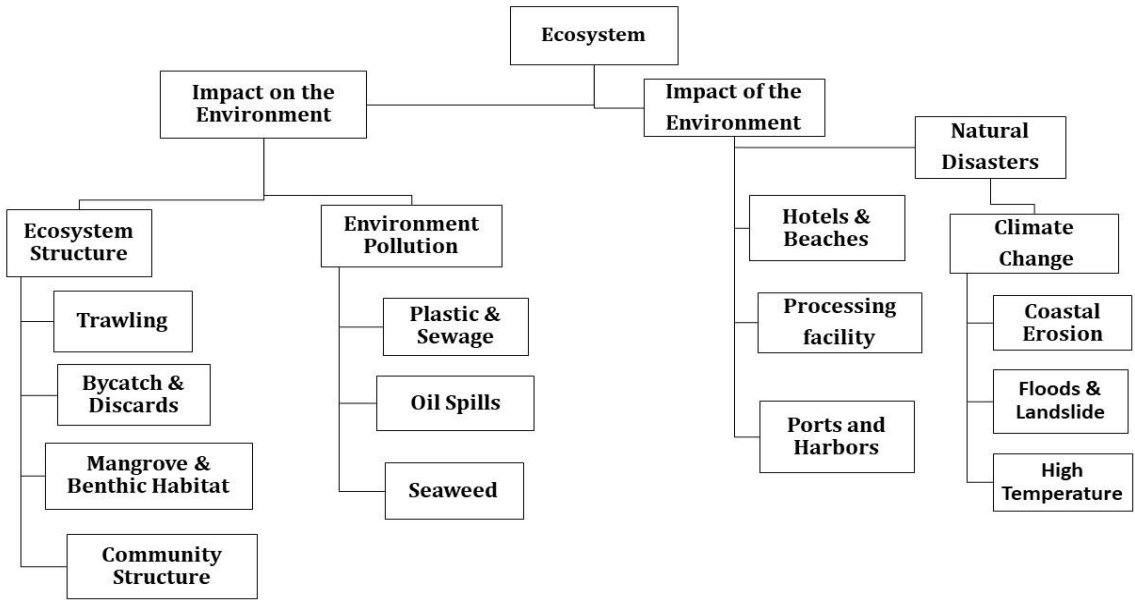


Figure 8. Ecosystem Risk Screening diagram for the industrial fishery of Sierra Leone.

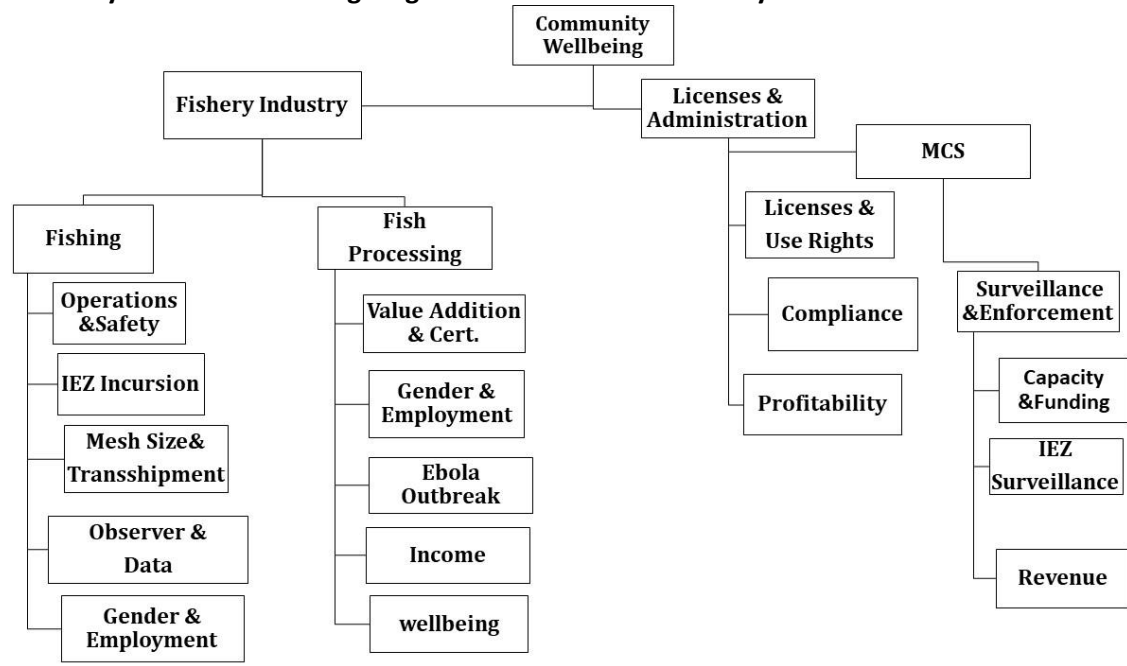


Figure 9. Risk Screening diagram for fishery community Wellbeing.

Table 8. ERS Screening for Croakers, Grunts and Penaeid shrimps.

Risk Issues	L	C	ERS Score	Risk Level	Comments
Ecosystem structure Problem	2	4	8	High	Allowable catches must be set for the stocks
Environmental Pollution	2	3	6	Medium	Although pollution is not currently an alarming problem, the bloom of seaweed (brown algae) that is washed on the beaches during the rainy season calls for research to investigate the consequences of the bloom
Mesh size and IEZ Incursion problem	2	5	10	High	Currents MCS efforts have not kept trawlers from the IEZ. Regular surveillance patrols are needed to combat Trawler Incursions into IEZ. Communities must be empowered for coordinated fisheries patrols
Low Value Addition	2	4	8	High	Additional effort is needed to construct fish harbor complex, improve standards of fish testing laboratories and conduct collaborative inspections of fishing vessels. Collaboration with fishing companies is required
Weak Compliance	2	4	8	High	Fishing right holders must improve compliance. Vessel Captains must be trained to understand the provisions of the Fisheries Act.
Data Collection Not Regular	2	4	8	High	Data collection must be improved. Quota Management Authority should be created to finance data collection and set up TACs for target fishery
Weak MCS	2	4	8	High	Regular patrols are required to achieve compliance
Low Revenues to Govt.	3	3	9	High	Fishing right regime must be replaced by quota systems so that fishing rights are allocated based on allowable catches. This will increase revenues
Use Rights ineffective	3	3	9	High	Fishing right allocation must be based on TACs
Weak capacity	2	2	4	Medium	Additional human resource capacity is needed. CMAs must be trained to collect catch and effort data

Low benefit Sharing	2	4	8	High	The fisheries development fund should be established to set aside percentages of revenues to be used to develop the fishery including support to artisanal sector
Climate Change Effects	2	3	6	High	The indications of future impacts is felt. The recent flooding and landslide event calls for climate change adaptation and mitigation initiatives.

Table 9. ERS Screening for pelagic Clupeids, mainly Sardinella and Bonga Shad.

Risk Issues	L	C	ERS Score	Risk Level	Key Measures
Ecosystem structure Problem	3	4	12	High	The problem is very serious as the main species of small pelagic clupeids including Sardinella are overexploited
Environmental Pollution	2	3	6	Medium	Coordinated pollution regulation among key MDAs is required. Dumping of plastic at sea must be prohibited
Mesh size and IEZ Incursion	2	4	8	High	Regular surveillance patrols is needed to meet objectives
Low Value Addition	2	4	8	High	This is a serious problem. Collaborative effort is required by stakeholders to improve official controls
Weak Compliance	2	4	8		Existing effort must be improved through regular patrols in order to meet management objectives
Data Collection Not Regular	2	4	8		Data collection system must be improved through increased funding for comprehensive data collection. Annual surveys must be conducted
Weak MCS	2	4	8		Regular surveillance patrol is required. Fishing communities must be empowered for community surveillance
Low Revenues to Govt.	3	3	9		Rights must be allocated based on allowable catches
Use Rights ineffective	3	3	9		Use rights must be improved with quota management system

Weak capacity	2	2	4		Human capacity must be built and CMAs must be trained in surveillance patrols
Low benefit Sharing	2	4	8		The fisheries development fund must be operational
Climate Change Effects	2	3	6		Important and signs of future effects is felt. Climate adaptation initiatives must continue and be improved

The Ecological Risk Screening (ERS) output provides important information on the effects of fishing on different ecological systems. The screening output reveals that the current management system where fishing rights are allocated through licenses is not effective to meet the fisheries management objectives of promoting food security, economic growth and fishery resource conservation. Efforts must be made to ensure that rights are allocated based on total allowable catches (TACs) to rebuild declining fish stocks. Fisheries management challenges that require immediate attention include the strengthening of MCS through regular surveillance patrols. Trawler incursions into the IEZ, data collection and the use of fishing nets with the wrong mesh sizes are important areas that need improvement. Seaweed and plastic pollution are key issues. The pieces of evidences of coastal erosions associated with climate change events, insufficient knowledge on catch levels for inshore pelagics, shrimps and demersal resources, limited credit facilities for fishers, post-harvest losses, poor hygiene and fish trade limitations are critical risk areas to address.

3.2 Economic viability

Industrial trawler operations cause significant impact on associated fisheries through the destruction of habitats. Juvenile fishes are caught in large quantities by shrimp trawlers, and this is partly responsible for declines in the population of some fish stocks in Sierra Leone. Industrial trawling can, therefore, have a future impact on the long term sustainability of fish stocks in Sierra Leone. There is a need for the non-disturbance of important fish habitats such as mangrove forests, to protect the fish stocks that are already fully exploited. The commencement of a temporary restriction (moratorium) on the establishment of new fishing companies and the capping of fleet numbers at original levels operated by previous fishing companies, could permit temporarily reducing the expansion of trawl fishing. However, this activity is not envisaged to continue due to the current priority of the revenue generation objective for the fishery. In Sierra Leone, the number of fishers in the industrial fishery, as well as the distance travelled by fishing vessels to access fishing grounds, have both been increasing over time. Fishing vessels now spend more time at sea in order to increase their catch. The trawling activities of shrimp vessels are particularly longer due to the life history of the shrimp. Penaeid shrimps burrow into the mud during the day and come out at night to feed. Therefore, shrimp vessels fishing during the day actually targets a number of demersal fish species as bycatch. As some captains of shrimpers modify the cod-end mesh size of the gears in order to increase the catchability of gears, there is bound to be an increase in the bycatch of juvenile fish species by shrimp vessels during the day. Fishing trips for fish trawlers also last between 30 days and two months prior to transshipment. This is largely due to the reduction of fish concentrations in fishing grounds owing to their declining populations, and thus shifting shrimp concentration areas as well. Additionally, there has been a decrease in the number of industrial trawlers, as well as in the size and powers of licensed fishing vessels, particularly trawlers, compared to the early 1980s and 1990s. This is an indication that fish stocks are declining in Sierra Leone. Efficient offshore vessels such as pelagic and mid-water trawlers will be required to catch the fast-moving offshore pelagic fish stocks that are currently underexploited. Although analyses suggest that the shrimp fishing is viable, precautionary approaches must be applied to

restrict fishing activities of shrimp trawlers to night hours, when the shrimps are actually available to the shrimp gears.

3.3 Social equality

Fishing rights under licenses, royalties and fishing associated levies is legally established in Sierra Leone based on the 1994 fisheries management and development Act and the 2010 Fisheries Regulations. These instruments have been updated into the new fisheries and aquaculture bill of 2015 and fisheries regulations of 2016, which would pave the way for stiffer penalties for violation of regulations. The current fishing license right allocation considers revenue generation and food security within a precautionary domain of economic viability of the fish stocks and conservation of marine biodiversity. Major provisions exist as fishing right limitations, including --but not limited to-- mesh size restrictions, exclusion zones (IEZ), illegal transshipments and conservation restrictions on specific non-target species. However, there are no limitations on the number of fishing vessels (fleet numbers) and catch levels (allowable catch) under the rights allocated for the fishery. The concentration of industrial fishing rights to foreign-owned fishing vessels in the current advent, where very few Sierra Leoneans own fishing vessels, have been questioned by the Artisanal Fishermen's Association--the Sierra Leone Amalgamated Artisanal Fishermen's Association (SLAAFU). The Fishermen Union advances the quest for Government to leverage the ownership of vessels at the advantage of indigenous Sierra Leoneans, and to share revenues collected from the industrial fishing right allocations with the artisanal fishing communities. This request expatiates on the grounds that fishing trawler incursions into the IEZ are having an unaccounted impact on the livelihoods of these fishers, who often lose their nets to trawlers without adequate compensations. The issue of inequality with regards to purchasing power parity has also been cited as a key social factor affecting the distribution of fishery benefits among Sierra Leoneans. Even where fish is available in the local markets, some groups of people, particularly the vulnerable poor who are not able to purchase the fish. This phenomenon is regarded as an impediment on the achievement of nutritional security from the fishery¹⁸. In the new fisheries bill, the establishment of a fisheries development fund (*'the fund'*) is provided for, to allow the setting aside of a separate fund from percentages of licenses, royalties, and other levies to be used for the development of the fisheries of Sierra Leone¹⁹. The MFMR has also suggested that part of this fund be used for the development of artisanal fisheries as a way of sharing the proceeds from the allocation of industrial fishing license rights. This is a semblance of the Sierra Leone Government's response to the call of artisanal fishermen to get equity in the distribution of the proceeds from license right allocations as an impetus of the new co-management initiative forged. As women entrepreneurs in Sierra Leone have increased since the 1980s and 1990s, their involvement in industrial fishing has risen, but fishing vessel ownership among Sierra Leonean entrepreneurs remains less than one percent nonetheless. It is envisaged that the introduction of a quota management system will facilitate the effective involvement and contribution of indigenous Sierra Leoneans from the industrial fishing right allocations.

Natural disasters, including flooding and coastal erosion due to climate change effects also affect the fishery. The poor fishing communities are often prevented from accessing fishing grounds during harsh weather conditions as their boats are small. Therefore, there is disproportionate access to fish resources between the artisanal sector and the industrial sector, with the latter benefiting due to technology and gear advantages. Fishing Companies operating fishing vessels in Sierra Leone are legally registered with

¹⁸ Bangura, P., and Sei, S. (2018). Review/Analysis of the contribution of National Policies and Strategies of Fisheries and Aquaculture to the Food and Nutrition Security of populations in West Africa. Report of the National Consultation for the Republic of Sierra Leone. GCP/INT/244/EC Food and Nutrition Security Impact, Resilience, Sustainability and Transformation (FIRST) (Under Preparation). FAO, Sierra Leone

¹⁹ Government of Sierra Leone (GoSL) (2015). The fisheries and Aquaculture Bill of Sierra Leone

recognized operational addresses and can be easily located in the event of hazardous events, including the effects of climate change. A recent landslide resulting from heavy downpours of rains in 2017 claimed over 1,000 lives and destroyed properties worth slightly over USD 30 million. Some families of fishing right holders were affected and fishing operations at sea were stopped during this period of heavy rains and flooding. During the aftermath, several fishing companies that were not adversely affected by the landslides and flooding donated fish and non-food items to displaced homes. Other reports of heavy weather effects include damaged fishing vessels at sea, the sinking of trawlers, and the loss of human lives. However, there is no compensation mechanism within the fishing right allocation for such damages due to hazards at sea, but licenses can be renewed to compensate for lost fishing time. There have also been situations where fishing companies have donated fish and fishery products to quarantined homes affected by the outbreak of the Ebola Virus Disease in Sierra Leone, which was considered to be carried by bush meat.

4. MAIN CHALLENGES AND WAY FORWARD FOR IMPROVING RIGHTS-BASED APPROACH

4.1 Challenges for industrial fisheries management

The major challenge for the management of the industrial fisheries of Sierra Leone is the weakness in the country's capacity to combat illegal, unreported and unregulated (IUU) fishing. This was exacerbated by the Ebola crisis in 2014, during which monitoring, control and surveillance efforts of the MFMR dwindled. The effect of IUU fishing is impacting negatively on the food security of the 7 million people of Sierra Leone, 80 percent of whom depend on fish as the main source of animal protein. Sierra Leone is among the West African countries with high incidences of IUU fishing, even though recent efforts of MCS investments from the West Africa Regional Fisheries Program (WARFP) has upgraded capacities to combat IUU fishing. The existing MCS system still suffers from funding bottlenecks, as regular surveillance is not conducted. Comparatively, however, there is increasing MCS effort in Sierra Leone through cost-effective vessel monitoring system and the use of Automatic Identification System (AIS). Over 80 incidences of IUU related offences were reported between 2010 and 2017; the country loses around USD 50 million to IUU fishing alone²⁰. In a recent encounter in April 2017, an environmental non-governmental organization, Greenpeace, using their ship, the *Esperanza*, under a joint surveillance patrol with the Sierra Leone Government Authorities, rounded up 4 IUU fishing trawlers caught fishing illegally in the Sierra Leone EEZ²¹. This was a patrol aimed at documenting IUU activities in the EEZs of West African countries that are members of the sub-regional fisheries commission (SRFC), in order to contribute towards the enhancement of food security in West Africa. Two of the vessels apprehended, *Fu Hai Yu 111* and *Fu Hai Yu 222*, were caught with illegal fishing nets that had mesh sizes below the required 60 mm required for pelagic and demersal fishing trawlers, under national regulations. The nets were found hidden onboard the fishing vessels; it is common practice to conceal illegal nets at sea. The vessels also conducted fishing in Sierra Leone waters without logbooks onboard, thus under-reporting their catches. There were additional evidence of unauthorized offloading of the catches by these same vessels in the port of neighbouring Liberia. The *Fu Hai Yu* vessels are owned by a Chinese Company, the *Fu Hai Fishing Company*. Another fishing vessel, *F/V Eighteen*, an Italian fish trawler owned by the Italian Company *Asaro*, was caught in possession of shark fins, which is illegal under European Council Regulations, although this is not yet enforced in the National Fisheries Act of 1994 currently in force. However, under the new Fisheries and Aquaculture Bill of Sierra Leone, which has not yet been enacted, the possession of shark fin onboard industrial fishing vessels is illegal. Another Korean vessel, *CONA* was also caught covering its name and illegal fishing nets were found on board the vessel with mesh sizes around 52 mm at cod end, which is far below the 60 mm minimum requirement. All these vessels are operated under

²⁰ Government of Sierra Leone (2018). Presidential Speech, State Opening of Parliament. State House, Freetown

²¹ Greenpeace Africa. (2017). *Hope in West Africa Ship Briefer*. Retrieved from <https://www.greenpeace.org/africa/en/publications/1941/hope-in-west-africa-ship-tour-briefer/>

Local Agents representing the interest of the Industrial fishing partners under some sort of agreement. Three of the apprehended vessels were fined for the violations based on the Fisheries Act of 1994. The falsification of catch labeling, concealing of fishing vessel call signs, illegal fish discharges, IEZ incursions and the turning off of vessel monitoring system (VMS) transponders at sea are among the numerous IUU fishing offences encountered in Sierra Leone. This is hampering the sustainability of the fisheries and fish food security in Sierra Leone. In the state opening of the 5th Parliament of Sierra Leone in May 2018, the newly elected President of the Republic of Sierra Leone emphasized IUU fishing as a key challenge for revenue generation and food production from the fishing sector. The President noted that IUU activities of industrial fishing vessels are negatively impacting the food security of Sierra Leone people. He also noted the challenge of the absence of a fisheries infrastructure including fish harbor complex and laboratories without necessary hygiene and sanitary control standards, which is impeding on the ability of Sierra Leone to meet the EU minimum standards for fish exports. He promised to provide the necessary resources and cooperate with development partners for effective surveillance of the fishery waters to combat IUU fishing, strengthen value addition for fish and fishery products, and promote the development of fisheries infrastructure²².

The issues surrounding value addition for fish and fishery product is a key challenge, as Sierra Leone is currently not listed among countries allowed to export fish to the EU markets. This is because Sierra Leone has yet to meet the EU minimum standards of official controls for hygiene and sanitation. Although the government has been contracting the EU food audit firm PRECON to build national capacities of official control for hygiene and sanitation since 2013, the process has been delayed by funding requirement delivery bottlenecks and ineffective cooperation among stakeholders. The Government has moved to set up a food safety authority to leverage hygiene requirements for the improvement of the trade of food products, including fish and fishery products. However, this process is also hampered by limited funding to develop national laboratory standards for testing and certification of fish and fishery products. The designated Competent Authority of the Foods Unit of the Ministry of Health and Sanitation has not been effective due to funding limitations and weak human and technical capacity. A key challenge to address urgently is the poor data collection on target fishery, leaving the status of inshore fish populations largely unaccounted for. Stock assessment is not regular and even where abundant surveys are undertaken, the research vessels have not been able to survey inshore waters less than 15 m deep. Comprehensive data collection to account for total fish production was halted in 2009 when the EU funded Institutional Support for Fisheries Management project phased out. Additionally, there is no fisheries research vessel in Sierra Leone as compared to other sub-regional countries of Guinea, Senegal and Cape Verde. This has posed difficulties for fishery independent data collection, as surveys relying on hiring research vessels are generally expensive. As a result, no allowable catches have been set for the fishing right regime, as licenses are only based on the size of the fishing vessels. This makes it difficult to sustainably manage the fishing capacity. A quota management regime as proposed by the fisheries management plan of Sierra Leone, can reduce the number of fishing vessels and control the intensity of declining fish populations²³. The current fishing right regime of licenses allocated to every vessel without any limitation on catches has decreased populations of commercial fish stocks and serves as an incentive for artisanal fishing net destruction conflicts through vessel incursions into the IEZ.

4.2 Improving future sustainability

Comprehensive data collection and analysis for both artisanal and industrial fisheries, including data on inshore fish populations is key for the future sustainability of the fisheries. Reliable data will be required for setting up a quota management regime, where licenses will be based on total allowable catches (TACs).

²²Government of Sierra Leone (2018). Presidential Speech, State Opening of Parliament. State House, Freetown

²³ Baio, A., and Sei, S. (2017). Management plan for pelagic, shrimps and demersal fish resources of Sierra Leone

A quota management and regulation authority must be set up as a separate arm of the MFMR, charged with the responsibilities of setting up and managing a quota system for the target species/categories of commercially exploited fish stocks. Shrimp trawling is causing untold impacts on inshore fish populations that interact with shrimps. In order to minimize bycatch and discard unwanted catches at sea, fishing rights for shrimp trawling should be restricted to 12-hour operations per day and should take place at night, from 6 pm to 6 am. This will improve the targeting of shrimp stocks as they come out of their mud burrows during the night to feed off the water column. An alternative to this proposal would be to introduce a dual license scheme where both finfish and shrimps are considered as target species under the fishing license rights allocated for shrimp trawlers.

The availability of a fast-moving fishery patrol vessel is an opportunity for increasing fishery surveillance patrols in Sierra Leone. The authors propose that this vessel should be used under a cooperation arrangement with SRFC member states in West Africa, to conduct joint surveillance operations where resources can be pooled from each country from time to time, to facilitate MCS operations. SRFC already had an effective sub-regional patrol scheme that worked well from the late 1990s to early 2000. The implementation of a sub-regional integration for regular fisheries surveillance operations under this proposed joint scheme will minimize IUU fishing in the region. Such joint patrols can be done under a regional memorandum of understanding (MOU), which can permit hot pursuits and apprehension of vessels in waters of SRFC member states. This arrangement can be further strengthened within the ECOWAS integration scheme for maritime operations in cooperation with the Mano River Union (MRU) and at the level of the African Union (AU) supported by New Partnership for Africa's Development (NEPAD) fisheries program, to give it the necessary recognition. Monitoring control and surveillance of the industrial fishing activities must also be improved by empowering local communities with the ability to report all spotted industrial vessels in the IEZ to the MFMR. Since patrols at the national level are often uncoordinated, regular and use large patrol vessels, they can be expensive; the surveillance operations must thus consider the inclusion of active artisanal fishermen as part of the MCS operations, through the strengthening of a community surveillance scheme forged through a coordinated effort. Under this scheme, coordinated communication technology between the patrol teams of the larger patrol vessel and smaller fishing community patrol boats can share real-time information, where the former can relay information on observed fishing vessels in the IEZ or nearby waters.

The improvement of fish handling and processing infrastructure is an important aspect of enhancing value addition for industrial fishery products. A fish harbour complex investment opportunity should be pursued, under a public-private partnership (PPP) arrangement, for the construction and operation of a multi-purpose fish harbour complex. The opportunity already exists, and feasibility studies by MFMR have identified spacious waterfront areas and natural harbour extensions, around most of the fish, offloading and transshipment points. A fishing port that operates cold storage facilities, bonded stores and ice producing units, and facilities for dry docking and vessel maintenance, rented under a PPP arrangement, will boost fish handling and processing and reduce post-harvest losses. This infrastructure should interface with improved national fish testing laboratories and the improvement of official control capacities of private fishing companies. A cooperation between the Fisheries Ministry, the Competent Authority (CA), and the Fishing Companies for a coordinated official control system are envisaged. Under this system, the Government would assign trained staff to fishing companies for the enforcement of official controls onsite, in line with EU guidelines. Once the hygiene and sanitary standards are improved, there will be a comparative advantage for Sierra Leone industrial fishery to leverage trade linkages in the sub-region as well as with international markets. This will help reduce fish trade vulnerabilities to the unexpected trade limitation shocks that are currently impeding on national fisheries investments and revenue generation.

The ongoing artisanal fisheries management initiative through marine protected areas will support the rebuilding of commercially important declining fish stocks, which will subsequently become available to the industrial fishery. This system of MPAs and territorial use right fisheries (TURFs) must be strengthened through alternative livelihood schemes and capacity mobilization within the fishing communities. The incursion of fishing trawlers into the IEZ is a key challenge in sustaining the fisheries within the partially regulated MPAs. This is affecting the livelihoods of fishermen whose nets are often destroyed by the trawlers. There is a conflict resolution system where the Ministry of Fisheries and Marine Resources arbitrate for settlement of net destruction conflicts and ensure that the industrial fishing companies compensate the victims. However, fishers are sometimes dissatisfied with the compensations reckoned. As stated earlier, surveillance efforts must be strengthened through the empowerment of the MPA management associations (CMAs) to undertake community surveillance in order to keep trawlers out of the IEZ. Alternative livelihood activities must be identified and supported by the ongoing development projects in order to sustain the MPAs and TURF management efforts.

Initiatives for the mitigation of, or adaptation to, natural disasters arising from climate change impacts must be considered in the allocation of fishing access rights. Considerations for creating resilience in coastal and estuarine habitats, including mangrove ecosystems, will support the breeding of fish stocks and the adaptation of communities to extreme weather events. A devastating flood and landslide occurred in Sierra Leone as a result of deforestation and heavy rainfalls in 2017, which led to the loss of more than 1,000 human lives coupled with the destruction of properties worth about USD 31.65 million. Higher death tolls occurred in vulnerable and low-income communities around river valleys, creeks and slums. Trawl fishing activity at sea was also affected during this period of harsh weather. Hydro-acoustic surveys in Sierra Leone have also shown evidence of sea surface warming and unfavourable salinity regimes accounting for the disaggregation of fish schools. Pollution control mechanisms must also be coordinated among Government Ministries, Departments and Agencies (MDAs) including the Sierra Leone Maritime Administration (SLMA), the Environment Protection Agency (EPA), the Universities and Marine and Oceanographic Research Institutes including those in the sub-region. The frequent observation of seaweed bloom (*Sargassum vulgare*) during the rainy season presents a concern for detailed research into the causes of algal blooms and their effects on fish resources. The blooms have been linked to high nutrient loading and sediment perturbations from mining activities that introduce heavy metals into the water column. There are concerns of the reduction of oxygen concentration due to anoxic conditions that might be associated with blooms. However, the algae that sink to the water column could also provide energy in the form of carbon to fishes and invertebrates in deeper layers of the sea. There are discussions that the *Sargassum* may actually be swept away during severe currents from the North Atlantic gyres of the Sargasso Sea²⁴.

Finally, a consideration for a multilateral fishing access agreement between countries having an interest in the industrial fisheries of Sierra Leone must be considered in the process of introducing fishing rights-based on TACs. This will help towards the sustainable control of fishing capacity and a number of problems, including the regulation of fishing vessels by flag states. Most of the foreign crew operating in the industrial fisheries of Sierra Leone are either Chinese, Koreans, Italians or French; they often find it difficult to communicate effectively in English or write English. This language barrier also serves as an impediment for the understanding of national fisheries management regulations. Fishing right allocation arrangement under multilateral cooperation with countries operating embassies in Sierra Leone will permit ease for mutual understanding. Fishing right arrangements through bilateral arrangements where countries are represented in Sierra Leone, could further support the simplicity of these operations.

²⁴ IMBO (2011). Investigations into the seaweed bloom in the coastal waters of Sierra Leone. WARFP project Consultancy Report, MFMR

Partner countries are more likely to afford interpreters onboard their fishing vessels than individual foreign fishing companies, the latter being more interested in profit-making than enhancing the sustainability of the fisheries where they operate. This example has been practiced in the past through the Sierra Leone –USSR fishing agreement, which worked well for several years, although the management arrangement for future agreements would require improvement.

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