

**The Project for the Formulation of
the Strategies and Practical Approaches
for Coastal Fisheries Development
in
The State of Eritrea**

Final Report

October 2023

Japan International Cooperation Agency

INTEM Consulting, Inc.

VSOC Co., Ltd.

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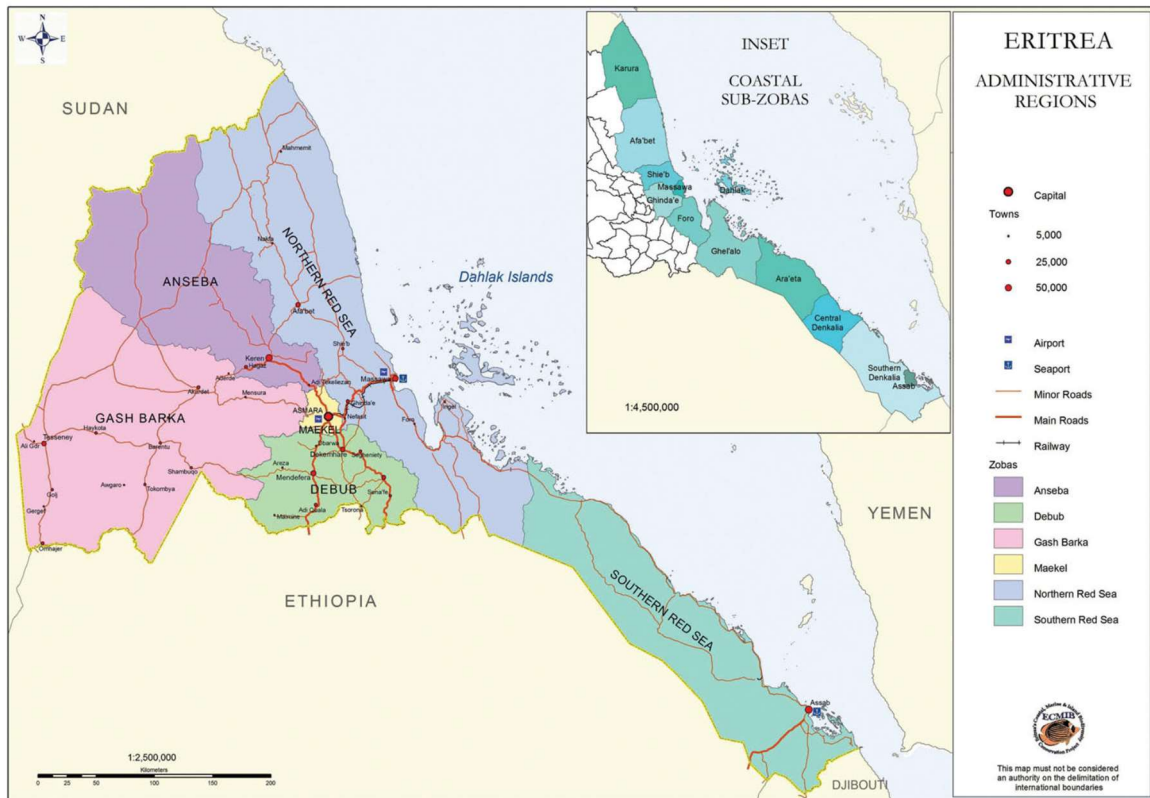
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6. Resource management textbook for coastal fisheries in Eritrea
7. Coastal Fisheries Managements under climate changes with SDGs
8. Fisheries Management for Rural Community Development
9. Training materials for Fishing Gears and Methods
10. The Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea



Administrative divisions of Eritrea

(Source : Edited by Dr. Alain Jeudy de Grissac and Kaleab Negussie, Eritrea's Coastal Marine and Island Biodiversity Conservation Project, Printed in December 2007)

Abbreviation and Acronyms

COMESA	Common Market for Eastern and Southern Africa
COVID-19	Corona Virus Disease 2019 (SARS-CoV-2)
C/P	Counterpart
CPUE	Catch per Unit Effort
EEZ	Exclusive Economic Zone
EMPC	Eritrean Marine Products Company
ERN	Eritrean Nakfa
FAO	Food and Agriculture Organization of the United Nations
FRP	Fiber Reinforced Plastics
GPS	Global Positioning System
IFAD	International Fund for Agricultural Development
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
MM	Minutes of Meeting
MMR	Ministry of Marine Resources
MSY	Maximum Sustainable Yield
NFC	The National Fisheries Corporation
PCM	Project Cycle Management
PIU	Project Implement Unit
PMU	Project Management Unit
PP	Pilot Project
TOT	Training of Trainers
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program

Introduction

“The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development in the State of Eritrea (FSPAC)” was implemented by the Ministry of Marine Recourses and Japan International Cooperation Agency (JICA) since October 2019 until October 2023 based on the Record of Discussion (R/D) signed between the Government of the State of Eritrea and JICA in July 2019. The component of the project shouldered by JICA for implementation was entrusted to the joint venture consisted of INTEM Consulting, Inc. and VSOC Co. Ltd., and the joint venture worked on related technical cooperation by forming a team of experts based on the contract with JICA (hereinafter, “JICA Study Team”).

During the implementation of the project, there was a global epidemic of COVID-19, which had a significant impact on the progress of the project. The Eritrean government also imposed strict restrictions on action for about a year, especially from around April 2020, when the number of infected people exploded in Europe, and project activities were virtually suspended. The gradual easing of restriction since then has led to the resumption of activities in Eritrea from mid-2021, and also the resumption of JICA experts' travel in November 2021. However, the impact of this has led to an extension of the project period, which originally ran until June 2022, by about 18 months to October 2023, as well as additional activities, equipment and materials as resilience enhancement measures for COVID-19. The implementation structure on the MMR side has also been significantly changed, with project activities resuming under a new structure.

Once the project resumed, pilot project activities and associated capacity-building efforts took precedence, and towards the end of the project, the drafting and consensus-building of the final product, the Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea, which reflected the results of the pilot projects, was intensively implemented under the ownership of the Eritrean side. Cooperation between the Japanese and Eritrean sides thus overcame a period of groping in the dark, and today the project has been completed. It is to be hoped that the various capacity-building achievements achieved in the project and the most important deliverable, the technical guidelines, will contribute to the future development of Eritrean coastal fisheries for a long time to come.

Chapter 1: Outline of the Project

1-1 Background

Eritrea (population 4.95 million (2016), 124,000 km²) has a coastline of about 1,950 km from the Sudan border to the Djibouti border facing to the Red Sea. It also has a 56,000km² continental shelf in an exclusive economic zone of 121,000km² and is endowed with a variety of marine products such as bottom fish, small to large pelagic fish, and crustaceans that inhabit reefs and sand. There are many less or unused resources.

Eritrea achieved independence from Ethiopia in 1993, but the 30-year independence straggle has severely impacted on the country's infrastructure and economy, and the government has worked to restore and rebuild it since independence. Nevertheless, while most of the working population is engaged in low-productivity agriculture and livestock farming, Eritrea is still importing 70% of its food, in addition, serious drought damage has occurred frequently, and food and nutrition situations are extremely vulnerable. Therefore, the abundant fishery resources in the Red Sea have great potential in contributing to the food security of Eritrea as a whole and to improving the livelihood of the coastal population.

The Government of the Eritrea has been working on the development of the fisheries sector with the goal of sustainable use of marine resources for economic development, food security, poverty alleviation and livelihood improvement of coastal residents by raising a policy to tackle the issues and requested cooperation from Japan. In line with this, it was agreed in the September 2014 Japan-Eritrea Economic Cooperation Policy Dialogue to consider the fisheries field as a new field of cooperation.

Following this development, JICA conducted a basic information gathering and confirmation survey from July 2017 to July 2018 in order to investigate the possibility of cooperation and to understand the current situation of the fishery sector in the country. It identified that most of the current commercial enterprise fisheries are operated by trawlers registered in Egypt, and these catches are landed on Egypt's fishing ports, so there is no benefit for the supply of seafood in Eritrea. The demand for seafood increased in the country, but supply has not been caught up. In addition, the environment in some areas in the coastal region is severe, thus the number of future fishermen is extremely small. Given such situation, priority areas confirmed for assistance are improving and stabilizing the productivity of coastal fisheries for food security and improving fishermen's livelihood, and promoting the supply of marine products to inland areas through the development of artisanal fisheries. Meanwhile, the Government of Eritrea has formulated the Ministry of Marine Resources Strategic Plan 2018-2022 (hereinafter referred to as the “MMR Strategic Plan”) as a comprehensive development plan (master plan) for the sector as a whole,

and requested “The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development in The State of Eritrea” focusing on the food security and poverty reduction, and strengthening the capacity of the officers of the Ministry of Marine Resources.

It is a hope that the implementation of this project will illuminate a path to the solution for development issues (improvement of operation rate of fishing vessels, diversification of fishery techniques, support for artisanal fishermen and women, etc.) guided by the Ministry of Marine Resources, and improve fishermen’s productivity and livelihood of coastal artisanal fisheries.

1-2 Project Overview

1-2-1 Purpose

This project is to formulate the “The Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea” by developing a coastal fishery development strategy / approach that will be effective for implementing the development strategy by the Ministry of Marine Resources officials through the situation survey and pilot projects in Asmara and Massawa and the surrounding coastal and island fishing villages. Through promoting the implementation of this development plan, it will improve the productivity of coastal artisanal fisheries, stabilize the production volume, promote domestic distribution, and contribute to improving food security of the country and the livelihood of coastal fishermen.

1-2-2 Structure of the project

(1) Output

Output 1: Technical report on the current state, issues and constraints of coastal artisanal fisheries

Output 2: “The Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea” formulated based on pilot project experiments.

(2) Activities

- 1) To thoroughly survey and evaluate current situation, issues and constraints of coastal fisheries (Baseline Survey).
- 2) To identify the essential elements of approaches for coastal fishery development based on the MMR Strategic Plan.
- 3) To verify the applicability of the strategies and approaches through pilot projects.
- 4) To prepare and validate the contents of the Technical Guidelines on practical approaches

(3) Study area

Asmara, Massawa and coastal/island fishing villages around Massawa

(4) Implementing organizations

Ministry of Marine Resources, the State of the Eritrea (MMR)

Japan International Cooperation Agency (JICA)

1-3 Flow of the Project

The flow of the project implementation agreed upon at the first JCC is shown in Figure 1-2. However, due to the pandemic of COVID-19, the activities had been stagnant since March 2020 and the project period was subsequently postponed until October 2023 under the agreement with JICA and MMR.

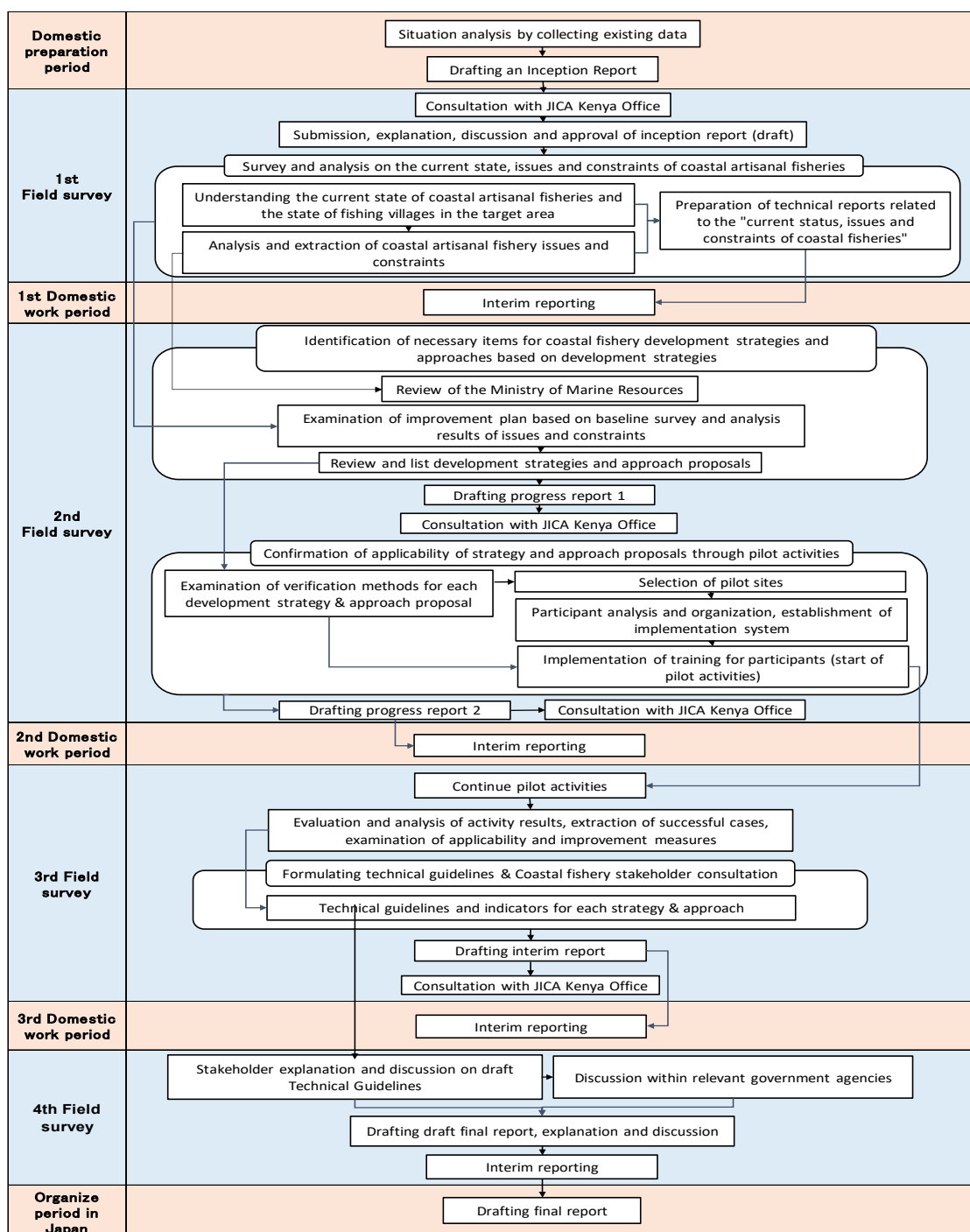


Figure 1-1 Flow of project implementation agreed at the first JCC

In the first round of the JICA expert mission, MMR and JICA Study Team agreed to select priority issues and plan pilot activities to demonstrate how to solve the issues based on the results of the baseline survey and problem analysis workshop and discussions with MMR, and the analyses of the "Current Situation, Challenges and Constraints of Coastal Fisheries" and the "Draft Strategy

and Approach for Coastal Fisheries Development based on the Development Strategy" were to be conducted in the second round of the JICA expert mission. It was also envisaged that the planned pilot activities would be implemented, the analyses mentioned above would be carried out, and the technical report would be prepared after the second mission. However, all these activities had to be suspended due to the emergency return of JICA experts in the middle of the second field survey due to COVID-19 and the infection control measures in Eritrea.

Subsequently, the project activities were then resumed in November 2021 and pilot projects were completed by March 2023. The first draft of the technical guidelines was prepared in June 2023, then the final version of the Technical Guidelines was developed in August 2023 after discussion and making agreement on the stakeholder consultation meeting.

1-4 Project Implementation Structure

The implementation structure of the project agreed upon in the first JCC is shown in Figure 1-1. The JCC is expected to serve as the highest decision-making body for the project management, as well as a communication and consensus-building function between MMR and JICA. The Project Director, the Director General of the MMR, is the chief executive officer of the project implementation team, and subsequently the Project Manager and the Project Management Unit (PMU). The actual activities were implemented by the Project Implementation Units (PIUs), which were organized for each subject area and taken responsible for pilot activities. The JICA Study Team provided specific technical support to the PMU/PIU in consultation and coordination with the Director/Manager.

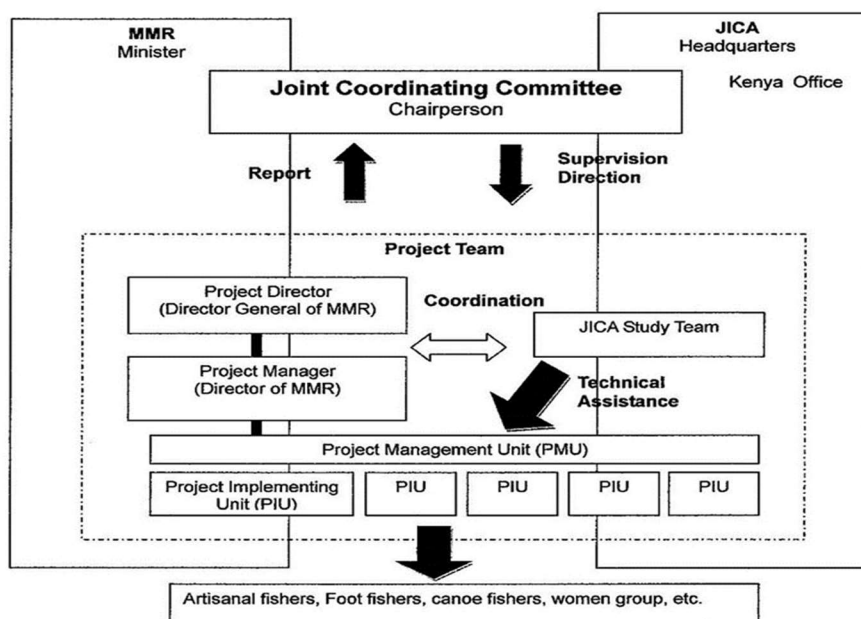


Figure 1-2 Project implementation structure

The composition of the JCC members agreed upon at the first JCC meeting is shown in Table 1-1.

Table 1-1 Members of the Project Joint Coordinating Committee (JCC)

Title	Member
1. Chairperson	Minister, MMR
2. Project team	<u>Eritrean side</u> - Project Director/Coordinator: Director General of MMR - Project Manager: Director of Marine Resources Development Department - Project Management Unit (PMU) <u>Japanese side</u> - JICA Study Team - Representatives of JICA Kenya Office - Other personal concerned to be assigned by JICA, if necessary
3. Observer	- Representative of the Ministry of Foreign Affairs - Representative of the Ministry of National Development - Representative of the Ministry of Finance

	- Representative of the National Fisheries Corporation - Representative of the Northern Red Sea Regional Administration - Members of JICA Missions
4. Other members	Accepted by the Chairperson, if necessary.

1-5 Impact of the COVID-19 Pandemic on the Project

1-5-1 Circumstances

As is well known, the new coronavirus infection (COVID-19), which was confirmed in China at the end of 2019, rapidly spread to the whole world in the first half of 2020, and in March of the same year, it had a direct impact on each JICA project being conducted in each country. This is also the case in Eritrea, where the first confirmed case in the country was an Eritrean who returned from Norway on 21st March, 2020. In order to prevent the spread of the disease, the Eritrean government has closed airports and borders, and established guidelines that prohibit inter-regional travel, suspend public transportation, prohibit gatherings of more than 10 people, suspend school classes, suspend the operation of restaurants and bars, and restrict the return of Eritreans living abroad. This led to restrictions on the activities of MMR staff, and project's field activities were effectively suspended. In April 2021, after the first wave of the outbreak was over, the Eritrean government relaxed the infection control measures with school classes, regular flights, restaurants, and public transportation were resumed, effectively lifting the strong lockdown policy that had been in place for about a year.

In this context, as of March 2020, when COVID-19 was spreading around the world, the second field survey was underway by experts Mr. Morimitsu and Mr. Tsurusaki. However, due to the rapid spread of the infection in Europe and the United States in mid-March, they were urgently notified by JICA and had to return to Japan. In addition, experts Dr. Echigo and Dr. Ishikawa were scheduled to travel to Eritrea in late April, but this has also been postponed. The schedule for the second field survey and its changes are as follows.

Table 1-2 Travel plan and revised schedule for the second field survey in 2020

Name	Responsible field	Original travel plan	Revised schedule
TSURUSAKI Tsuneo	Fishing community development	21 st Feb – 31 st March (40 days)	21 st Feb – 23 rd Mar (32 days)
MORIMITSU	Fishing gear & method	28 th Feb – 12 th Apr	28 th Feb – 23 rd Mar

Ritsuo		(45 days)	(25 days)
ISHIKAWA Satoshi	Fisheries Development 2	27 th Apr – 8 th May (12 days)	Traveling postponement
ECHIGO Manabu	Team leader / Fisheries Development 1	27 th Apr – 26 th May (30 days)	Traveling postponement

Subsequently, COVID-19 continued to expand worldwide, and the field trip of each expert was tentatively postponed until around October 2020 that expected when the project would resume. In the meantime, the project was implemented without JICA Study Team visiting to Eritrea and their work reassigned to domestic operations for the time being, with surveys and guidance to be conducted remotely via phone and Internet. However, the infection situation continued to spread, and in late August, JICA requested a review of the work plan with the assumption that travel would resume in April 2021. For this reason, it was decided to suspend project activities for the time being after October 2020 in principle, and only periodically check the progress of local project activities. Since then, the dispatch of experts was postponed until the JICA decision on the resumption of travel was completed in October 2021, and travel resumed in November for the first time in about a year and a half.

1-5-2 Extending the project period

As a result of above, the project was virtually dormant for one year and seven months, from April 2020 to October 2021, with little progress made. The project implementation period is 2 years and 9 months, from October 2019 to June 2022, but it will be difficult to make up for this 1 year and 7 months delay in the remaining 8 months. In particular, the project plans to conduct pilot activities to verify the technology to be introduced in both the fishing season and the hot season, and there is not enough time to conduct activities in the fishing season as well as not being able to conduct activities in the hot season in the remaining period. In addition, activities to strengthen resilience against infectious diseases have been added as a countermeasure against COVID-19 disasters, so several months are needed to prepare for activities during the fishing season, including procurement of necessary equipment.

Therefore, it was considered desirable to extend the project period to October 2023 by about one and a half years, including the period required for pilot activities for the next peak fishing season (about six months from November 2022) and the subsequent reports compilation period. After obtaining agreement from JICA on this point, the proposed project period extension was approved at the 2nd JCC meeting as described in Chapter 2. In response, the Eritrean Minister of Finance and National Development, a signatory of the RD for the project implementation, issued a request

for extension of the project period on December 13, 2021, and the project cooperation period was extended until October 2023.

Table 1-3 Revising the project duration

Original duration	Revised duration
From October 2019 to June 2022 (31 months)	From October 2019 to October 2023 (48 months)

1-5-3 Changes in MMR's Project Implementation Structure

During the period of stagnation of the project activities mentioned above, there was a significant change in the project implementation structure on the MMR. As the lockdown policy in Eritrea was effectively lifted in April 2021 and the government and administration normalized their activities, a major reorganization took place within the MMR in October of the same year. The former three departments structure, Marine Research and Human Resources Development Department, Marine Resources Development Department, and Marine Resources Regulatory Service Department, has been abolished and reorganized into two departments.

Table 1-4 Reorganization of MMR in October 2021

Before	After
Marine Research and Human Resources Development Department	<i>Abolished</i>
Marine Resources Development Department	Marine Resources Development Department
Marine Resources Regulatory Service Department	Marine Resources Regulatory Service Department

As a result of this reorganization, the MMR organization chart was changed as shown in Figure 1-3.

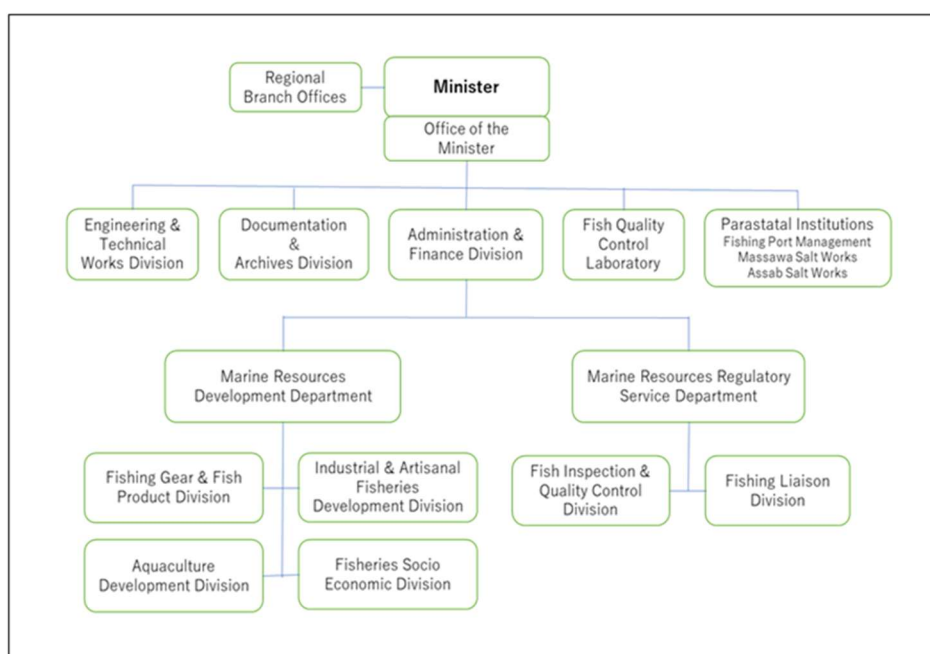


Figure 1-3 Organizational chart of MMR after the reorganization in October 2021

In line with this reorganization, MMR's project implementation structure was also changed by the order of the Minister of Marine Resources. Prior to the reorganization, Amb. Tewolde, Director General of the Marine Resources Development Department, was the Project Director (PD) and Mr. Johannes, Director (later Acting Director General) of the Marine Research and Human Resources Development Department was the Project Manager (PM). In their places, Mr. Adonay of the Projects and Commissions Coordination Office was appointed as PD and Mr. Idris of the Marine Resources Development Department as PM (Table 1-5).

Table 1-5 Changes in the project implementation structure of MMR

	Before	After
Project Director / Coordinator	Amb. Tewolde Woldemikael Director General, Marine Resources Development	Mr. Adonay Heruy Head of Projects and Commissions Coordination Office
Project Manager	Mr. Yohannes Teclemariam Director, Research Department	Mr. Idris Saleh Director General of Marine Resources Development Department

There was some confusion within the MMR at first because the original PD position was changed to PM and the PD position was filled by an administrative department rather than a technical

department, which was somewhat unusual, but the new PD, Mr. Adonay, is a practitioner who is familiar with both the fishery field and the administrative work within the MMR, and he is well qualified to manage the project. The new PM, Mr. Idris, is also a former vice president of the College of Marine Science and Technology, so he has a good academic background and is well qualified to take charge of the project.

The above changes to the MMR's project implementation structure were also agreed at the second JCC meeting on 1 December 2021.

1-5-4 Additional support for countermeasures against COVID-19

In June 2020, when the prolonged impact of COVID-19 was expected to be inevitable, JICA decided to review each project under implementation. In this context, it was decided to provide additional support for COVID-19 countermeasures, and the method and estimated project cost were discussed. In this project, it was discussed to implement additional activities and input equipment to strengthen the resilience of small-scale fishing communities against infectious diseases within the JICA Study Team.

As a result of the discussion, it was decided to (1) input additional fishing gears, (2) develop a cold chain infrastructure to maintain the freshness of the catches, (3) input additional fish processing equipment, (4) develop the Community Fisheries Centers (CFC) to serve as a base for the distribution and processing of fisheries products, and (5) implement additional technical guidance and pilot activities using these tools. The main additional materials and equipment are as follows.

Table 1-6 The main additional materials and equipment as countermeasure against COVID-19

Technical field	Materials and equipment	Inputs	
		Original plan	After addition
Fishing gears and methods	Materials of pound nets	1 set	2 sets
	Drift gillnet	1 set	10 sets
	Surrounding gillnet	1 set	5 sets
	Electric net hauler	—	3 sets
Fishing Community Development	Soler power ice making machine	—	1 set
	Soler power deep freezer	—	4 sets
	Bone meet separator	—	2
	PC projector	—	1
	Community Fisheries Center	—	2

1-5-5 Resuming visit of JICA Study Team to Eritrea

As mentioned above, the lockdown of Eritrea was lifted in April 2021 and MMR operations gradually resumed. Also, as the number of infected people decreased worldwide from May to June 2021, JICA's procedures for resuming travel became more intensive. Although it took some time to conduct the safety confirmation survey in Eritrea because no JICA office or branch office had been established there, JICA's approval for the resumption of travel was completed on 28th October, and the third visiting of JICA Study Team was conducted by Dr. Echigo, Mr. Morimitsu and Mr. Tsurusaki from 20th November (Table 1-6). It had been a year and seven months since the emergency return to Japan in March 2020, and this was the first trip to Eritrea since then.

Table 1-7 Travel schedule of third visiting of JICA Study Team

	Travel period
ECHIGO Manabu	20 th Nov – 12 th Dec 2021 (23days)
MORIMITSU Ritsuo	20 th Nov – 26 th Dec 2021 (37days)
TURUSAKI Tsuneo	20 th Nov – 26 th Dec 2021 (37days)

As a result of the safety confirmation survey conducted by JICA Kenya Office, all the project sites including Asmara, Massawa, Hirgigo, Zula and Dharak Islands were approved as the scope of activities of JICA Study Team.

Chapter 2: Outline of the Fisheries in Eritrea

2-1 Outline of Fisheries

2-1-1 Fishery Structure and Catch Trends

The Eritrean fishing industry consists of four levels; 1) Industrial fishery, 2) Semi-industrial fishery, 3) Artisanal fishery, and 4) Subsistence fishery/Foot fishery¹. 1) uses the large bottom trawler operated by the National Fisheries Corporation (NFC)² and the Egyptian-flagged large bottom trawler licensed by MMR based on the catch quota set by MMR. 2) refers to the small bottom trawl-net and longline (tuna longline/bottom longline) fisheries operated by 18-meter class FRP vessels. 3) refers to gillnet fishing (driftnets and surrounding-gillnets) and handline fishing by ordinary fishers using small wooden boats of mainly traditional types less than 18 meters in length. 4) is a very small-scale fishery that very few to use fishing boats, and refers to gillnet fishing on foot and handline fishing with simple floating gear. Of these, catch statistics (landing amounts) have been recorded for fisheries 1) through 3) only, and the actual status of catches for subsistence fisheries has not been ascertained.

Figure 2-1 shows the overall catch in Eritrea according to FAO statistics (FishStat). The same amount is reported in 2013 and beyond in this figure, so it is unlikely to be a true representation of the catch situation. It seems that the catch increased rapidly after the war of independence from Ethiopia, peaked in 2000, showed a downward trend until around 2008, then recovered slightly, and has been hovering around 4000 tons in recent years.

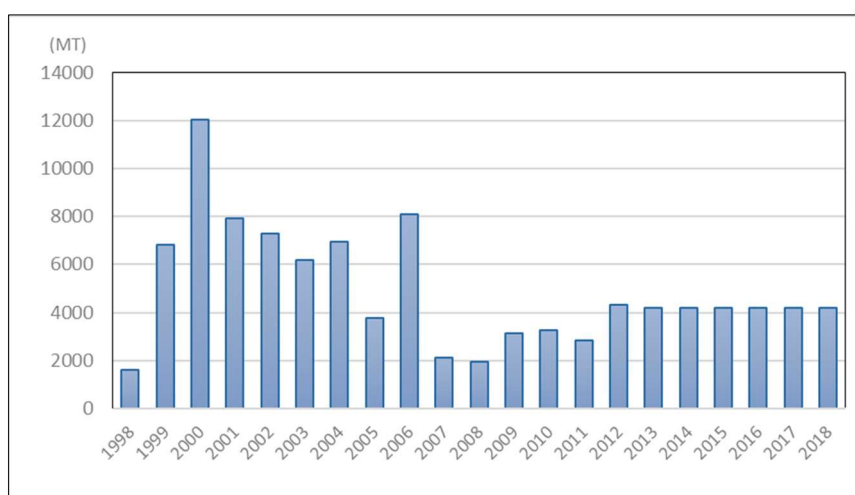


Figure 2-1 Eritrea's total fish catch (1998-2018) (Source: FAO, FishStat)

¹ In some cases, inland fisheries and aquaculture are added to these, but it is believed that there is little or no actual operation at present.

² There are about 10 large trawlers operated by the NFC, but they are not currently in operation.

Looking at the breakdown of catches by species in 2018 (Figure 2-2), lizardfishes were by far the largest with 55% of the catches, followed by threadfin breams fishes with 17%, but both species are thought to be caught by purse seines due to the characteristics of the resource (72% of the total for both species), suggesting that the proportion of catches by industry-type fisheries is very high. In addition, the third largest catch of clupeoids (7.2%) is also thought to come from Egyptian fishing vessels, which alone account for nearly 80% of the total catch. Almost all of the catch by Egyptian fishing boats is landed in Egypt, and only Eritrean observers on board the boats keep records of the catch. In other words, about 80% of the fisheries products caught in Eritrea's territorial waters and EEZ are not distributed and consumed within Eritrea. A small percentage of the catch is seemed to be from semi-industrial and artisanal fisheries, such as Spanish mackerel (2.2%), queen fish (1.3%), sea-catfishes (2.7%), silver grunt (2.1%), tuna-like fishes (2.9%), and groupers/seabasses (1.2%).

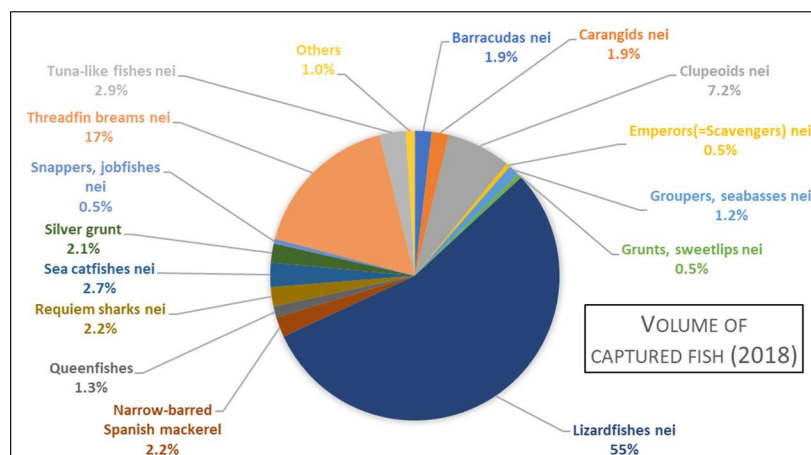


Figure 2-2 Eritrea's total fish catch by species (2018) (Source: FAO, FsihStat)

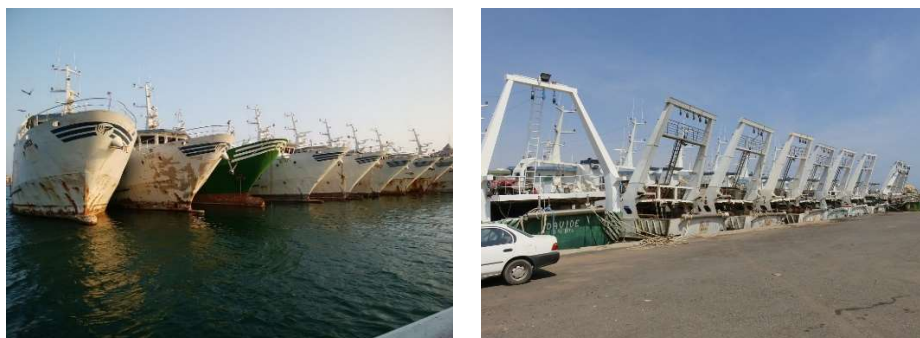


Figure 2-3 Large-scale bottom trawler owned by NFC

2-1-2 Artisanal Fisheries

The mainstay of the Eritrean coastal fishery is the artisanal fishery. Artisanal fishery is operated with small fishing boat which requires registering by the government and obtain an operating license. There are two types of fishing boats, the Huri with outboard engines and the Sambuk with inboard engines (Figure 2-4), and in recent years a new category called the "Fiber grass boat" made of FRP has been added. The size of fishing boats is mainly 10 to 13 meters in length.



Figure 2-4 Artisanal fishing boats (left: Huri, right: Sambuk)

The number of artisanal fishers in each zoba/region is shown in Table 2-1. The sub-zobas with large number of fishers are Assab, Ara'eta, Massawa, and Ghela'elo where are also largely populated sub-zobas.

Table 2-1 Number of artisanal fishers by zoba

Zoba/Region	Sub-zoba	population	Number of fishers
Northern Red Sea	Massawa	38,802	540
	Dahlak	2,725	299
	Foro	5,311	80
	Ghela'elo	8,286	426
Southern Red Sea	Assab	29,712	1,050
	Maekel SRS	3,175	195
	Ara'eta	5,262	683
Total		95,754	3,273

(Source: JICA Report, August 2018)

On the other hand, according to data from the MMR Northern Red Sea Regional Office, the number of registered fishing vessels operating within the region's jurisdiction and their catches (Table 2-2) both show that Dahlak is the most prolific. Dahlak is an archipelagic region that

stretches off the coast of Massawa, and can be seen as an area with a major home place for artisanal fisheries. Dahlak fishing boats operate in a cycle: fishing in the islands area, landing in Massawa, and returning to the islands with purchased subsistence goods and water in Massawa. In addition, the maintenance of fishing boats and the preparation of fuel, ice, and food necessary for operations are all done in Massawa, so the base of fishing operations is in Massawa apart from the islands that is the base of life for fishers. In many cases, fishers from other regions board in the vessels as crews, and these fishers were distributed in areas with large population.

Table 2-2 Number of operating fishing vessels and catches by sub-zoba (2016)

Sub-zone	Huri		Sambuk		FRP boat		Total	
	Number of registered	Catch (ton)	Number of registered	Catch (ton)	Number of registered	Catch (ton)	Number of registered	Catch (ton)
Massawa	19	51.3	15	97.4	1	0.05	35	148.8
Dahlak	78	267.5	5	28.1	4	13.6	87	309.3
Foro	0	0	1	6.5	0	0	1	6.5
Ghela'elo	16	26.7	1	0.2	0	0	17	27.0
Tio	0	0	6	12.3	0	0	6	12.3
Total	113	345.6	28	144.8	5	13.6	146	504.1

(Source: MMR Northern Red Sea Regional Office data)

Figure 2-5 shows the changes in catches by artisanal fisheries. According to this figure, there is a slightly different fluctuation from the changes in overall catches in Eritrea. The same trend of increase has been observed since 1993 when Eritrea became independent until 2000, but the catch in 2005 and 2006 was exceptionally low, and since 2009 (except for 2012), the catch has been gradually decreasing. Since the main targets of artisanal fisheries are pelagic fishes such as spanish mackerel and queenfish, and since the number of fishing vessels is limited, it is difficult to imagine that overfishing caused a decrease in the resource. So, there may have been some factors such as a decrease in the number of fishing vessels that caused a decrease in fishing effort.

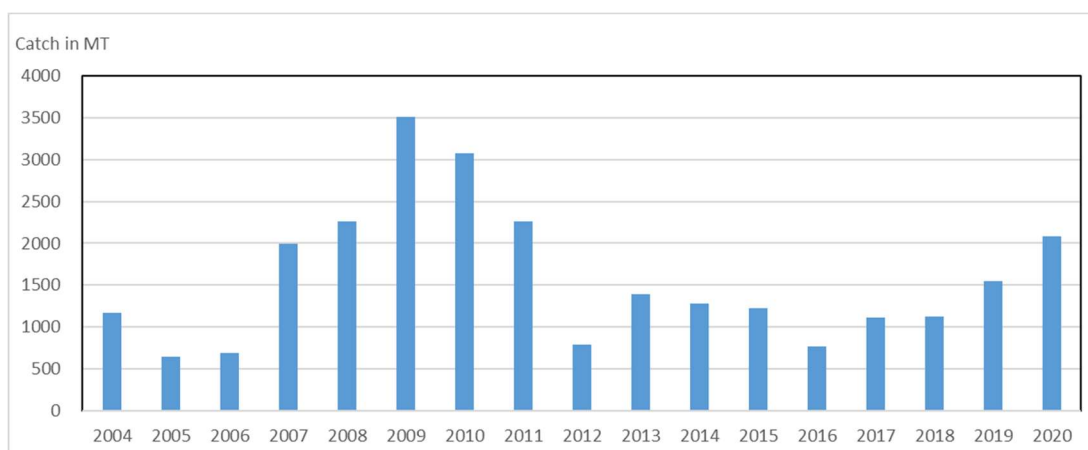


Figure 2-5 Catch landings of artisanal fisheries in the Eritrean Red Sea (2004-2020)

(Source: National Fisheries Corporation)

2-1-3 Subsistence Fishery/Foot Fishery

The subsistence fishery in Eritrea consists of two fishing methods; gillnet fishing, which targets mainly mullet and is done on foot on the beach in front of a village without fishing boats, and hand fishing which is mainly for indian mackerel and silver grunt using floating gear that is made of polystyrene wrapped in nylon bags and reinforced with ropes (Figure 2-6). It is not a fishing boat fishery, but the fishery based on the local community. Although this fishery is mainly for self-consumption and consumption within the village, in some places close to Massawa, the catches are transported and sold in a free market in Massawa. It is an important source of income for the fishers. Unlike the artisanal fishery, there is no basic information on the number of fishers, catches, and other aspects of the fishery structure. Therefore, detailed information was collected in the baseline survey conducted at the beginning of this project. Regarding to the details of the subsistent fishery structure, refer to "Chapter 3. Baseline Survey".

In the Hirgigo village (population 2000 and 466 households), a typical fishing village near Massawa, there are about 50 subsistent fishers, 16 of whom belong to the Hirgigo fishery cooperative. In the village of Zula (population 3250 and 650 households), about 56 km south of Massawa, there are about 50 subsistent fishers, 40 of whom belong to the Zula fishery cooperative. In both cases, many fishers operate handline fishing and only a few have gillnets. The catches mainly include mullet and milkfish in gillnets, and Indian mackerel, silver grunt, small size horse mackerels, and snapper in handline fishing. The fisheries infrastructure, such as landing sites and processing facilities, has not yet been developed.



Figure 2-6: Fishing gears of subsistent fishery (left: mullet gillnets, middle: floating gear for handline, right: handline)

2-1-4 Fishing Season

Along the Red Sea coast of Eritrea, the temperature rises during the summer months from June to September which is called as the hot season. During the hot season, the surface water temperature of the Red Sea rises, making it unsuitable for many fish species, and the intense heat makes the daytime working environment extremely poor. Conversely, the good fishing season is from October to May, especially during the rainy season from January to April. Figure 2-7 shows the monthly changes of sea surface water temperature in the Red Sea. This shows that the seawater temperature around Massawa and Dahlak rises the most from August to October at 32°C. It should also be noted that the water temperature is higher until October, which is longer than what is generally considered to be the hot season.

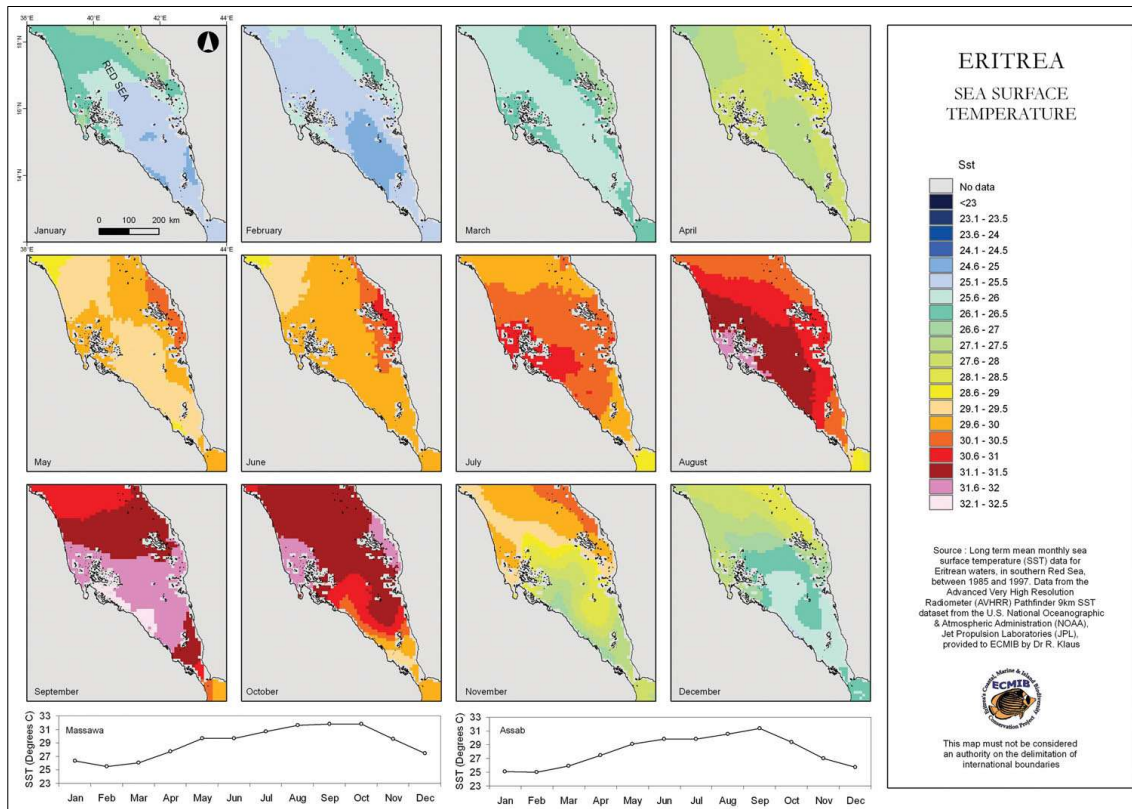


Figure 2-7 Seasonal changes in sea surface water temperature in the Red Sea

(Source : Edited by Dr. Alain Jeudy de Grissac and Kaleab Negussie, Eritrea's Coastal Marine and Island Biodiversity Conservation Project, Printed in December 2007)

As will be described in detail in the next chapter, the fishing method of the artisanal fishery is surface driftnets operated during the good fishing season, and mid-water surrounding gillnets operated at night using a generator and fish aggregating lights during the hot season. The fishers also operate handline fishing for bottom fishes, but there seems to be little daytime fishing during the hot season. The number of fishing boats in operation decreases during the hot season, and catches also decrease significantly during this time.

The subsistent fishery also becomes low during the hot season. In coastal fishing villages near Massawa such as Hirgigo and Zula, many women, children, and elderly people leave their villages in this season, and fishing operations become inactive. During the peak fishing season, the gillnets fishing is possible relatively close to the shore, but in hot season, handline fishing is to be main method at slightly deeper water.

2-2 Fisheries Administration and Policy

2-2-1 Ministry of Marine Resources

The Ministry of Marine Resources (MMR) is in charge of fisheries administration in Eritrea, with the main office in Massawa and a branch office in Asmara (the main office was moved to the former campus of the College of Marine Science and Technology in Massawa in 2019). The organization is divided into; 1) the Marine Resources Development Department, and 2) the Marine Resources Regulatory Service Department, as well as the Regional Branch Offices which consist of Northern Red Sea Regional Office and the Southern Red Sea Regional Office as regional branches with jurisdiction over coastal fisheries. The regional offices include the Fisheries Development and Extension Unit, the Loan Support Unit, and the Inspection and Licensing Unit, which are responsible for various administrative and service tasks for artisanal and subsistent fisheries. The number of MMR staff is 534 (2018), of which 220 are assigned to the two departments of the policy implementation units, and 120 to the regional offices. The MMR organizational chart is shown in Figure 2-8.

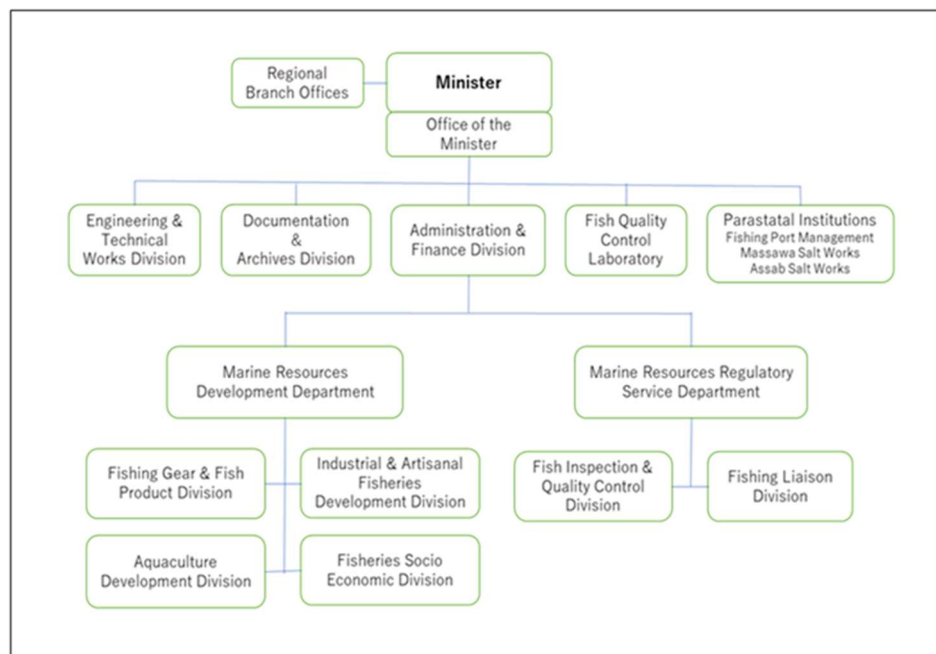


Figure 2-8 Organization chart of the Ministry of Marine Resources, 2021 (Source: MMR)

Of these, the main sections related to the project are Fishing Gear and Fish Product Division of Marine Resources Development Department, Fish Inspection and Quality Control Division of Marine Resources Regulatory Service Department, and the Northern Red Sea Regional Office.

In addition, MMR's Fisheries Training Center, which was established in Hirgigo village to

improve fishery-related skills of local fishers, was transferred to the facilities of the former College of Marine Science and Technology when the main office was relocated to the facility in 2019. There various training and educational equipment originally owned by the college are being used to improve the capacity of fishery technology for fishers.

2-2-2 Fisheries Development Policy

The Government of Eritrea has formulated a comprehensive development plan (master plan) for the entire fisheries sector, the "Ministry of Marine Resources Strategic Plan 2018-2023" (hereinafter referred to as the "MMR Strategic Plan"), which sets the following three specific goals under the "Ensure the sustainable use of marine resources" as the Mission.

- 1) Endeavor for the natural marine resources to play a role in the national socioeconomic development.
- 2) To contribute to alleviation of poverty and achieve national food security.
- 3) Improve the income and livelihood of the coastal and island communities.
- 4) Ensure sustainable development to protect and conserve the resources and ecosystem.

The strategy and approach to coastal fisheries development to be undertaken in this project should also be in line with these four goals and objectives. MMR Strategic Plan also sets objectives/activities as policy implementation targets for each MMR department as follows. However, the following stations are pre-2020 structures.

< Marine Resources Development Department >

- To improve and strengthen fisheries activities.
- To increase and diversify fisheries production.
- To increase fish supply and fish consumption in the national food security.
- To improve the life standards of fishery community.

< Marine Research and Human Resources Development Department >

- To make concrete studies for the sustainable management of marine resource.
- To make studies on sustainable and community based aquaculture.
- To increase the uses of mangroves and other trees based on studies.
- To increase the capacity of human resource of the ministry.
- Rehabilitation and improving of Hirgigo training center.

< Marine Resources Regulatory Services Department >

- Improve fish quality and get international acceptance.
- Manage and monitor marine resources.

< Laboratory Unit >

- To improve the quality of laboratory service to international standard.
- Diversify its activities to cover microbiological and chemical tests.

< Fish Landing Port Administration >

- Strengthen the service of fish landing port.
- To keep the landing port to international standard.

Chapter 3: Baseline Survey

This section summarizes the methodology and results of the baseline survey. For details, please refer to the baseline survey report. The baseline survey was conducted by each of the project implementation units on; 1) fishery community and subsistent fishery, 2) fishery product distribution and consumption, and 3) fishing gear and fishing methods, to collect information necessary to analyze issues and constraints at different levels of fisheries class and distribution, and to plan immediate pilot activities. The following is a report for each survey. See Annex 1 “Final report of the baseline survey” for details of the baseline survey.

3-1 Fishing Communities

3-1-1 Method of the Survey

The fishing communities surveyed were the communities around Massawa; Hirgigo village (Massawa sub-Zoba), Zula village (Foro sub-Zoba), and Dehil Island (Dahlak sub-Zoba). The survey was conducted by the Fisheries Community Development PIU, together with a team of JICA experts, by visiting each fishing village twice for six days in October-November 2019 to interview community leaders, government officials, and fishers.

Table 3-1 Survey sites and schedule

Baseline survey site	Date of survey
Hirgigo village (Massawa sub-Zoba)	Oct. 29, Nov. 5, 2019
Zula village (Foro sub-Zoba)	Oct. 28, Nov. 6, 2019
Dehil island (Dahlak sub-Zoba)	Oct. 31, Nov. 8, 2019

The interview survey items were set separately for the following categories; overview of the target fishing village, status of fisher's organization, and status of each fisher and fishing household (Table 3-2).

Table 3-2 Survey items for fishing communities and subsistence fisheries

Survey category	Question item	
Outline of the target fishing village	Community overview	Population, number of households, main source of income, existence of fish market, etc.
	Overview of the fishery	Number of fishers, number of fishing vessels, fishing methods, fishing grounds, fishing season, fishery-related infrastructure, traditional management framework, etc.
Status of fishers' organizations	Overview of associations and cooperatives	Name of the fishers' organization, representative, number of participants, number of fishing vessels, role and activities of the organization, income and expenditure, availability of subsidies, etc.

	Implementation status of fisheries promotion activities	Items to be implemented, implementation system, existence of government/partner support and dissemination activities, progress, etc.
	Problems and needs	Availability of potential resources, problems and needs in terms of fishing gears and methods, distribution, sales, processing of fisheries products, etc.
Status of each fishers and fishing households	Actual situation of fishery	Fisheries classification, operation system by season, target fish species, main fishing grounds, fishing income and expenditure, etc.
	Status of fishing households	Household size, household income and expenditure, problems in household finances, income opportunities, fish consumption, role of women, customs related to fishing and fishery products, etc.
	Problems and needs	Availability of potential resources, problems and needs in fishing gears and methods, distribution, sales, and processing of fishery products, potential of women and youth, etc.

3-1-2 Results of the Survey

(1) Hirgigo Village

The village of Hirgigo has a population of about 2,000 people and 466 households. The main sources of income are agriculture and fishing (artisanal fishing) using fishing boats based in Massawa port. Fisheries infrastructure such as markets and landing facilities have not been developed. The fisheries operated in the village are handline fishing for Indian mackerel and other small fishes and small gillnet fishing for mainly mullet in the shallow waters of the foreshore, and both of which are classified as the subsistence fishery. No one owns a fishing boat, but they fish by hand using floating gear made of polystyrene boards wrapped in bags and reinforced with ropes. During the good fishing season, the fishers focus on small fish such as Indian mackerel, scads, and small snapper in shallow fishing grounds, while during the hot season, when the sea surface water temperature is high, they target larger fish such as trevallies, groupers, and barracuda in slightly deeper fishing grounds. The gillnet fishing is conducted throughout the year within the depth range of the standing water, using small mesh nets during the hot season (June to September) and slightly larger mesh nets during the peak fishing season (October to May).

There are about 50 people engaged in the subsistence fishing, 16 of whom belong to the Hirgigo Fishery Cooperative. Most of them are mainly engaged in handline fishing, and only a few own gillnet. The cooperative is planning to develop an operation and activity plan to receive financial and technical support from MMR, but no progress has been made and there is no prospect of receiving such support. The main problems identified are difficulty in obtaining fishing gear and materials, inadequate facilities for fish



Fig 3-1 View of Hirgigo village

processing to keep quality, and difficulty in accessing markets. There is also a women's association for repairing and making fishing nets in Hirgigo, which has 40 members who have been trained by the MMR to repair and make fishing nets. At present, however, there is almost no activity.

Most of the catches are sold at the market in Massawa, where the fish price is estimated to be 20-30 ERN/kg and the fishing income is about 6,000-30,000 ERN/year. On the other hand, fishing expenditure, including transportation cost to the market, costs 4,000 to 8,500 ERN, thus the profit is very small. In general, household expenditure is estimated to be 1,500-3,000 ERN per month, and most of the household depends on non-fishing income such as charcoal production, agriculture, and livestock, etc.

(2) Zula Village

Zula village is in Foro sub-Zoba, Northern Red Sea Zoba, about 56 km south of Massawa. It is a village of 650 households with a population of 3,250 whose main livings are fisheries, agriculture, and livestock farming. The fisheries structure is similar to that of Hirgigo village, and the fishery operated in the village is the subsistence fishing of handline and small gillnets, without the use of fishing boats. There are about 50 subsistence fishers, and fisheries infrastructure such as landing sites and processing facilities are not yet developed, and there is no customary fisheries management system.



Figure 3-2 Zula Village

A Zula fishery cooperative has been organized with 40 subsistence fishers, but no concrete activities have been carried out as a cooperative yet, and no financial or technical support has been provided by the MMR because no clear plan has been formulated. As for the problems related to the fishery production and sales, it was pointed out that there is a shortage of fishing gear and materials, ice is not available to maintain the quality of the catches, and there is not much demand for fishery products in the village. So, they want to sell their catches in Foro, the center of the region, but there are limited means of transportation and sales. In addition, a cooperative for the repair and manufacture of fishing nets in Zula village has been established for women, as in the village of Hirgigo, but many members have not had the opportunity to receive technical training.

The catches are sold in the village and in Foro. Fishing income is estimated to be about 7,000-27,000 ERN/year, while fishing expenditure is estimated to average 5,200 ERN/year, making fishing income negligible. Household expenditures range from 1,500 to 3,000 ERN per month,

and it is still difficult to support a household with only fishing income.

(3) Dehil Island

Dehil Island is one of the few inhabited islands in the Dahlak archipelago, located about 32 km off the coast of Massawa, with a population of about 600 people and 90 households. The island's main income source is fishing, unlike the two villages mentioned above, and it has a fishing structure based mainly on the artisanal fishing with fishing boats. After landing in Massawa, the fishers load ice, drinking water, food, and daily necessities for consumption in the island onto their boats, and return to the island where they drop off their daily necessities before heading out to sea. Most of the fishing boats are Huri type. The main fishing methods are driftnets, surrounding gillnets with fish aggregating lights, and handline fishing, as well as the traditional



Fig 3-3 Dehil Island

trolling line “Majruur”. The main fishing methods during the peak fishing season (October to May) are driftnets and handline fishing, and surrounding gillnets during the hot season (June to September). The main target fish species are Spanish mackerel, queenfish, barracuda, trevallies, sharks, snapper, and groupers. The fishing grounds are widely located in the waters around the Dahlak Islands, but during the hot season, fishers avoid traveling long distances and concentrate around Dehil Island.

The artisanal fishers and boats belong to the fishery cooperative in Massawa, while the Dehil Fishery Cooperative (15 members) is organized for the subsistence fishing for the islanders and the Dehil Shellfish Collecting Cooperative for women. The fishery cooperatives are expected to be recipients of government loan support to alleviate shortages of fishing gears and materials and to improve access to markets. However, these cooperatives have been in existence for a short period of time, and at the time of the survey, no concrete activities had been undertaken.

The fishing boat of artisanal fishery had 6-24 fishing trips per year (average 12.5 trips), 5-15 days of operation per trip, and monthly per capita income of 400-31,500 ERN. Fishing household income, including non-fishing income, ranges from 1,100 to 15,000 ERN per month, and household expenditure ranges from 1,200 to 11,000 ERN per month, with some households having negative household income. There is no drinking water on the island, and the environment is too harsh for agriculture and livestock farming, so little subsistence production is possible.

3-1-3 Problems Identified

Based on the results of the above study, the following main issues were identified regarding the fishing community.

1) Marketing and distribution

In Hirgigo, there are many fishers and most of the catches are sold in the market in Massawa, but the high transportation cost is a cause of downward pressure on the fishery income. Efforts to reduce transportation costs or increase the value added to raise the price of fish for sale are needed. On the other hand, most of the Zula fishes are sold and consumed within the village due to the limited catches. But since the village is located next to Foro, which is expected to have a large demand, the village envisages to increase its catches and sales volume in the future. However, they are unable to sell their catches frequently due to limited means of transportation, and they are unable to keep their catches for long period of time due to the lack of storage facilities and means of keeping them cool in the village. In addition, there is no market for fishery products in Foro, so there are limited opportunities to sell them.

2) Fishing gears and methods of subsistence fishery

The gears used for the subsistence fishery in Hirgigo and Zula are low quality handline and gillnets only. And there are no fishing boats that only floating gears made of polystyrene, thus the fishing efficiency is very low considering the quality of gears. The target species are all small-size pelagic fish such as mullet, Indian mackerel, scad and small-size Spanish mackerel, which are thought to have large amounts of resources. So, there is a great room for resource development. Current fishing gears are neither qualitatively nor quantitatively sufficient for the development of this resource. It is necessary to introduce fishing gears and methods with high catch efficiency to promote the fishery development.

3) Fishing gears and methods of artisanal fishery

The Dehil Island's fishing structure is mainly based on the artisanal fishery, and most of the fishing boats are based in the Massawa Port. Since there is not enough drinking water in the island and the food production is almost non-existent, most of the residents depend on cash income from fishing for their livelihood, but due to high operation costs, the fishing income is not plenty. In order to solve this, it is necessary to increase the fish catches per operation. But fishers pointed out problems, such as "Unsuitable fabric and design of gillnets," "Lack of fishing gear to develop resources that have not been used much," and "Lack of fishing equipment such as fish finders and GPS." These issues will be discussed separately in Section 3-3 Fishing Gears and Methods.

4) Source of income for women

In each village of Hirgigo and Zula, the fishing net mending and making cooperative has been organized to improve women's income, but none of them are functioning. However, there is a high need for women to improve their income, and it is clear that there is a need to develop any kind of income sources.

3-2 Distribution and Consumption of Fisheries Products

3-2-1 Method of the Survey

The survey on the distribution and consumption of fisheries products was conducted in Massawa, Asmara, and Mendefera through individual interviews. In Massawa and Asmara, both sellers and consumer at markets and fish stores were interviewed, and in Mendefera, door-to-door visits were made to ordinary households to learn about the actual state of consumption of fisheries products. The following table outlines the survey methodology.

Table 3-3 Summary of the survey on the distribution and consumption of fisheries products

Site		Period	Interviewee	
			Seller	Consumers
Massawa	• Edaga open fish market • 2 retail shops in Sigalet	November 11-12, 2019	12	12
Asmara	• Markato fish market (3 shops) • A shop at EMPC	March 14, 2020	4	20
Mendefera	Ordinary household (10)	March 15, 2020	—	10

The survey items related to distribution of sellers include fish species, sales volume, frequency, production area, transportation method, popular fish species, sales problems, restrictions, etc. The items related to actual consumption for consumers include household composition, income, expenditure, fish species purchased, quantity purchased, processing method, cooking method, frequency of eating fish, satisfaction with price, quality, etc.

3-2-2 Results of the Survey

(1) Structure of Fisheries Products Distribution

Major distribution flows of fisheries products in Eritrea are; 1) landing at Massawa and each fishing village, 2) sales and consumption in Massawa, and 3) transportation and sales to Asmara and regional cities. Figure 3-4 shows an overview of the actual distribution of fisheries products in the target areas of the survey.

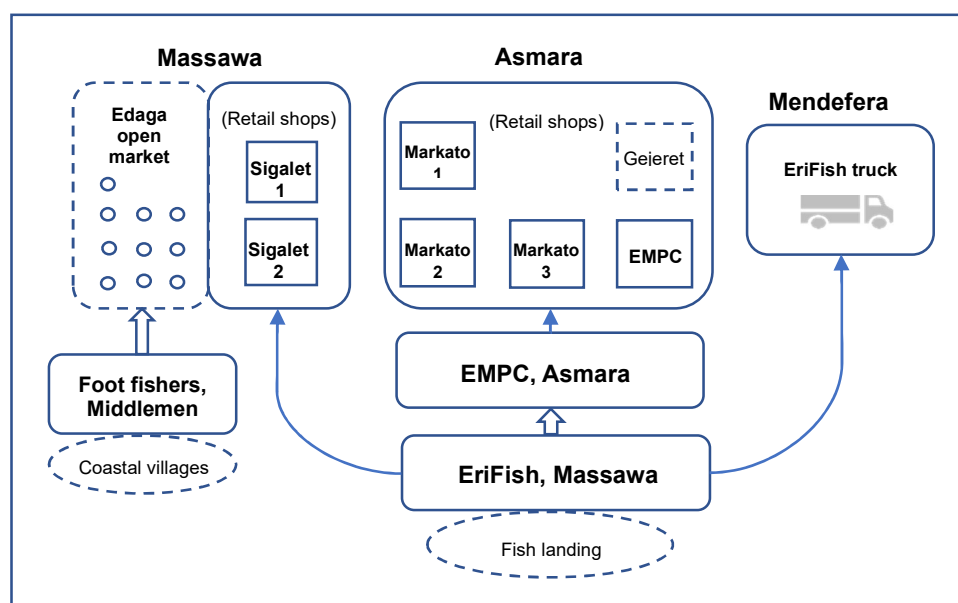


Fig 3-4 Outline of fisheries products distribution in the survey area

(2) Distribution and Consumption of Fisheries Products in Massawa

In Massawa, the Edaga open fish market and two fish shops in the Sigalet district are the only places where fishery products are sold. Each of these is described below.

< Edaga open fish market >

The Edaga open fish market is a place where subsistence fishers and middlemen freely sell their fishes to consumers without any special facilities, management system, or government control. Small fishes caught by subsistence fishers and artisanal fishers of which EriFish refuses to buy are sold here as fresh fishes. The selling price is 40-50 ERN/kg which varies depending on the seller and the species of fish.



Fig 3-5 Edaga open market

The main species are mullet, grouper, snappers, silver grunt, small barracuda, kawa-kawa, trevallies, Spanish mackerel, Arabian flower crab, etc. Subsistence fishers in Massawa and its suburbs often transport fishes by three-wheeled bicycles, while fishes from long distances sell to the middlemen who are using pickup trucks equipped with large FRP refrigerated containers. The amounts of fishes sold varied depending on the seller, but from 10 to 200 kg/day on the day of the survey, and about 470 kg/day in the entire Edaga market.

According to the interview with consumers who purchase fish in Edaga, most of them purchase about 1 to 2 kg of fish, and 50% of them said they eat fish every day, while 80% of them said they

do not have the habit of eating fish at restaurants, indicating that Edaga market plays a major role in the supply of fish products to general consumers. In all households, mothers or daughters are responsible for cooking, and common cooking methods are frying, zigney, and soup. Most of the buyers were satisfied with the quantity and quality of fishes, while almost half were dissatisfied with the high prices. In other words, the potential demand for fishery products in Massawa is high, and if the prices could be kept down, consumption would increase.

The following problems were identified in the Edaga market; 1) lack of sanitation facilities for washing the fish to be sold and disposal of processed residues, 2) lack of facilities to maintain the quality such as roof for sales area, cooler box, refrigerator, and freezer, 3) lack of means and funds for transportation such as bicycle and automobile (or their fuel), and 4) shortage of fishes during the hot season, causing the fish prices to soar.

< Sigalet fish shops >

The two fish shops in Sigalet buy fishes from EriFish, the fishes are landed from artisanal fishing boats at the EriFish landing site of the Massawa Fishing Port managed by EriFish, and sell it to consumers in Massawa with the government permission. Two small shop buildings built in 1993 with UNICEF assistance provide space for processing and selling. The main products traded are large pelagic fishes, some of which are filleted or frozen for sale. They pay an annual tax of 5,000 to



Fig 3-6 Sigalet fresh fish shop

9,000 ERN to the Massawa City Administration and 5% of sales to EriFish. Although only two customers were interviewed in the day of the survey; both purchased 2.5kg of fish which was more than the Edaga market, and the species of fishes were cobia and Spanish mackerel with a unit price of 63 ERN which was higher than the Edaga market. Customers purchased fishes have them processed into fillets in the shops, and their cooking methods were the same as those in Edaga: frying, soup, and zigney. Both respondents were satisfied with the freshness and quality of the fish they purchased, but they were dissatisfied with the price and the lack of supply of Spanish mackerel, the most popular fish in Eritrea. Other problems/needs mentioned were as follows.

- 1) Aging of facilities.
- 2) Lack of materials for processing (scales, cutting boards, knives, gloves, sanitary caps, etc.).
- 3) Lack of processing and cooking skills for quality control and value addition.

(3) Distribution and Consumption of Fisheries products in Asmara

In the capital city of Asmara, there are three major markets and sales facilities for fresh fishes; the Markato Fish Market in the city center, the retail shop in the fish processing plant of the Eritrean Marine Products Company (EMPC), and the Gejeret Fish Market. The survey was conducted at two of these locations, such as the best known Markato Fish Market and the retail shop in EMPC. There are three retail shops that operate in Markato Fish Market and one in EMPC, four shops were included in the survey. The fresh fishes sold in Asmara are large pelagic fish and bottom fish purchased from fishers by EriFish at the fishing port in Massawa and supplied through EMPC. Currently, one of EMPC's refrigerated trucks transports the fish between Massawa and Asmara every



Fig3-7 EMPC fish processing plant

other week, and EMPC sells the fish at its retail shop in its premises and also distributes the fish to retailers in Asmara, including the Markato Fish Market. Fish species handled include Spanish mackerel, queenfish, sharks, skipjack and tunas, barracuda, groupers, snappers, emperors, catfish, mullet, milkfish, and trevallies. The amounts of fishes sold per shop per day was estimated to be between 200 and 4,000kg. However, fish arrives from Massawa every other week (if it arrives every day for a week, it does not arrive the following week). Thus, the Markato Fish Market is open almost every other week depending on the fish stock supplied by EMPC, and business is suspended when fishes do not arrive and the fishes in stock are sold out. In addition, fresh fish sellers in Markato pointed out problems such as aging market facilities, malfunctioning wastewater treatment systems, lack of water, high permit and facility rental fees, lack of refrigerators, cooler boxes, fish processing equipment, inadequate supply of fish, etc. While EMPC officials pointed out problems such as malfunctioning frozen warehouses and the need for fairer and lower fish pricing.

According to interviews with consumers at the Markato Fish Market and EMPC, their purchased fishes are catfish, skipjack and tunas, queenfish, Spanish mackerel, grouper, barracuda, etc., and per capita purchases range from 0.5 to 7 kg per time, or an average of 2.86kg per month. In terms of cooking methods, fried foods such as fries and cutlets were most frequent, and two respondents also reported that they process salt-dried fish at home. The frequency of eating fish was highest with 55% eating fish 1-3 times a month, 15% eating 8-12 times a month (2-3 times a week), 10% eating every day, and 20% eating occasionally, indicating that many of those who buy fresh fish consume it at a high frequency. While 70% of buyers were satisfied with the quality of the fish, more than 80% were dissatisfied with the price and quantity of supply. This can be attributed to the fact that although the sales volume of catfish is high these days, the need for large pelagic fish



Fig 3-8 Markato fish market

such as Spanish mackerel and queenfish which many people prefer, is not being met, the supply of fresh fish that is not frozen is limited, and the need for small-lot purchases through filleting is not being met. A supplementary interview with people in the vicinity of the market who do not purchase fish suggested that the high price of fresh fish, lack of supply of fish species that meet their tastes, and concerns about sanitation in the market may be restraining them from purchasing fresh fish. It

was also suggested that limited knowledge of how to process and prepare fish is also an issue for consumers.

(4) Consumption of Fisheries Products in Mendefera

Mendefera is the capital of Debub Zoba, located 60km south of Asmara. The MMR staff tried to conducted the survey because there was a fish market established by the city of Mendefera, but the market is currently closed and only fish supplied by EriFish from Massawa by refrigerated truck is sold irregularly. Therefore, the survey was conducted through the individual visiting interview with ordinary households. As a result, there are only three species of fish consumed; Spanish mackerel, queenfish, and milkfish, which are very limited compared to Asmara. The main cooking method is fried fish such as fries and cutlets, and sometimes sandwiches and stews. No processing such as salt-dried products was done. The frequency of eating fish was clearly lower than in Asmara, with 30% eating fish eight times a month (twice a week), 20% eating fish once a month, and 50% eating fish four times a year or less. Residents' satisfaction with the supply of fishery products was also low, with almost all of them dissatisfied for the low supply and high prices, and half of them dissatisfied with the quality. The price of fish is the same as in Asmara, but consumers seem to feel that it is more expensive than in Asmara. Since they can't get fresh fish consistently, hotel and restaurant owners go out of their way to purchase fishes in Asmara, which are costly and prone to quality deterioration.

3-2-3 Problems Identified

In Massawa, the Massawa Fishing Port and surrounding fishing villages provide abundant and relatively inexpensive supply of fishery products, but the Edaga fish market, a key distribution point, lacks hygienic sales facilities and equipment for quality control. From the producer's point of view, the limited means for fishers transporting their catches to Edaga and their high cost are the problems. The fresh fish stores in Sigalet district were concerned about aging facilities, lack of equipment, and lack of processing technology to add value.

The Markato Fish Market in Asmara needed to improve its facilities and cold storage equipment. The fish diet was quite popular in Asmara, but the lack of supply and high prices are major issues. There is a high demand for large pelagic fishes such as Spanish mackerel and queenfish, which are favored by the citizens of Asmara, and by increasing the supply and lowering prices, consumption is expected to increase. It was suggested that further demand could be stimulated by providing training on cooking methods.

Mendefera is facing more serious supply shortage than Asmara. Only one EriFish refrigerated truck is responsible for the distribution of fishery products, and sales are infrequent. At the same time, consumers feel that the price of fresh fish is very expensive, and this is one of the major problems in the distribution of fishery products.

From the above, the problems related to the distribution and consumption of fishery products in the studied areas can be broadly classified as follows.

- 1) Inadequate hygiene and quality controls at Edaga open fish market in Massawa.
- 2) Transportation to the Edaga market is limited and costly.
- 3) Aging of the facilities and cold storage equipment at the Markato Fish Market in Asmara.
- 4) Inadequate supply and high prices of fishery products to Asmara and Mendefera.
- 5) Although the potential demand for fishery products is high in both cities, consumption cannot be increased due to insufficient supply and high prices.

3-3 Fishing Gears and Methods

3-3-1 Method of the Survey

Interviews on the gillnet fishing by artisanal fishery and bottom longline fishing by the semi-commercial fishery were conducted at the Massawa fishing port on November 4-8, 2019, and interviews on subsistence fishers were conducted also at the Massawa fishing port on November 12, 2019. The survey items are shown in Table 3-4.

Table 3-4 Interview items on fishing gears and methods

Target	Category	Interview item
Gillnet fishery (Artisanal fishery)	Fishery status	Fishing vessels, engines, equipment, fishing grounds, fishing season, target fish, sales and revenue, and expenses per voyage
	Cost and expenditure	Specifications of the fishing vessel, purchase price of the vessel and engine, borrowings, cost of fishing gear, useful life of the gear, cost of navigation/communication equipment, number of days per voyage, expenses per voyage, average catch and sales, profit sharing method
	Design of the	Gillnet type, length, weight, shrinkage ratio, floater and sinker type and

	gillnet	quantity, sinking force and buoyancy of fishing gear, etc.
	Problem and issue	Reasons for operating gillnet fishing, disputes, problems with fishing gear materials, other issues, solutions to problems and challenges
Bottom longline fishery (Semi-industrial fishery)	Fishery status	Fishing vessels, engines, equipment, fishing grounds, fishing season, target fish, sales and revenue, expenses per voyage, etc.
	Problem and issue	Reasons for engaging in bottom longline fishing, fishery-related disputes, problems with fishing gear materials, and other issues
Subsistence fishery	Fishery status	Fishing ground (sea area, depth, seabed quality), fishing season, target fish to be caught, specifications of fishing gear, operation hours and cycle, handling of fish after catch, landing site, fishing conditions
	Problem and issue	Reasons for subsistence fishing, disputes, problems with fishing gear materials, other issues, solutions to problems and challenges

3-3-2 Results of the Survey

(1) Gillnet Fishery (Artisanal Fishery)

Interviews were conducted with eight fishers from eight different fishing groups who engage in gillnet fishing. There are two types of gillnet fisheries; driftnets, which are mainly operated during the good fishing season, and surrounding gillnets, which are operated at night during the hot season using fish aggregating lights. The sea depth range of the former is about 10 to 20 meters, while the latter is about 20 to 40 meters. The fishing boats were 9 to 18 meters in length. Six of the eight boats were Huri equipped with 60 or 75 horsepower Yamaha outboard motors, and two were Sambuk equipped with 33 or 35 horsepower Yanmar inboard motors. The main catches were Spanish mackerel, skipjack and tunas, sharks, barracuda, and queenfish. There are also many snappers, emperor, and trevallies that are probably caught by the handline fishing method operated at the same time.

The fishing days per operation ranged from 7 to 18 days, and the cost of fuel ranged from 6,000 to 42,000 ERN, ice from 2,200 to 10,000 ERN, food and water from 3,000 to 8,000 ERN. The cost per operation including engine maintenance and others ranged from about 15,000 to 73,000 ERN (average 42,000 ERN). On the other hand, the income per operation was about 21,000-150,000 ERN (700-5,000kg of catches) during the peak fishing season and about 6,000-45,000 ERN (200-1,500kg) during the hot season, suggesting that there may be a deficit during the hot season. The material of the gill nets was nylon twisted yarn (PA multi), and the net length was estimated to be 160-190m for driftnets and 420m for surrounding gillnets as the survey results. However, qualities of the netting, floats and sinkers are poor, the life span is short, and the structure is inefficient. In particular, the gill nets that operate in the deep-water zone are connected vertically in three sections since there are few fish in the surface zone, therefore, the weight of the gear is unnecessary heavy and inefficient for operation.



Fig 3-9 Gillnets and landings of artisanal fishing boat

(2) Bottom Longline Fishery (Artisanal Fishery/Semi-industrial Fishery)

Some of the artisanal fishing boats based in Massawa sometimes operate the bottom longline fishing when small fishes are available as a bait. Although it is known to be cheaper and more efficient than gillnet fishing, it is not operated consistently due to the difficulty in obtaining the bait. National Fisheries Cooperation (NFC) operates the bottom longline fishery as the semi-industrial fishery using 18m class FRP fishing vessels and reel gear of tuna longline. The fishery operates year-round catching groupers, snappers, catfish, giant trevally, sharks, queenfish, and cobia. The fishing grounds are mainly around islands near Massawa, and the fishers operate in 20 to 30m depth during the peak fishing season, and over 30m depth during the hot season. The catch amount per operation is 5 to 6 tons during the peak season and 2 to 2.5 tons during the hot season, and the catch seems to be gradually decreasing.



Fig 3-10 Bottom longline gear appropriated from tuna longline and catches (catfish and giant grouper)

In the Red Sea, the sea surface water temperature rises during the hot season, causing fish populations to move to deeper waters, making it impossible to operate the main driftnets. During this season, fishers switch to the surrounding gillnets at deeper waters in nighttime but catches

decline. Bottom longlines are a promising alternative during this season. On the other hand, the lack of widespread use of bottom longlines by artisanal fishers was attributed to the difficulty of obtaining the bait, but since NFC fishing vessels operate year-round, it does not mean that the bait itself is not available. In order to promote the use of bottom longlines among artisanal fishers in addition to develop appropriate fishing gears and methods, measures such as the supply of bait and storage facilities for artisanal fishers seem to be important.

(3) Subsistence Fishery

There are two types of subsistence fisheries in operation; the gillnet fishing for mullet and other fishes conducted on foot from the beach, and the handline fishing for Indian mackerel, scad and small demersal fish in shallow waters using polystyrene floats and canoes. For details of actual operations, please refer to the survey results in 3-1 Fishing Communities and Subsistence Fisheries, above. However, the fishers living in Massawa who were interviewed occasionally rent fishing gears and boats to operate. The main fishing grounds are around Massawa, Hirgigo bay, and Sheikh Sied island.

Problems they thought were that they needed boats and engines for more efficient operations but could not afford them due to high prices, the quality of fishing nets and gears was low and the supply was insufficient, the price of gillnets was high, fishing grounds were far away, rental fees were high if they did not own fishing gears or boats, and there were no fishing gears and methods that were more efficient.



Fig 3-11 Gillnets used in subsistence fishery (left) and fishing line sold at a shop (right)

3-3-3 Problems Identified

To summarize the above results, the following problems were identified in the field of fishing

gears and methods.

< Artisanal fishery >

- 1) The quality and size of gillnet are not appropriate.
- 2) The structure of the gillnets used during the hot season is not appropriate, resulting in inefficient work.
- 3) Operating costs are high compared to the revenue from fish landed, often resulting in losses.
- 4) The introduction of fishing gear and bait supply system for the spread of bottom longline fishing has not been established.

< Subsistence fishery >

- 1) The quality of fishing gears used in current fishing is poor and supply is insufficient.
- 2) Boats and engines are expensive and difficult to obtain.
- 3) Fishing gears and methods for efficient resource utilization have not been developed.

Chapter 4: Problem Analysis Workshop

4-1 Workshop Participants and Implementation Method

In addition to the baseline survey described above and to get a bird's eye view of the issues surrounding each fishing community, a workshop on "Problem Analysis for Coastal Fisheries Development" was conducted on November 20, 2019, inviting coastal fishery stakeholders. The venue was Anchor Hall near the causeway in Massawa. A total of 31 people participated in the workshop, including 4 representatives (1 government official, 2 fishers, and 1 woman) from the communities of Hirgigo, Zula, and Dehil island, 2 invited participants from NFC, and 17 people including counterparts from various departments of MMR. The list of attendees is shown in Table 4-1.

Table 4-1 Participants in the workshop on Problem Analysis for Coastal Fisheries Development

Category	Village/ Agencies	Participants
Community representatives	Hirgigo	Halima Osman Saleh, Administrator Mehammed Mussa Said, Fisher Aman Ahmed Romedan, Fisher Amna Mehammednur Omer, Women Representative
	Zula	Abdelkerim Abdelahi Omer, Administrator Osman Jabra Ahmed, Fisher Halima Ibarhim Saleh, Fisher Ibrahim Omer Ibrahim, Women Representative
	Dehil island	Ahmed Meqbul Abdu, Administrator Mehsen Mehammed Mehzen, Fisher Salem Sulem, Fisher Kedaja Ahmed, Women Representative
Related organization	NFC/Eri-fish	Ibrahim Kelifa, Post-Harvest representative Asmerom Paulos, Post-Harvest representative
Ministry of Marine Resources	Marine resources development department	Tesfamichael Okbazghi Zenawi Frezghi Meskel Fatuma Mehammed Omer Samuel kiros Misghina Tesfu
	Marine resources research and human resource development department	Yohannes Teclemariam, <u>Project Manager</u> Mahta Goitom Isaac (Facilitator) Zeweldi Haile Okbatu (Assistant Facilitator) Mekonen Shishay Ahmed Ibrahim
	Minister office	Merhawit Amanuel (Assistant Facilitator) Tekle Mengstu Mahmud Idris Selim
	Fish Quality Control Laboratory	Yohana Negasi Nejah Adem
	Northern Red Sea Branch	Samson Zekarias Makda Belay

The problem analysis workshop was led by the project manager, Mr. Johannes, and facilitated by his staff member, Mr. Mahata, who used the PCM (Project Cycle Management) method to analyze problems related to coastal fisheries specific to each community. First, the method of problem analysis was explained to the community representatives who were not used to doing this kind of brainstorming, and after a preliminary exercise in small groups, the problem analysis was conducted in three groups of community representatives including the MMR staff. In each group, participants who had received the JICA training of fisheries in Japan acted as moderators and its assistants, and used conference room walls to put up the theme cards of problems presented by the participants, and then tried to sort the cards with the cause-and-effect relationship in the form of a problem-tree. Each group finalized it after an hour and a half of discussion and presented to all participants which was followed by a question-and-answer session.



Fig 4-1 Problem analysis workshop

4-2 Results of the Problem Analysis

4-2-1 Hirigigo Village

The village of Hirigigo is primarily a community of small-scale subsistence fishers. Figure 4-2 shows the problem tree resulting from the problem analysis. The central problem is "Limited fishing activities," and problems that cause this are "Lack of fishing boats and gears," "Lack of fisheries infrastructure," "Lack of fish markets," and "Weak institutional arrangement."

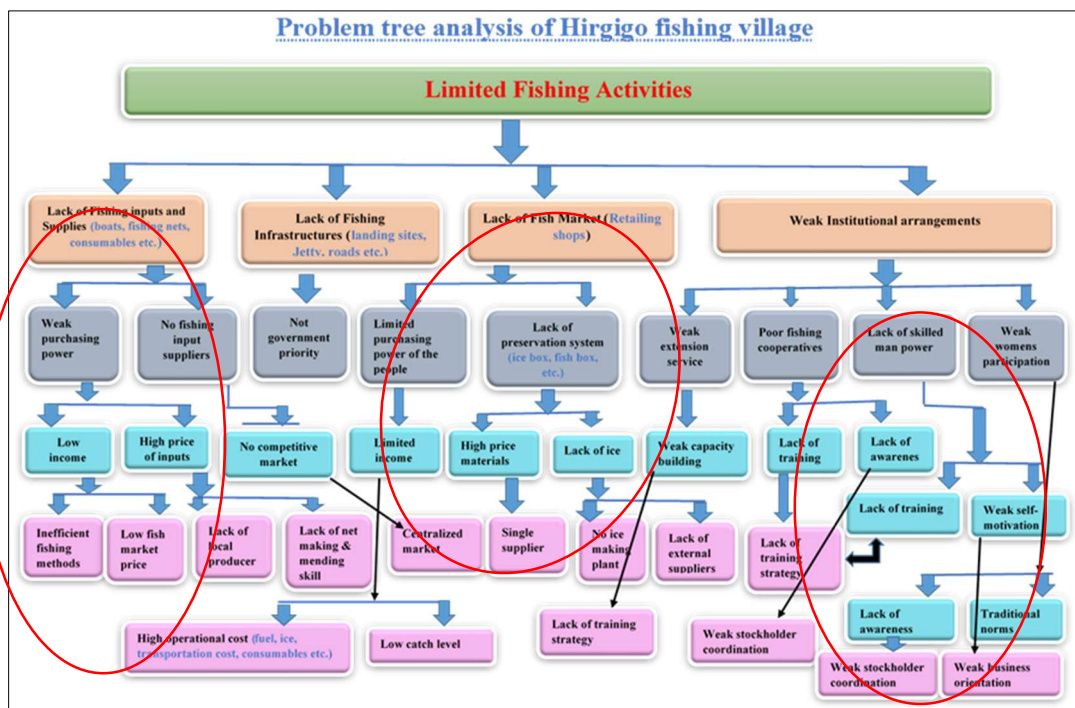


Fig 4-2 Problem tree for coastal fisheries in Hirigigo village

In the process of analyzing the problems, the most discussed issues and thus subdivided into the lower levels of the cause-effect diagram were "Lack of fishing boats and gear" and "Lack of market capacity," and "Lack of cooperative capacity" and "Lack of labor skills" were among the institutional issues. "Lack of fishing boats and gears" was caused by inefficient fishing methods, low income due to low fish prices, and high prices of fishing gears. "Lack of market capacity" resulted from the low purchasing power of consumers and the lack of ice and cooler boxes to keep fishes fresh. The main reason cited for both "Lack of cooperative capacity" and "lack of labor skills" was a lack of opportunities to improve capacity through training.

4-2-2 Zula Village

Zula village, like Hirigigo, is a community centered on the subsistence fishing. The results of their

problem analysis are shown in Figure 4-3. The central problem was "Low fishing income," and the four direct causes were "Inappropriate fishing techniques," "Many post-harvest loss," "Lack of opportunities for capacity building of fishers," and "Lack of fishing income opportunities for women."

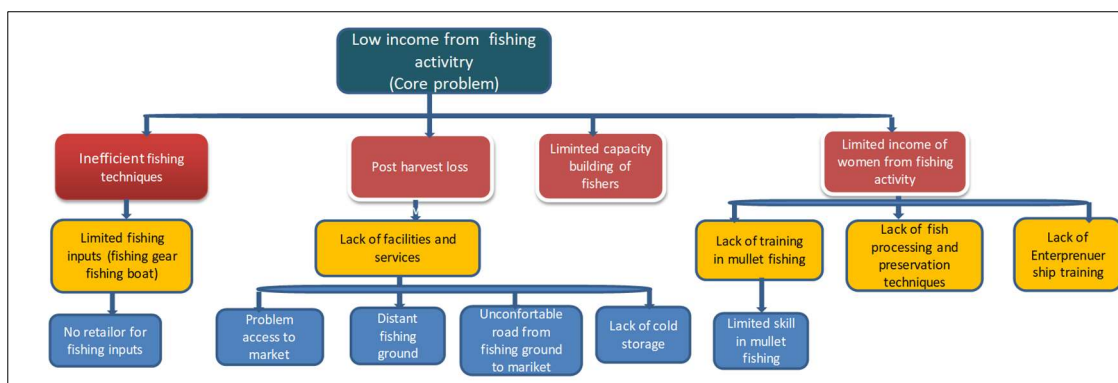


Fig 4-3 Problem tree for coastal fisheries in Zula village.

The problem analysis team of Zula village narrowed down and consolidated the problems after a lively exchange of opinions, so the number of problem cards was reduced, and the problem tree was simply organized. In the case of "Inappropriate fishing technology," it was determined that there were no suppliers of fishing materials and therefore no access to appropriate fishing gears. "Many fish catches are discarded" due to the long distance to the fishing grounds, limited opportunities to sell the fish in the market, lack of roads to transport the fish, and lack of refrigerator-freezers. "Lack of income opportunities for women in the fishing industry" was resulted from the lack of training opportunities in fishing technology, lack of training opportunities in fish processing and quality control technologies, and lack of training opportunities to start a retail shop, indicating the need to provide appropriate training opportunities.

4-2-3 Dehil Island

Since Dehil island is a community that mainly engages in artisanal fishing (boat fishing), there is a significant difference in the background of problem awareness compared to the two fishing villages mentioned above. Figure 4-4 shows the problem tree, which is the result of problem analysis on coastal fisheries of the island. The central problem was "Low fishery production," and the four direct causes were "Lack of fishery infrastructure and facilities," "Lack of supply of goods necessary for production and livelihood," "Many restrictions due to inadequate institutions," and "Low skills of workers."

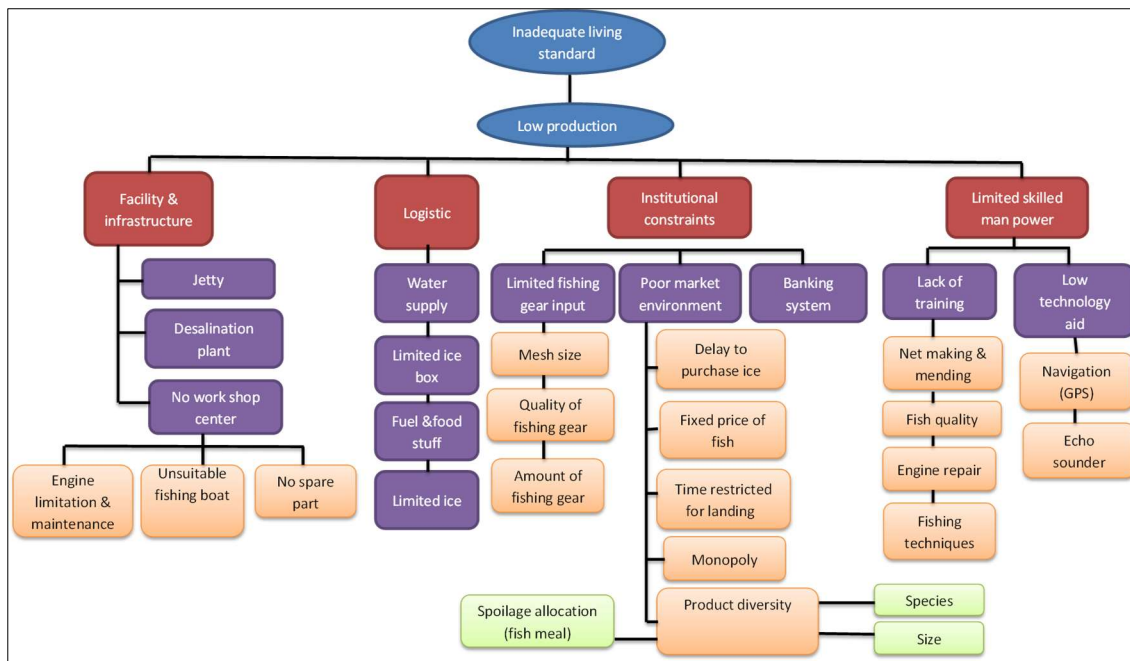


Fig 4-4 Problem tree for the coastal fishery of Dehil island

The reasons for the "Lack of fishing infrastructure and facilities" were the lack of a pier, desalination equipment, and a place to maintain fishing boats and engines. Dehil island is an island formed by uplifted coral reefs and relies almost entirely on transportation from the mainland for the water for not only for fishing but also for daily life, which is provided by fishing fleets of Dehil island. As the island is hardly able to produce food for its own consumption, fishing income has become a major means of obtaining daily necessities, and fishing infrastructure and livelihood infrastructure have become almost synonym. Other direct causes of the lack of fishing boat and engine maintenance facilities were the inability to maintain engines, lack of availability of parts, and inadequate structure of fishing boats, all of which are characteristic of Dehil island's reliance on boat fishing. "Lack of supply of goods necessary for production and livelihood" was directly caused by the lack of water supply, insufficient number of cooler boxes; and inadequate supply of fuel, ice, and food. The causes of "Many constraints due to inadequate institutions" include: inadequate supply of fishing gear of the right size, quality, and quantity; poor marketing environment for the catch; and inadequate financing system. As for the poor marketing environment, the respondents strongly pointed out their dissatisfaction with the government's fishery policies and systems, such as the slow supply of ice, fixed fish prices, limited landing time, and limited sales to one company, EriFish. As for the "Low skill of workers," it was directly attributed to the lack of training on fishing net production and repair, catch quality control, engine repair, and fishing techniques, as well as the lack of GPS and fish finders necessary for efficient fishery production.

Chapter 5: Challenges and Constraints for Coastal Fisheries Development

This chapter summarizes the issues surrounding coastal fisheries and the constraints that are hindering coastal fisheries development as identified from the results of the baseline survey (Chapter 3) and the problem analysis workshop (Chapter 4). For a more detailed discussion and results, see Annex 2 “Technical Report Current Situation, Issues and Constraints of the Coastal Fisheries in Eritrea”.

5-1 Identified Challenges

5-1-1 Subsistence Fisheries

(1) Challenges in Fisheries Production

(a) Efficient use of the small pelagic fish resources

The coastal areas of Eritrea where subsistence fisheries operate are assumed to be less abundant fishery resources than offshore areas, and the resources are not used effectively because of few numbers of fishers. While the accurate fish catch amounts and Allowable Biological Catch are awaiting specific studies, the main target species of subsistence fisheries, such as mullet (*Mugil cephalus*) and Indian mackerel (*Rastrellinger kanagurta*), are considered to be the sufficient potential for exploitation. The efficient use of small pelagic fish resources is a major challenge for Eritrean coastal fisheries, both in terms of improving the livelihoods of fishers and supplying food to consumers.

In addition, small sardines such as bluestripe herring (*Herklotsichthys quadrimaculatus*) and shorthead anchovy (*Encrasicholina heteroloba*), which are prolific small pelagic fishes, are assumed to be more abundant than mullet and Indian mackerel, and their effective use has long been an issue. These species are caught by beach seines and their current fishing grounds are solely in the southern coastal areas around Assab, Eddie, Borum and Berasole. It is processed by sun drying and used as a livestock feed. Though various efforts have been made to make it edible for human, it has not yet become as an established food since its quality deteriorates rapidly due to the fact that it is caught by seine netting and processed without boiling, as well as the Eritrean's custom that has not eaten small sardines.

(b) Increasing fisheries production

According to the results of the baseline survey, seafood consumption has traditionally been high in coastal areas such as Massawa, and there is a shortage of supply in Asmara and inland areas

despite high demand on seafood. The MMR and FAO's efforts since the 1980s to promote fish eating in inland areas have been successful, and have now entered a stage where a larger supply chain is required. Increasing production to meet this high demand is important from a food security perspective, and also provides an opportunity for fishers to improve their livelihoods. Together with the issue of expanding fisheries production of the artisanal fisheries, which will be discussed below, there is a social need to increase the production of subsistence fisheries based on the development of small pelagic fish resources described above.

(2) Challenges in marketing

(a) Reducing transport costs

The village of Hirgigo, which was the target site of the baseline survey, sells many fishery products at the Edaga Market in Massawa. But there is a problem that transport costs are high when transporting fishes to the market in small batches each time the catch landed. In case of Zula village, transport costs are not a major issue due to the high demand within the village, but as mentioned above, the distribution outside the village is essential if fisheries production is to be improved through the development of small pelagic fish resources. A promising market is in the neighboring town of Foro, where ice is essential to maintain the quality of the product as it has been carried over rough roads for many hours. However, necessary ice has to be ordered from Massawa as it is not available in the village. Minimizing these transport costs is a major challenge in economic management to fishers and its necessity will become more apparent as fisheries production improves.

(b) Improvement of the distribution environment for Massawa

When Hirgigo fishers want to increase the volume of fish products sold to Massawa market, it will have to improve its distribution environment. At present, ice for quality control is not usually used and transportations are only motorbikes basically. And there are no sales facilities at the Edaga market, hence the fishes are sold in baskets placed on the street which are not well shaded. It is not possible to increase the volume of sales in this environment because it is difficult to increase the transport volume and to keep fishes in fresh for a long time. The improvement of distribution environment is an essential task for improving fishery production and sales volumes.

(c) Improvement of the distribution environment for Foro

As mentioned above, Foro is the most promising market for increasing fisheries production for Zula village. However, there is no fish market in Foro like Edaga in Massawa, and the ice needed for transport has to come from Massawa. The improvement of an environment for the distribution

of fresh fishes to Foro by ensuring sales opportunities and means of quality control will be a key issue for the successful development of the fishery in Zula village.

(d) Establishment of distribution methods and promotion of sales to inland areas

As mentioned above, meeting the demand for fishery products in inland areas including Asmara is required from the perspective of national food security, but to date, there has been only little experience of selling fishes to inland areas by subsistence fishers, and distribution methods have not been established. Larger fishes such as Spanish mackerel, queenfish and groupers have become widespread fishes consumed in Asmara and inland area. However, the fishery products would be supplied by the subsistence fishery are mainly small pelagic fishes. As large fishes are a substitute for livestock meat, consumers favor large portions to be edible and limited ways to cook the fish. There is a need to establish a way of distributing the fish products of subsistence fisheries such as mullet and Indian mackerel, and to promote their consumption.

5-1-2 Artisanal Fisheries

(1) Challenges in Fishing Gears and Methods

(a) Increase of fishery production in the peak season

During the peak fishing season, gillnet fishing (drift nets) is the main fishing method of the artisanal fishery and is thought to account for a large proportion of the catch, but fishers have pointed out problems such as inadequate mesh sizes and the high effort required to operate them. On the other hand, the demand for seafood in Asmara/inland areas is higher than the supply, hence there is a need to improve fishery production and increase the supply. Increasing fishery production and supply by improving fishing gears and methods for production efficiency is a high priority for Eritrean coastal fisheries.

(b) Increase of fishery production in the hot season

As noted above, supply is not keeping pace with demand for seafood in Asmara/inland area, this is more conspicuous in the hotter season when production is lower. During the hot season, large pelagic fishes, which are the target of gillnet fishing, move to deeper water as the surface temperature of the sea rises drastically. Also, the extreme heat in hot season makes working conditions uncomfortable, so fishers switch to the surrounding gillnets and operate at night, but catch amounts are lower than in the peak fishing season.

Many subsistence fishers also engage in bottom handline fishing which is particularly important during the hot season because it allows them to operate during the night and early morning. There are still opportunities for the exploitation of bottom fish resources, thus the development and introduction of simple and widely used fishing gears and methods that enable more efficient use

of resources are also required. Improvement of fisheries production in some way to increase fishers' income and supply to consumer during the hot season is a big challenge.

(2) Challenges for Market Development

(a) Sales promotion to inland area

As mentioned repeatedly, the fish supply to Asmara and other inland areas is not keeping pace with the increasing demands as the fish consumption becomes more widespread. While it is necessary to increase fishery production to cope with this issue, the challenge is to improve the environment to ensure a stable supply of fishery products to inland areas. To achieve this, it is necessary to strengthen the EriFish's purchasing function at Massawa fishing port and the EMPC's fresh fish transportation capacity, and to prepare sales points in inland cities such as Mendefera.

(b) Fish price liberalization

The biggest complaint of fish consumers in Asmara/inland area is the high prices as well as the lack of supply. As fish consumption becomes more widespread and potential demand increases, the supply of fishery products at low prices could trigger further consumption. Conversely, for fishers, the low landing prices are seen as a problem and seem to encourage many fishers to illegally land in neighboring countries. It is thought that the official price set by the NFC based on the government policy is causing this mismatch in fish prices. In the past, the official pricing of fishery products was very effective policy to combat famine and to promote fish consumption. But at present time that the famine has passed and fish consumption has become more widespread, it seems that the role of official pricing is gradually coming to an end. The challenge is to promote price liberalization in the seafood trade and to strive to formulate prices that are appropriate for both fishers and consumers.

(3) Challenges for Improvement of Infrastructure and Facilities

(a) Fishing infrastructure and facilities in the island communities

Most of the artisanal fishers are based on remote islands, most of which lack fishing infrastructure and facilities such as jetties, boats and engine maintenance facilities. As a result, boats are anchored offshore of the island and maintenance is carried out in Massawa inconveniently. As these islands are also a place of livelihood for the villagers, mainly fishers, the development of fishing infrastructure and facilities will also improve the livelihood of the communities. The development of fishery infrastructure and facilities in those islands is considered a necessary issue for the development of artisanal fisheries.

(b) Strengthening Massawa's landing capacity

Fish landings for artisanal fisheries are limited to the Massawa and Assab fishing ports only. In particular, the Massawa fishing port is responsible for the supply of seafood to major inland centers such as Asmara, but has only one landing facility where EriFish buys the products. In addition, because of the limited access to the port from 6 am to 6 pm and the fish landing is accepted only for a short time in the morning, fishing boats are sometimes anchored in the harbor for days waiting for landing. Increasing production to meet the high demand in Asmara and inland area will be difficult if the landing capacity of the Massawa fishing port remains low. Therefore, strengthening the landing capacity of Massawa fishing port is also an essential part of coastal fisheries development.

5-2 Constraints to the Coastal Fisheries Development

The challenges to the development of coastal fisheries have been outlined above, but there are a number of constraints that need to be solved in order for the Government of Eritrea to address these challenges. At present, the possible constraints that need to be resolved are as follows.

5-2-1 Constraints in Subsistence Fisheries

(1) Lack of Fishing Technology for the Development of Small Pelagic Fish Resources

The development and effective use of small pelagic fish resources is fundamental to the future development of subsistence fisheries, but the fishing gears currently in use are limited to simple gillnets and handline only, making it difficult to further increase catches. Subsistence fishers' lack of fishing vessels and the difficulty of making large investments have also been constraints to the development and introduction of efficient small pelagic fisheries technology.

(2) Inadequate Supply of Fishing Gears

The stable supply of good quality fishing gears and materials is essential for the future development of the fishery, but only a few are currently available in the villages. Even in Massawa, fishing gears and materials are sold exclusively by the government and fishers cannot choose what they want.

(3) No Facilities for Quality Control and Logistics Bases

There is no infrastructure or facilities in the villages to serve as a base for quality control, processing and distribution of fishery products. This condition is limiting means of fish distribution, but infrastructures/facilities such as cold storage, processing and transport are

essential for improving fishery production and strengthening sales to large markets of Massawa and Asmara.

(4) Lack of Fish Processing Techniques

A key to the development of subsistence fisheries is the expansion of sales channels for small pelagic fishes to Asmara/inland areas where people are not accustomed to eating them. For this reason, the development of processed products that offer new ways of eating fish is a challenge. For villages where electricity and refrigerators are not widely available, the development of processed fish products that can be preserved without cool storage is required. MMR has attempted to develop processed products, but to date there has been no demonstration of product development for the widespread consumption of small pelagic fish and there is a lack of expertise in these villages.

5-2-2 Constraints in Artisanal Fisheries

(1) Lack of Know-how for Improving Fishing Gears and Methods

Artisanal fisheries face a number of challenges in improving and developing fishing gears and methods that are suitable for both the peak season and the hot season. However, there is currently a lack of expertise to develop these technologies.

(2) Limited Transport Links to Inland Areas

Refrigerator trucks of EriFish are used to transport fresh fishes from Massawa to Asmara/inland areas, but this is not sufficient to increase fishery production and supply in the future. The lack of cold chain transport capacity from Massawa is one of the major constraints to the development of coastal fisheries.

(3) Limited Fish Landing Capacity of Massawa

Similarly, the current landing capacity of the Massawa fishing port is not sufficient in terms of institution and facility capacity to increase the supply to Asmara/inland area.

(4) Fish Prices are Controlled

The prices of fishes are perceived by both fishers and consumers to be inappropriate. Fair pricing can be a major driver of fisheries development to motivate fishers to catch and consumers to buy, and it makes benefits for both. To promote making this market environment, the controlled price currently set by the NFC is one of the major constraints to the development of coastal fisheries.

Chapter 6: Pilot Activities

6-1 Pilot Projects for the Fishing Gear and Method

This section provides an overview of pilot projects related to fishing gear and method. For more information, see Annex 3 “Pilot Project Final Report of Fishing Gears and Methods Project Implementation Unit”. Also, the materials produced for capacity building of counterparts and fishers in this pilot projects are shown in Annex 9 “Training materials for Fishing Gears and Methods”.

6-1-1 Planning of the Pilot Projects

(1) Priority challenges

The Government of Eritrea aims to make effective use of the abundant fishery resources in the Red Sea in order to improve the domestic food and nutrition situations. For achieving that purpose, it is essential to strengthen the capacity building of the MMR staff and those involved in fisheries, improve the fishing gears and methods, and increase and stabilize the fishery production by disseminating the fishing technology. Before planning the pilot project, the project team conducted the baseline survey and problem analysis workshop on the fisheries situation in Eritrea from October 2019 to November 2019. On the basis of the survey, the following issues on fishing gears and methods for coastal fisheries development were recognized after considering the current situation, problems and constraints.

(a) Insufficient fishery training texts and materials

The MMR staff must understand the actual fisheries theoretically and practically in order to support the development of fisheries in Eritrea. For that purpose, it is necessary to prepare appropriate textbooks and audiovisual materials for conducting fishery training at the MMR Fisheries Training Center in Massawa.

(b) Responding to the increase of fishery production and the shortage of fishers

In order to increase fishery production in Eritrea, it is necessary that not only to improve fishing gears and fishing methods, but also to obtain modern fishing boats and high-quality fishing gears. However, catches are declining due to the poor performance and inefficiencies of the fishing gears currently used in both of artisanal and subsistence fisheries. In addition, it is difficult for fishers to secure appropriate profits because the catches are purchased at a fixed price. Resolving these issues is expected to increase fishery production. In general, fishers hesitate to work if they are unable to earn enough income in the harsh and dangerous conditions in the sea. As aiming to increase the number of new fishers, it is important to

introduce effective fishing gears and methods, adequate supply of appropriate fishing equipment, and increase of production and income.

(c) Fisheries in the hot season

The Red Sea in Eritrea is a closed sea with slow tides. Schools of fishes move to deeper waters as sea surface temperatures rise during the hot season. As a result, the fishery production declines. However, well-capitalized fishers continue to operate using the surrounding gillnet with fish aggregating lights during the hot season. To achieve the goal of increasing fish production even in the hot season, it is important to introduce new types of fishing gears and methods that can be used by many artisanal fishers.

(d) Fishing boat and engine maintenance facility

In addition to the lack of fishery-related facilities for repairing and maintaining fishing boats, it is difficult to obtain spare parts for fishing boat engines. At the time of the baseline survey, it was confirmed that many non-operating fishing boats were moored around the port of Massawa. Thus, there are many issues to be solved for the improvement of fishery status, such as the provision of available fishery-related services to fishers and the modernization of the fishing technology.

The exploitation of sardines and anchovies, which are considered to be abundant in Eritrea and likely to be promising resources for human consumption, is not included in the pilot project for the following reasons.

- Since the main fishing grounds for sardine/anchovy are in the Southern Red Sea, specific operational information for the fishery was not available at the time of the baseline survey around Massawa area where the project was planned.
- Sardine/anchovy needs to be cooled immediately with a large amount of ice water after being caught for keeping freshness, and processed quickly in order to be for human consumption, but it is difficult to procure ice in rural coastal areas.
- The most promising process for preserving large amounts of sardine/anchovy is called “Niboshi” in Japanese, which requires a processing plant where the catch is boiled in boiling water and then dried. In order to carry out this sardine processing, it is necessary to build a processing plant near the fishing grounds and to establish a system that can transport the caught sardine/anchovy with ice water in a short time. Of course, this type of project requires a lot of cost and time, so it is difficult to deal with it within the framework of this project.

In the project "Fisheries Resources Management Program (2016-2023)" being implemented by MMR with the support of IFAD, the activity to strengthen the catch, processing and distribution of small sardine/anchovy is one of the major pillars. At present, construction of fish drying processing facilities is underway at major landing sites of sardines such as in remote islands. As these circumstances, information for verification of this issue will be collected properly from the IFAD project.

(2) Selection of pilot projects

In the section of fishing gears and methods, the project team discussed and planned the following three pilot projects based on the materials reported on the Eritrea fishery industry and the information obtained from the baseline survey.

- 1) "Pilot project for improvement of gillnet and its making capacity building (PP1)" for the purpose of improving the gillnet fishing, which is the main fishing of the artisanal fishery.
- 2) "Pilot project for development of small-scale bottom longline fishing (PP2)" for the purpose of operating all year around by artisanal fishers.
- 3) "Pilot project for introducing small scale setnet fishing (PP3)" aiming for effective utilization of coastal fishery resources by subsistence fishers.

These pilot projects consider effective improvement measures and effective approaches to coastal fishery development, including not only the technical aspects of the fishery but also the high availability of local materials. For the decided project, fishing gears and methods PIU will play important role respectively in charge of the activity, and then the trial operation test will be conducted jointly with the fishers. In addition, these pilot projects aim to contribute to the livelihoods of fishers and stabilizing the productivity of coastal fisheries. During these pilot projects, JICA experts will provide support to the PIU and fishers through seminars and practical trainings in terms of both theory and technology regarding to fishing gears and methods.

(1) Pilot Project for Improvement of Gillnet and its Making Capacity Building (PP1)

This pilot project will provide MMR staff as trainer with the opportunity to acquire expertise through gillnet making practices and conducting operation tests of fishing efficiency with fishers.

The main activity items are as follows.

- 1) Design of two types of improved gillnets (driftnet and surrounding gillnet).
- 2) Workshop for MMR staff as trainer (TOT).
- 3) Net making practice of 2 types of improved gillnets.

- 4) Making training texts and materials.
- 5) Installation of a net hauling machine on fishing boat.
- 6) Comparative operation tests of fishing efficiency using the existing gillnet of fishers and the newly provided one by the project.
- 7) Gillnet making training for fishers by MMR's trainers.

In the workshop for trainers (MMR staff), JICA experts will give lectures; (a) gillnet composition, (b) shrinkage calculation method, (c) fishing gear buoyancy and sinking force calculation method, etc. to understand the necessary elements. In addition, the gillnet fishing gear used for the operation test will be made by the MMR staff, and the expertise will be strengthened through a series of theoretical and practical learnings. At the same time, training materials for fishers will be prepared at the MMR Fisheries Training Center in Massawa. At the end, it will be possible to deepen the understanding of not only gillnets but also other net fishing gears as a whole through this pilot project, and it is expected that the technology dissemination service by MMR will be enhanced.

Currently, the gillnet used by fishers is the nylon multifilament 210d/36 with the mesh size 120 mm. Although the twine of this net is thick and durable, it has the following disadvantages; (a) poor workability by heavy netting, (b) poor catch efficiency by high visibility of the net. As a matter of fact, the fishers on the boat need to haul up their heavy gillnet manually, because there is no machinery such as the net hauler on the boat. To solve these problems, PP1 will provide a light weight and high workability nylon monofilament net and compare the work efficiency and catch efficiency of this gillnet with fisher's one during the trial test operation. As a result, the superiority of the gillnet proposed by the project will be proved and promote the introduction of fishing gear with high fishing efficiency. Ultimately, the plan is to improve the livelihoods of fishers and stabilize the system for supplying marine products to inland areas by increasing fishery production in Eritrea.

(2) Pilot Project for Development of Small-Scale Bottom longline Fishing (PP2)

In this pilot project, MMR staff and JICA experts will jointly assemble a small-scale bottom longline fishing gear that can be operated all year round including hot season. After the completion of fishing gear, the demonstration and verification test of fishing efficiency will be conducted in collaboration with artisanal fishers. The main activity items are as follows.

- 1) Preparation of configuration diagram for small scale bottom-longline.
- 2) Workshop for MMR staff as trainer (TOT).
- 3) Making and assembling of small bottom-longline fishing gear.

- 4) The fishers and MMR staff will jointly conduct a trial operation to check the workability and catch efficiency of the gear.

In the baseline survey, the bottom longline fishing was operated by only semi-industrial fishing boats owned by the National Fisheries Cooperation (NFC) and a few artisanal fishers. Therefore, dissemination rate of this fishing was low. Presumable causes of low dissemination are difficulty in obtaining the fishing gear and bait fish as well as delays in the introduction of equipment such as fish finders. On the other hand, the survey team believed that the bottom fish resources were abundant from the observation at the landing site in Massawa because many large demersal species were landed at that time. Some artisanal fishers also said that they would like to obtain the bait fish consistently and like to continue their operations because bottom-longline fishing has a great possibility to catch many fishes.

During the hot season (June to September), many artisanal fishers stop their fishing operation due to decrease of catches. On the other hand, small scale bottom-longline fishing is considered to be a promising fishery with a small amount of initial investment and a high possibility of all year-round operation including the hot season. The characteristic of this fishing gear was developed for the purpose of streamlining the handline fishing. This fishing gear has many branch lines with hooks attached to one main line, and it is possible to catch many fishes in one operation. Furthermore, even small fishing boats can operate easily, so it is suitable for introduction to artisanal fishers.

In this pilot project, the workshops of bottom-longline fishing composed of lecture items of fishing methodology, gear structure, and fishing grounds will be held as part of the training of trainer (TOT) by JICA expert. After the lecture, the trainers will be trained for the making of fishing gear and the practical operation at sea. In addition, the completed fishing gear will be lent to the fishers who participate in the experimental operation test, and the effectiveness will be verified by collecting operation data such as workability, catch, sales, profit, etc.

These trial operations will be implemented in responding to the expansion of fishery production and the fishery development in Eritrea by various fishing gear and fishing methods during the hot season, which is a challenge in Eritrea.

(3) Pilot Project for Introducing Small Scale Setnet Fishing (PP3)

The purpose of this project is to make a prototype of a small scale setnet “Pound net”, to conduct a test operation in collaboration with subsistence fishers in Hirgigo village and Zula village, and to verify the effectiveness of fishing gear and fishing method. The main activity items are as follows.

- 1) Design of setnet fishing gear (2 sets).
- 2) Workshop for MMR staff as trainer and deciding setnet design.
- 3) Setnet fishing gear making (2 sets).
- 4) Deciding fishing ground, setting the gear and implementation of trial fishing for verification effectiveness of the setnet in cooperation with subsistence fishers
- 5) Fishing gear making and operation training for subsistence fishers by MMR trainers

In Eritrea, there are many subsistence fishers so called “foot fishers” who do not have fishing boats, and they operate small scale fisheries in the shallow waters in each village. Basically, they carry out gillnet fishing on foot and handline fishing using a floating raft (bag-shaped contained polystyrene). Therefore, the fishing area is limited and the fishery production is small. From October to May of the following year, when the water temperature becomes low, the subsistence fishers catch mullet, Indian mackerel, scad, snappers, and barracuda that migrate to the coastal areas with gillnet. In the night operation, enmeshed fishes are collected by fishers from deployed gillnet while patrolling all night.

During the period of hot season, the temperature of the sea surface rises and the fish does not come to the shallow area. Therefore, fishers try to catch the fish by handline fishing with floating raft. However, since the floating raft is driven by using beach sandals, the fishing ground range is accordingly limited. And the efficiency of operations also becomes worse under the rough sea condition. The proposed small scale setnet is suitable for efficient catching of small fishes because it has the following features. This fishing net blocks the path of migratory fish by a leader net and guides it to the pocket net of the harvest space. Also, since the caught fishes are alive, it is easy to keep them in fish cage and no need to use ice for keeping freshness, and it can be sold any time they want because fishes are alive in fish cage. In addition, this fishing method is nature-friendly without fear of overfishing, and at the same time, it is an effective fishing method for fishing community development because this net is managed by local residents.

In this pilot project as well, setnet fishing gear making practice will be carried out at the MMR Fisheries Training Center in cooperation with the JICA expert who gives the lecture of TOT training for MMR staff on the composition and operation methods of fishing gear. The completed setnet will be jointly deployed with the subsistence fishers in each village. At the same time, operation guideline and management system will be prepared, and the superiority of this fishing gear and method will be verified from the point of view of fishery management such as catch results, sales and operation costs.

6-1-2 Implementation structure of the pilot projects

This pilot project was strongly requested to develop human resources of the Ministry of Marine Resources (MMR) staff through capacity building on fisheries technology and knowledge. In this context, the following members actively worked as a Project Implementation Unit (PIU) team in the Fishing Gear and Fishing Methods sector.

Table 6-1 The team members of the fishing gear and method PIU

	Photo	Name	Position	Main activities in charge
1		Mulugeta Mahdere	Leader (Fishing gear development)	1. Oversee Project activities 2. Operation management and Report making
2		Yosief Redae	Assis. leader (Fishing gear development)	1. Support the leader for project activities and Report making 2. Operation management for PP1
3		Filmon Bereket Bairu	Fishing coordinator (MRDD)	1. Data management for PP2 2. Training material making for basic computation of fishing net
4		Dita Amanuel	(MRDD)	1. Presentation materials making 2. Training material making
5		Filmon Bereket Berhe	(MRDD)	1. Report making of PP2 trial operation 2. Leader of PP3
6		Osman Ibrahim Ahmed	(MRRSD)	1. Operation management for PP2 2. Report making of PP2 trial operation
7		Temesgen Amanuel	(MRDD)	1. Data management for PP1 and PP2 2.3. Report making of trial operation

6-1-3 Pilot Project for Improvement of Gillnet and its Making Capacity Building (PP1)

PP1 Drift Gill Net

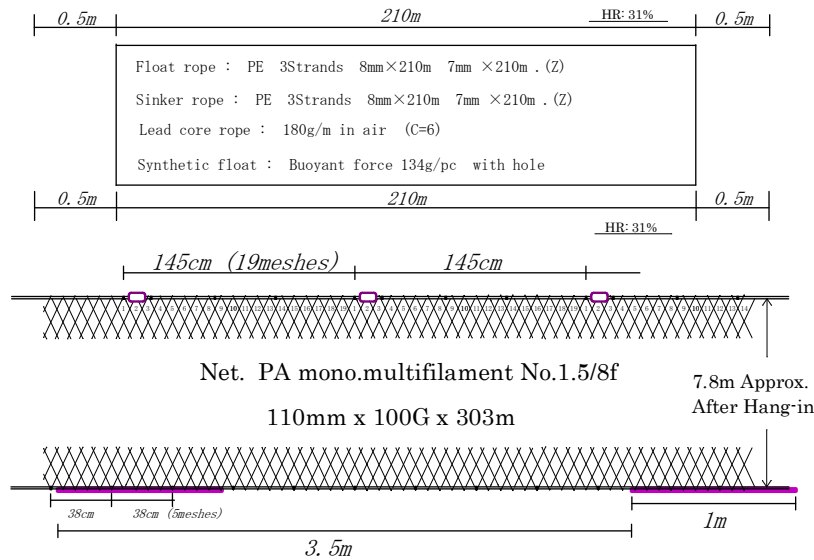


Fig 6-1 PP1 produced drift gillnet

(1) Outline and purpose of the pilot project

The baseline survey clearly showed that many changes in materials and technology are needed to develop the drift gillnet fishery in Eritrea. Those changes will require the improvement of fishing techniques and support for fishermen by the PIU team, which is comprised of officials from the MMR.

In this project, the PIU team will acquire practical knowledge by conducting at-sea training and monitoring surveys in collaboration with fishermen using gillnet that they have prepared through lectures and gear construction. Activities were conducted in the following order: ①lecture, ②gear making, ③operational practice, and ④monitoring evaluation. In the monitoring survey to improve gillnet fishing, differences in operational workability and fishing efficiency were verified by comparing fishing gears provided by PP1 with those of fishermen. Based on these results of the comparative study, the introduction of effective technologies to improve fishing techniques will be supported by MMR.

In addition, PP1 has developed the necessary fishery textbooks and presentation materials as part of fishery education.

Implemented period of PP1: March 2020 – March 2023 (37months)

The main objectives of PP1 are:

- 1) Improve the efficiency of gillnet fishery and strengthen the fishery technology dissemination service.
- 2) PIU team and fishery officials of MMR will understand the gillnet fishery and acquire construction technics.
- 3) Improve the efficiency and productivity of fishing gear and fishing methods through the proposed gillnets by the project.

(2) Gill net fishery training and related documentation

MMR staff and the PIU team conducted a workshop on gear configuration, basic calculations, gillnet construction and hands-on training at sea to gain a better understanding of the drift gillnet fishery. The main contents of the workshop were as follows.

- 1) Gear characteristics and materials, basic net calculations, buoyancy and sink forces of gear materials, and hang-in ratio calculations.
- 2) Learn how to calculate gillnets and how to cut the netting material.
- 3) Hands-on training in net construction for the pilot project.
- 4) At-sea training on the pilot project by PIU team members
- 5) Preparation of textbooks, manuals and presentation materials for fisheries training.

(3) Implementation plan and project sequence

PP1 has conducted trials of nylon monofilament gillnets with lead core sinkers, which are highly regarded worldwide for their ability to improve productivity. However, Eritrea has been slow to adopt this gillnet gear, so this project decided to verify its effectiveness and efficiency by comparing it with gillnets used by the fishermen.

The project procured netting materials for drift nets, encircling nets, and depth adjustable drift nets and constructed these nets with the PIU team in Massawa. Then, the PIU team selected a person in charge of the on-board survey and conducted data collection in cooperation with local fishermen through test operations at sea.

As for the project supportive fishing boat, the boat was selected in cooperation with the Northern Red Sea Branch of MMR and consensus was reached with the boat owner for the project activities.

(4) Outline of the project implementation

Since the Massawa area was also closed the business activities due to COVID-19, the pilot project was led by PIU team leader Mr. Mulugeta, who negotiated with reliable fishing boat owners, and the

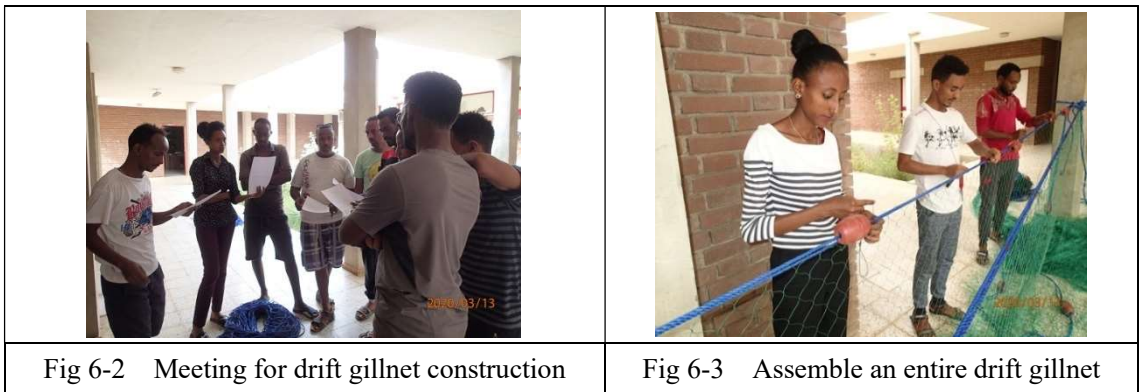
survey activities were conducted by sending observers from the PIU team to collect data at sea. Finally, the PIU team conducted the project, including three pilot drift gillnet operations, two pilot night encircling gillnet operations, and two pilot depth adjustable drift gillnet operations. The survey results showed that the performance evaluation of the fishing gear and fishing method proposed by PP1 as a prototype was generally favorable and can be evaluated by the report.

(5) Drift Gillnet Project

(a) Construction of drift gillnet

During this training, MMR staff and the PIU team learned about gillnet fishing gear and fishing methods in general, as well as how to configure gillnets and calculate the buoyancy and sink force of the nets. Then new drift gillnets were constructed by the PIU team as PP1 experimental gear.

In the end, the PIU team produced a total of 4 drift gillnets for the experimental operation, and the participants strengthened their fishing gear making skills through the construction of drift gillnets. In addition to materials purchased in Japan, some gillnet materials, such as floats and sinkers were purchased from MMR.



(b) Drift gillnet test operation

The first drift gillnet test operation was conducted by Mr. Temesgen Amanuel of the PIU team aboard the sambuk boat Msgna-1 for 13 days from December 2020 to January of the following year. During the test operation, the PP1 proposed drift gillnet (214 m long x 7.8 m net depth) and the fishermen's drift gillnet (260 m long x 5.6 m net depth) were connected together. Although it was the full moon season and the sea was rough, the necessary operation data were collected.

The PIU team also reported the results of the second drift gillnet test operation conducted by Mr. Yosief Redae aboard the sambuk boat Msgna2 for 19 days in November 2021. The survey was conducted using the drift gillnet proposed by PP1 (total length 214 m x net depth 7.8 m) and the fishermen's drift gillnet (total length 1485 m x net depth 9.75 m).

The third test operation was also conducted in December 2022 for 15 days by Mr.Filmon Bereket Berhe and Mr.Yosief Redae of the PIU team aboard the fishing boat Alqiema.

Drift gillnet operation processes are as follows:

- 1) As the skipper maneuvering the boat forward, two fishermen cast the nets into the sea and finally tie the ends of the nets to the boat.
- 2) After 3 hours of soaking, the nets are hauled up on deck and the caught fishes are stored in a cooler box.



Fig 6-4 Setting the drift gillnet



Fig 6-5 Retrieving the drift gillnet

(c) Results and evaluation

In the 1st test operation, the number of fish caught per 100m² was 13.7(PP1) and 8.5(fishermen's net), respectively, so the drift gillnet proposed by PP1 caught 1.6 times more fish than the fishermen's drift gillnet. $13.7 \div 8.5 = 1.6$

The catch weight per 100m² was also 32.1kg and 17.8kg, respectively, so the drift gillnet proposed by PP1 caught 1.8 times more weight of fish than the fishermen's drift gillnet. $32.1 \div 17.8 = 1.8$

In the second test operation, the number of fish caught per 100m² was 6.8(PP1) and 0.7(fishermen's net) respectively, so the drift gillnet proposed by PP1 caught 9.7 times more fish than the fisherman's drift gillnet. $6.8 \div 0.7 = 9.7$

The catch weight per 100m² was also 10.5kg and 1.3kg, so the drift gillnet proposed by PP1 caught 8.1 times more weight of fish than the fisherman's drift gillnet. $10.5 \div 1.3 = 8.1$

The results of the number of fish caught and the weight of fish caught by two types of drift gillnets showed from these two test operations that the fishing efficiency of gillnet proposed by PP1 was high. The fishermen also pointed out the superiority of the drift gillnet proposed by PP1.

	
Fig 6-6 Produced drift gillnet	Fig 6-7 Fisherman's drift gillnet

(d) Conclusion

Through the test operation, the fishermen provided the following information on the catch rate and workability of the proposed PP1 drift gillnet fishing gear.

The advantages are as follows:

- The thin monofilament net makes it easy for fish to get caught and entangled in the mesh.
- The color of gillnet is green, which reduces the visibility of net and makes it easier to catch fish. From these characteristics, PP1 drift gillnet would be possible to operate under a full moon.
- The gill nets are light and can be operated by a small number of fishermen, and reducing the operation costs.

On the other hand, the following disadvantages are also pointed out:

- ✓ The netting line is weak and easy to break, but it is difficult or impossible to mend.
- ✓ It is difficult to remove fish entangled in the net.
- ✓ The buoyancy is too strong, so seaweed is easily caught while fishing.
- ✓ Small fish are sometime caught and entangled in the net.

From these three reports and the fishermen's indications, the following information was found that the drift gillnets produced by the project were more efficient in catching and better workability than the fishermen's drift gillnets. On the contrary, they also had problems such as weak lines and difficulty in repair.

Based on the information obtained, it is necessary to reconsider the material, line thickness, and mesh size of the nets. In addition, the buoyancy and sinking force and hang-in ratio should also be recalculated in order to introduce appropriate fishing nets.

Fortunately, the PIU team has mastered the basic calculations and construction methods of gillnets and is ready to implement measures to improve the fishing gear.

(6) Encircling Gillnet Project

(a) Construction of encircling gillnet

In March 2020, the JICA experts had to urgently return to Japan due to COVID-19, but the PIU team took the lead in constructing the necessary number of encircling gillnets (three sets of 100 m in length and 16 m net depth) in May of the same year and conducted test operations.

Prior to the following year's fishing season, the fishermen suggested the need of additional sinking force and buoyant force of the encircling gillnets in order to deploy them quickly in the water during operations. Accordingly, PP1 provided the necessary fishing materials for this purpose, and the fishermen modified the net and verified its effectiveness.

(b) Encircling gillnet test operation

The hot season encircling gill-net operation consists of three fishing boats: one mother boat, FRP netting boat, and FRP fish attraction boat equipped with generator. The size of the assembled net: length: $100\text{m} \times 3 = 300\text{m}$, net depth: 16m, and the operation order is as follows.

- 1) Select a fishing ground and turn on the attraction light for about 3 hours to aggregate fish at night.
- 2) Encircling gillnets are deployed counterclockwise around the fish-attraction light boat.
- 3) Stone throwing is done in the surrounding circle area to intimidate the fish and entangle them in the net
- 4) The encircling gillnet is retrieved onto the boat and the catch is taken out from the net.



Fig 6-8 Encircling gillnet preparation

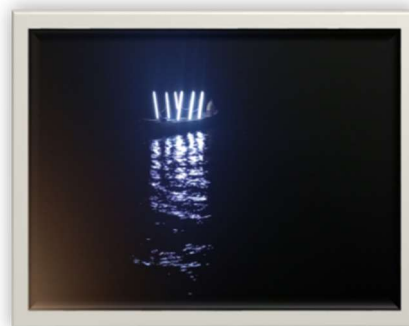


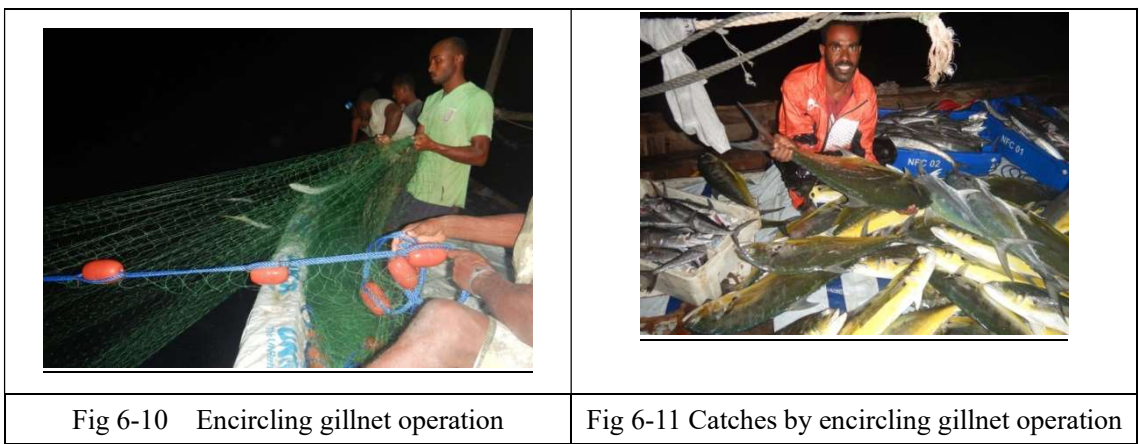
Fig 6-9 Lighting from fish attraction boat

The 1st test operation of the encircling gillnet was conducted in August 2021 by Mr. Yosife Redae of the PIU team aboard the fishing boat Alnesiem for 11 days. The total catch in this survey was 1074.8

kg, but sales and other information were not recorded, so the survey items were modified for the next survey.

The 2nd encircling gillnet test operation was conducted by Mr. Temesgen Amanuel of the PIU team aboard a Sambuk fishing boat for 9 days from the end of May to the beginning of June 2022, using an encircling gillnet modified by the fishermen.

The test operation resulted in a catch of 2,587 kg (skipjack, Spanish mackerel, milkfish, and shark), sales of 80,405.5 nakfas, expenses of 22,500 nakfas, and gross profit was 57,905.5 nakfas (approximately 550,000 yen). $80,405.5 - 22,500 = 57,905.5$



Encircling Gill Net for PP 1+ Fisherman

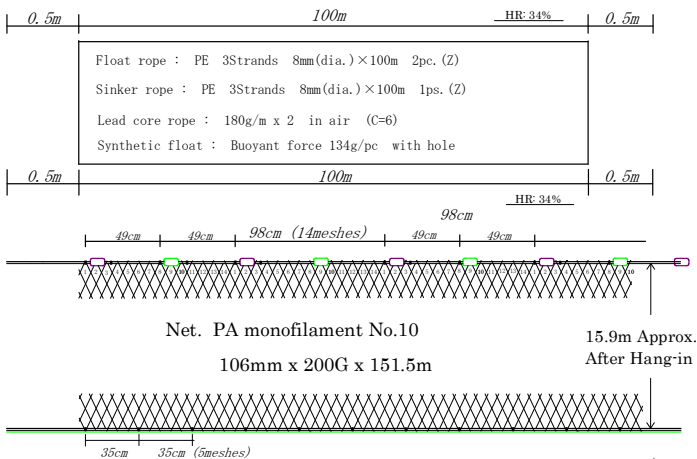


Fig 6-12 Modified encircling gillnet

(c) Results and evaluation

The PIU team has conducted two test operations of encircling gillnets with a fish-attracting light during the hot season and prepared the report, but the superiority of the encircling gillnets produced by the

PP1 could not be proven by data because they could not be operated at the same time by the fishermen's encircling gillnets. At the suggestion of the fishermen, the buoyancy and sinking force of the PP1 net were increased in the second test operation, allowing the net to deploy more quickly in the water. Although the second operation days with the modified PP1 net were fewer than the first operation, the catch per 100 m² was higher.

However, it is not possible to determine the superiority before and after the net modification due to the large differences in operation date, fishing grounds, and fish aggregation effectiveness. At all events, the fishermen evaluated the PP1 encircling gillnet work is more effective in terms of operational and economic efficiency compared to their own encircling gillnets.

(d) Conclusion

The fishermen provided the following information on the proposed encircling gillnets of PP1.

- The net is lighter and requires less labor, making it more profitable.
- Higher catch rate than the fishermen's encircling nets.
- The use of lead core sinker makes less noise when cast the net into the water, preventing fish from escaping.
- With lead core sinker rope, net deployment and hauling is smooth and does not get tangled in the net during operation.
- Fish are easily caught due to less visibility of the net

On the other hand, the disadvantages are as follows:

- The netting line is thin and light, so the nets break easily and are difficult to repair.
- The net is too slow to deploy in the sea due to the lack of sinkers and floats. (Modified by fishermen)
- The net depth is 16m, which is shorter than the fishermen's net depth of 28m.

The selection of materials for monofilament type of encircling gillnets also needs to be reconsidered because of the weakness of the netting line and the difficulty of repairing it. When monofilament net is used, the size of the netting line should be increased to strengthen the durability.

Although the multifilament twine is slightly more expensive than the monofilament twine, it is easier to repair and more durable. In the case of gillnets in this country, it is recommended to use thinner multifilament twine from 210D/36 (fishermen's net) to 210D/18-24.

The buoyancy and sinking force of the encircling gillnet should be recalculated as needed to improve workability and fishing efficiency.

(7) Depth-adjustable drift gillnet project

The new prototype drift gillnet is designed to sink gradually in the water and has no floats attached to the head rope.

The unique feature of this gear is that buoys are attached to the head rope at intervals of 10 to 20 m. By adjusting the length of the buoy rope, the net can be deployed at any depth of the target fish, which varies with the seasons and growth of the fish. In addition, the net is lightweight and easy to use, reducing the amount of labor required for operation.

(a) Construction of depth-adjustable drift gillnet

The depth adjustable drift gillnet workshop was held in March 2022. After the workshop, the PIU team and the expert worked together to make 2 different types of depth-adjustable drift gillnets with different net depths. Another four nets of the same type were made by the PIU team.

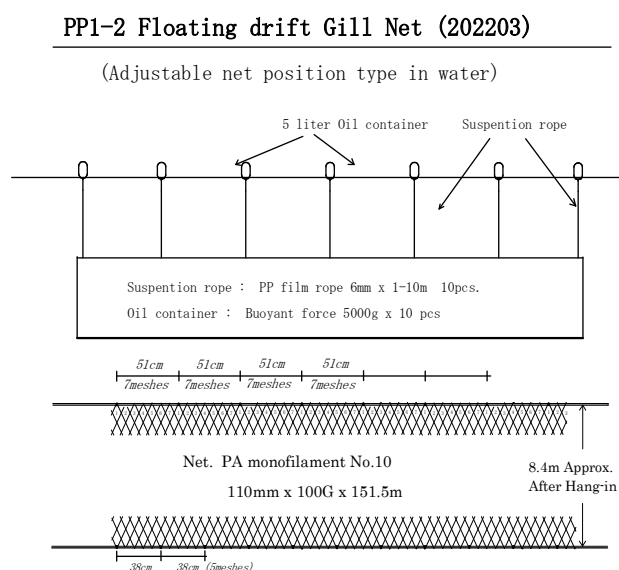


Fig 6-13 Depth-adjustable drift gillnet

(b) Depth-adjustable drift gillnet test operation

The depth-adjustable drift gillnet was tested by the PIU team on April 5 and 6 (two days) in the waters off the southeast coast of Green Island in Massawa at a sea depth of 25-35m. As a result of trial operation, the functions of the net were verified that the drift gillnet could be set at the required depth with stable net shape in the seawater as expected. At the same time, the trial operation at sea provided a valuable opportunity for the PIU team to gain practical experience throughout the real fishing activities.

The 1st test operation of the depth-adjustable drift gillnets was conducted by Mr. Yosief Redae and Mr. Filmon Bereket Berhe in collaboration with the fishermen on board for 10 days starting from October 20, 2022,. A total of 6 sets of nets were used for the test operation: 110 mm (mesh size) x 100 m (total length) x 8 m (net depth) x 3 sets, and 110 mm (mesh size) x 100 m (total length) x 16 m (net depth) x 3 sets.

The 2nd test operation of the depth-adjustable drift gillnets was conducted for 15 days in December 2022, by Mr. Yosief Redae and Mr. Filmon Bereket Berhe in collaboration with fishermen on board.

The sequence of operation is as follows:

- 1) One fisherman handles the head rope and attaches the buoy rope at regular interval.
- 2) Another one handles the sinker side to deploy the net properly while the skipper navigates the fishing boat forward.
- 3) The end of net is tied with the boat after the net setting.
- 4) After 3 hours of soaking, the net is started to retrieve for harvesting fish.
- 5) During retrieval, fishermen start to haul the net manually and the nets are stacked properly.

During the survey period, the PIU team provided a detailed report on the catch and operation status.

However, since only a few operations have been performed and no operations have been conducted in deeper water, it was reported that it is necessary to conduct continuous test operations in order to make appropriate evaluations.

(c) Results and evaluation

Spanish mackerel and queen fish, which are the main targets of the Eritrean drift gillnet fishery, are subject to seasonal changes in seawater temperature and swimming depth during their growth process. However, the fishermen's drift gillnet is not suitable for year-round operation because the depth of the net cannot be adjusted. To solve these problems, a depth-adjustable drift gillnet was designed and implemented as a pilot project.

Through the test operation, fishermen provided the following information about the PP1 depth-adjustable drift gillnets.

- The monofilament nets used are lighter and easier to cast and lift than multifilament nets because they do not absorb water.
- Fishing expenses can be reduced because operations can be carried out by a small number of fishermen.
- The fishing gear can be deployed to the required depth by adjusting the length of the buoy rope.

- The use of lead core sinker rope avoids the net tangling and enables smooth net casting.
- The nets are difficult to see in the water, so this net can be operated even under a full moon.

On the other hand, some problems have been pointed out.

- The netting material is weak, and even new nets may break during operation or due to catch.
- Sinker ropes are light and easily affected by waves and currents.
- There is no space to keep buoys in the small boat

(8) Overall Evaluation

From this pilot project, the effectiveness in increasing the operating opportunity and improving the productivity of depth-adjustable drift gillnet was judged. However, the fishing gear used in the survey is a prototype and should be optimally improved in terms of gear buoyancy, sinking force, hang-in ratio, appropriate length of suspension rope, buoy shape and buoyancy, etc.

After testing the three types of gillnet fishing gears and fishing methods proposed as the pilot project, fishermen generally expressed similar opinions about the advantages and disadvantages of monofilament nets.

On the other hand, multifilament nets, the predominant type of gillnet fishing gear in Eritrea, have more durable materials and are easier to repair, but their thicker netting twines(210D/36) make them inferior to monofilament nets in terms of workability and catch efficiency. To improve this situation, it is important that fishermen be able to procure appropriate fishing nets, buoys, floats/sinkers, ropes, and other related materials domestically. At the same time, technical assistance to fishermen by the MMR will be essential to promote new fishing gear and fishing methods.

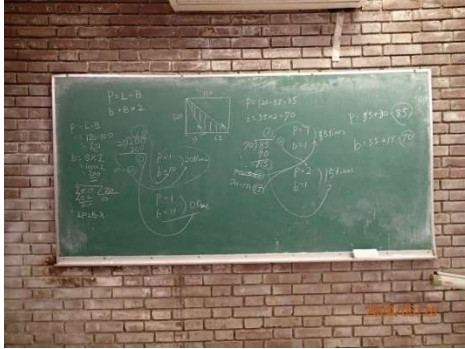
The fishing demonstration was carried out together with the artisanal fishermen at their expense. As a result, it was driven by their conditions, sometimes they use gillnet and other days they use encircling gillnet which made it difficult to operate the test operation in the same fishing trip. As a result, the frequency of operation was very few. Therefore, test operation should be implemented independently to get comprehensive data.

The materials and equipment prepared for the PP1 project are as shown in “Pilot Project Final Report Appendix Materials” but unused materials and equipment are being stored in the MMR warehouse.

(9) Training to improve fishing techniques

Fishing experience, basic fishing gear calculations, and net cutting skills are important in the construction and modification of net fishing gear. The pilot project provided training in these

knowledge and skills, which are not only necessary to improve the fishing skills of PIU team members, but are also essential for the modification and construction of many types of net fishing gear.

	
Fig 6-14 Formulas required for net cutting	Fig 6-15 Calculation of fishing gear construction

(10) Electric net hauler for gillnets

Gillnet fishing in Eritrea is inefficient because it requires a large number of fishermen due to the heavier netting (thicker netting twine). To address these problems, MMR requested a feasibility study on the introduction of net hauler machine. In response of that, the PP1 project planned to procure three electric net haulers and verify its usefulness through the trial operation on a fishing boat.

As a preliminary step, in April 2022, the PIU team set up an electric net hauler on a wooden pallet at the MMR facility in Massawa and conducted a test operation to prepare it for training and local demonstrations.

The test operation of the net hauler for gillnet fishing was conducted after the installation on fishing boat of Selam3 by the PIU team and Mr. Zenawi Frezghi and Mr. Bilen Alazar with the fishermen.

From the results of the test operation, it was concluded that the gill nets used by the Eritrean fishermen are heavy; therefore some modifications to the net hauler are necessary. For responding to that issue, the PIU team reviewed some photos of the Japanese case study and planned to modify the net hauler by lengthening the shaft of the roller and installing a bearing on the opposite side like the Japanese style.

This machine is currently being tested on a fishing boat to obtain further information. According to the fishermen, the net hauler would be useful for bottom gillnet fishing in deep water, which is difficult to pull up by hand. Other uses include longline fishing if the main line can be wound onto a drum.



6-1-4 Pilot Project for Development of Small-Scale Bottom longline Fishing (PP2)

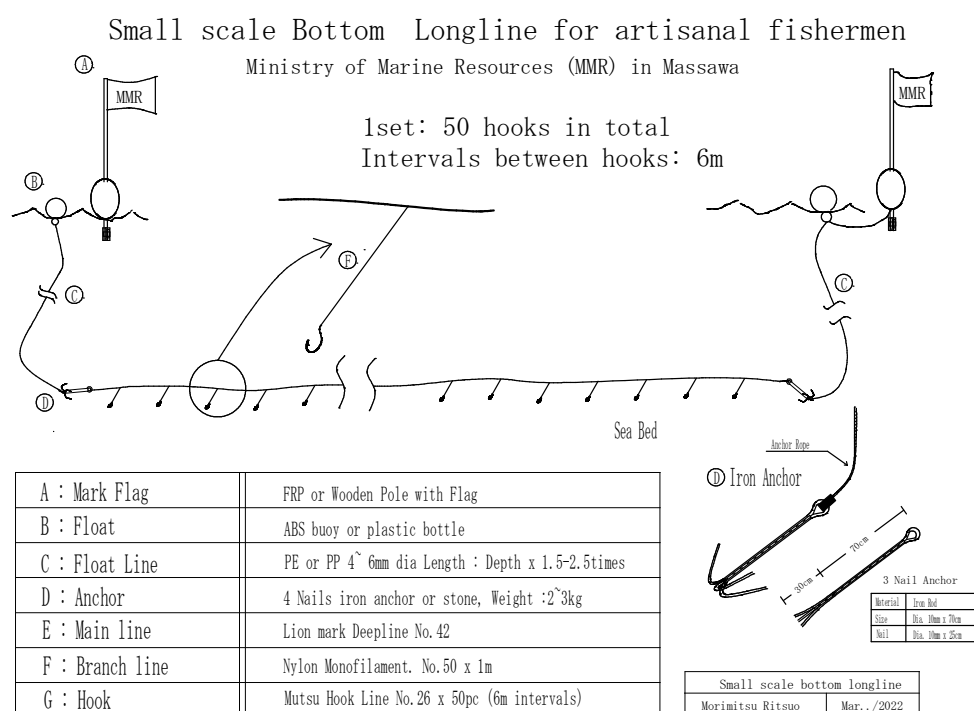


Fig 6-18 Small bottom longline gear (after modification)

(1) Outline and Purpose of the pilot project

This pilot project was designed to explore the potential of different production methods for underutilized bottom fish resources. Although Eritrea's bottom fish resources are considered abundant, utilization of the resources by small-scale fishermen has been slow, and there is a strong need to expand fishery production. Especially during the period when the sea surface temperature rises (May-September), the fishing operation environment is harsh as many fish migrate to the deep sea, resulting in a drastic decrease in fishery production. Under these climatic conditions, small-scale bottom

longline fisheries are considered to be highly efficient because of their low initial investment and relatively simple operation methods.

At present, only semi-commercial vessels owned by the National Fisheries Cooperation (NFC) are engaged in bottom long-line fishing, and some small-scale fishermen are also engaged when bait fish are available, but many others are not. This may be due to lack of access to suitable long-line gear and difficulty in obtaining bait fish. This fishery could easily be operated by small boats and canoes of small-scale fishermen, and the plan was to explore the possibility of developing the fishery using a variety of fishing gear, even in the hot season that is requested by the Eritrean government.

Implemented period of PP2: March 2022 - March 2023 (13 months)

Project objective :

- Develop new fishing techniques to increase catches and introduction of diverse fishing gear and fishing methods
- Ensure the effectiveness of small bottom long-lines fishing for increasing fisheries production and income of fishermen
- Promote the development of bottom and mid-water fish stocks

(2) Implementation plan and project sequence

In addition to the information obtained from the baseline survey, the small size of the fishing boats meant that bottom long-line gear was considered to occupy less space on board and be easier to operate. The selection of fishing gear for the Red Sea area was also determined in accordance with the target species to be caught as follows.

- Main line: "Deep line No. 42" braided polyester line with a diameter of approximately 3 mm was selected to avoid disturbing the working efficiency.
- Branch line: No. 50. Nylon monofilament with a length of 1.5 m or less was selected in consideration of working efficiency. (Longer branch line is easily twisted on the main line)
- Hook: No. 26 Mutsu type with the tip bent inward to prevent the hooks from getting caught on the seafloor and fish from escaping.

The project started with a training session on small bottom long-line fishing → gear-making → operational practice at sea. Then PIU team conducted a small bottom-long-line test operation in cooperation with the fishermen and prepared reports.

The proof of increased profits from this small bottom long-line fishery is a prerequisite for the development and dissemination of this fishery. The selection of a cooperative fishing boat was

determined in cooperation with the Northern Red Sea Branch of MMR, and PIU team observers were on board to collect information and support fishing activities.

(3) Briefing and training for project cooperating fishermen are as follows

Briefings and training were held for fishermen who were willing to test the introduced fishing gear, with the following content

- 1) Overview of the project
- 2) Purpose of the project and provision of fishing gear
- 3) Activity plan (implementation period and schedule)
- 4) Support structure from MMR
- 5) Demonstration of the advantages of this fishery compared to other fisheries (fuel, food, bait, ice, and other expenses, sales)
- 6) Questions and Answers



Fig 6-19 Hook hold attachment on basket



Fig 6-20 Bottom longline gear making

(4) Outline of the project implementation and operation survey

From March to April 2022, after learning about long-line fishing in general, the PIU team prepared five sets of small-scale bottom longline fishing gear for small boats and for canoes, respectively, and conducted trial operation practice by MMR boat at sea.

The first small bottom long-line test operation was conducted by PIU team member Osman Ibrahim and the above-mentioned fisherman for 11 days starting from the end of June 2022. During this research period, sea conditions, casting and hauling times, fishing grounds, catch amounts, species composition, etc. were recorded in each operation.

(5) Contents of activities for operation

- 1) Attach bait to all hooks before fishing.

- 2) Decide on a suitable fishing ground. (Taking into consideration of the direction and strength of the wind and tidal current, as well as the seafloor condition)
- 3) Buoy and anchor are connected with the rope of 1.5 times of sea depth, and main line is attached with anchor.
- 4) The casting order is from the buoy, anchor rope, anchor, and main line.
- 5) One person casts the branch line with baited hooks one by one along with the boat speed.
- 6) A small buoy and weight are attached to the connecting part of the main line with the rope at 1.5 times of the sea depth to prevent the fishing gear from being lost.
- 7) After 3-4 hours, hauling the main line along with the boat speed.
- 8) One person hauls the main line, while the other person collects the catch and stows the branch line into the basket.



Fig 6-21 Baiting work on the hook



Fig 6-22 Stored Queen fish in the ice

(6) Activity Results and Evaluation

(a) 1st test operation

The first test operation was conducted during the period 26/06/2022 to 06/07/2022, in different fishing ground conditions (around coral reef and muddy area) when the weather was rough and hot season. The operations were continued during this period in order to determine the feasibility of the fishing conditions, including catches. The test operations were performed manually in the early morning and evening. The operation was conducted with a member of fishing cooperatives of the Zoba Northern Red Sea with boat type hurry 13m in length and it is powered by diesel inboard engines of 160 HP (3 piston) navigating speed of 6-7 knots.

Initially, the fishing grounds were chosen in accordance with the widest possible coverage of the area. As per the predetermined fishing grounds, the fishing operations conducted by gillnet achieved good fish catch. Later, some caught fish were used as bait for the trial operation of the bottom long-line fishing. By using that bait, the bottom long-line fishing gear was set and soaked for one hour. The

species used as bait were Indian mackerel, ray fish, tuna, catfish, and barracuda. These species were cut off into small pieces before being hooked.

During this fishing trip, the fishermen operated 12 units of gillnets and caught approximately 600 kg. Although the number of gillnet operations was not recorded and accurate comparison between small bottom long-line fishing and gillnet fishing cannot be made, the fishermen expressed their desire to operate bottom long-line at the un-operation time of gillnet.

The summarized result of the test operation of bottom long-line fishing is as follows:

Number of operation: 7 times.	Number of hooks: 900
Total catch: 345.5kg (64 fishes)	Average catch rate: 0.38 kg per hook

Comparing the catch to the cost, the total cost of the test was 6,050 Nakfa, while the total revenue from the sale of the fish was 10,135.75 Nakfa, thus making a profit.

(b) 2nd test operation

The second bottom long-line test operation was conducted from 18 to 29/08/2022 by PIU team members Mr. Filmon Bereket Berhe and Mr. Yosief Redae at Dolphidol. The test operation was performed by reinforced fiberglass boat 7m in length, 4m width, and with another mother boat 20m in length, 4m width, and it was driven by a skipper Mr. Mohamed Abdela Mohamed. The main species used for bait was fresh Spanish mackerel that was caught by gillnet. The fishing gear was set and retrieved manually after three hours of soaking.

The results were summarized as follows:

Number of operations: 2 times	Number of hooks: 250
Total catch: 20.2kg (10 fishes).	Average catch rate: 0.08 kg per hook

This test operation was not implemented enough due to lack of bait, and fishermen shifted to other fishing gear, such as enclosed gill nets and drift-float gill nets.

(c) 3rd test operation

The third bottom long-line test operation was conducted by PIU team members Mr. Filmon Bereket Berhe and Mr. Yosief Redae. It was involved in different islands (Desei, Madot, and Dahlak (Nokra)) from 17 to 23/12/2022. The lines were laid on the coral reef for fishing in the morning and in the evening. The main species used for bait were fresh jackfish and Spanish mackerel.

The results can be summarized as follows:

Number of operations: 7 times

Number of hooks: 350

Total catch: 64.7 kg (32 fish)

Average catch rate: 0.18kg per hook

In comparison with other fishing gear, PP2 bottom long-line fishing has several characteristics of selectivity of catch, simple to prepare and easy to handle when setting and hauling, and also the harvested catch was higher in price and quality.

(d) Information collected from fishers

The fishermen expressed the following opinions concerning the small-scale bottom longline fishery.

- 1) This bottom longline fishery is simple, takes up little space on a fishing boat, and is easy to move from fishing area to fishing area.
- 2) It can be operated by a small number of fishermen.
- 3) The fish caught is fresh and can be sold at a high price.
- 4) With the right size of hooks, it is possible to catch a large number of fish.
- 5) The branch line is easily detached or loosed from the mainline when a fish is hooked.
- 6) The main line is easily broken when hooking the line in coral reef.
- 7) It is necessary to catch bait fish before operation.
- 8) Sometimes, the bottom long-line cannot be operated due to a lack of bait fish.

The disadvantageous points that need to be solved, Regarding point (5), "the branch line comes off when a fish is hooked", this problem has been solved by improving the making method of the fishing gear. Regarding (6), it is necessary to prevent damage to fishing gear by avoiding coral reefs. In addition, some types of fishing equipment like fish finder and GPS will be important in the future for the stable development of bottom long-line fishing. Regarding (7) and (8), it is necessary to utilize inexpensive fish caught by operating with gillnets as bait.

If the fishermen can keep their bait fish in cold storage at the Massawa fishing port facilities, it is likely that the small-scale bottom long-line fishery will be quickly popularized.

(7) Overall evaluation

The test operations with three different boats were carried out in the period from June 26/2022 up to December 23/2022 including the hot season. In overall trial operation was carried out 16 times, 1500 hooks and the total harvested catch was 430.4kg (106 fishes) and also the average catch rate was 0.28kg/hook. In general, the fish caught were coral reef species and large pelagic species. Cooperating fishermen suggest based on their skill and experience that the gear should have a loop or eye in the main-line to reduce twisting and make it easy to repair. The main bottleneck to the expansion of the

small-scale bottom long-line fishery is the shortage of bait, which was the main concern of most of the fishermen.

Since the Eritrean small bottom longline fishery is an irregular operation, it is difficult to obtain the necessary information to compare it with the gear proposed by PP2. The PIU team recognized that the small bottom long-line fishery is highly advantageous because of the small amount of investment money needed to make the gear, and the small amount of operating expenses since this fishing can be operated with a minimum number of fishermen.

In the case of the test operation, the project had to provide fuel and other necessities to the fishermen; without such support, the fishermen focus on their fishing and it is difficult to obtain the necessary data.

The Eritrean drift gillnet fishery is often forced to stop operations at sea during stormy weather or around the full moon period.

In such cases, the small bottom long-line fishing can operate not only during the full moon but also during stormy weather, in the shadow area of islands, or in bays where the fishermen can avoid the effects of wind and waves.

These many advantages are considered to have been verified through the test operation. If this fishery can be operated year-round, including during periods of the hot season. It is expected to increase the income of the fishermen and improve their livelihoods by expanding fishery production, and providing a stable supply of marine products to the people of Eritrea.

No major technical problems have been identified so far in the dissemination of this fishing technology. It is expected that MMR will promote the small-bottom long-line fishing technology and approach the fishermen based on the information obtained from this project. In that case, MMR should establish a specific and practical support system focusing on the economic aspects of sustainable fishing.

Promotion and Support of Small-Bottom Longline Fishing

- 1) The MMR need to assist the fishermen by providing adequate supply of fishing gear materials at affordable prices.
- 2) The key to popularizing this fishery is the stable availability of bait fish, so MMR need to support refrigeration and frozen storage of bait fish.
- 3) Supply of fishing gear and fuel for the test operation to fishermen.
- 4) For the gear capacity building to the fishermen, providing some training on fishing gear and fishing methods are useful.

- 5) Establish a system within the MMR to improve fishing techniques and knowledge of the small bottom longline fishery.

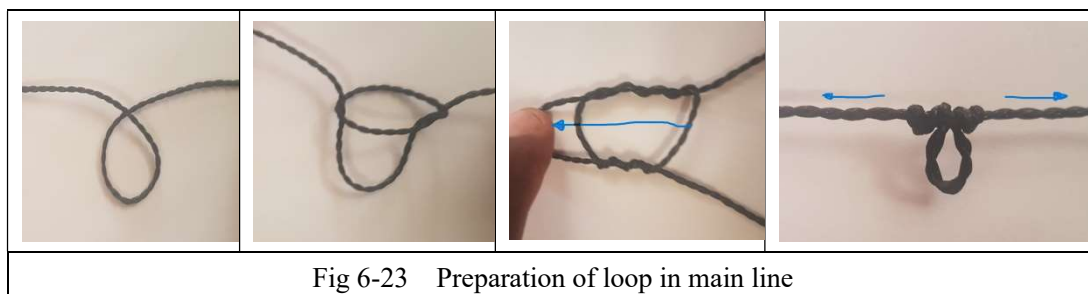


Fig 6-23 Preparation of loop in main line

6-1-5 Pilot Project for Introducing Small Scale Set net (Pound net) Fishing (PP3)

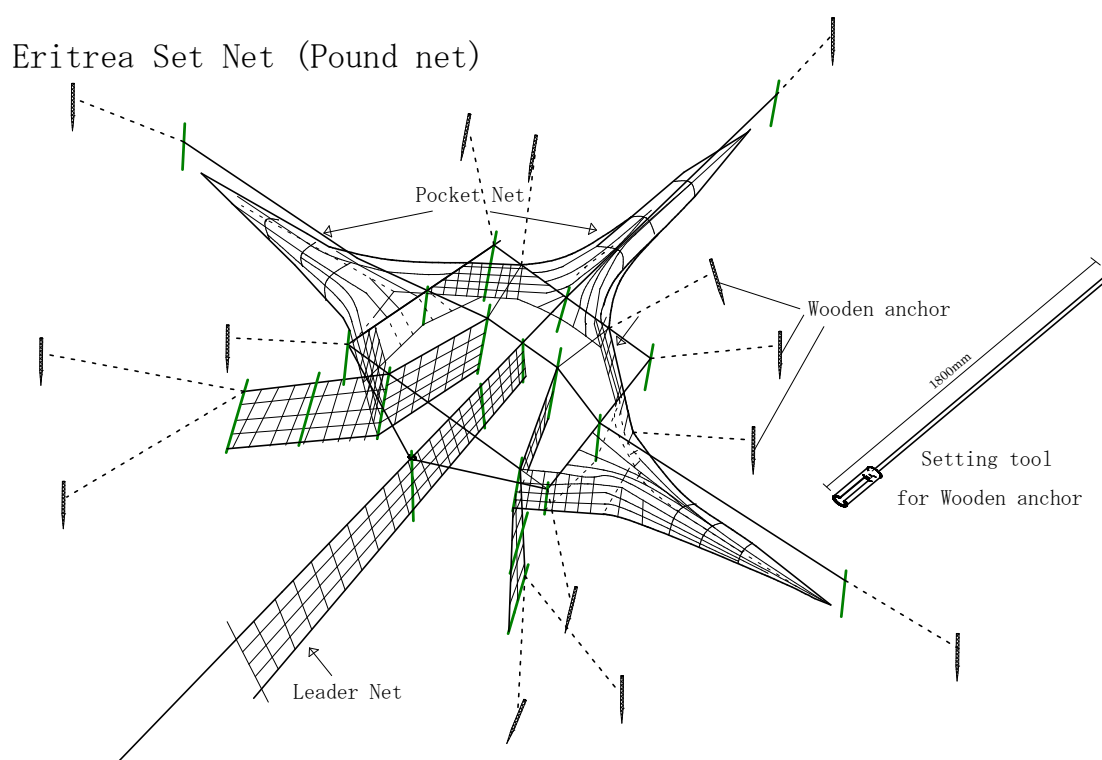


Fig 6-24 Pound net

(1) Outline and purpose of the pilot project

Eritrea has a coastline of approximately 1,350 kilometers, and many subsistence fishermen (foot fishers) live along the coast. They mainly fish with small-scale gill nets and hand lines during the fishing season from October to May of the following year, when the water temperature is low.

The purpose of this pilot project was to verify the effectiveness of this new fishing method by constructing small-scale Set net (Pound nets) and conducting test operations in collaboration with

subsistence fishermen in the villages of Hirgigo and Zula. The proposed Pound net fishery is a nature-friendly fishing method that utilizes the habits of fish migration in coastal areas. Once set up the net in the sea, it is an efficient fishing method that requires only one to two hours of operation each day, except for net changes every three weeks. Furthermore, this fishing method is expected to increase fishery production and improve livelihoods in fishing village through community development as the net is managed by village fishermen who survive in the coastal areas. In addition, in the construction of fishing gear for Pound nets, the project aimed to improve the fishery knowledge and technical skills of the PIU team members of MMR staff, such as calculation and practice of net cutting and splicing of ropes.

Implemented period of PP3: Nov.2021-Mar.2023 (17 months)

Project Objective:

- 1) To introduce Pound net to subsistence fishermen as a new technology to increase fish production and improve fishing efficiency.
- 2) Acquire knowledge and practical skills in Pound net fishery by MMR officials, PIU team members and other fishery stakeholders.
- 3) Diversify marketing opportunities by catching live fish species that come to coastal waters.

(2) Implementation plan and project sequence

For this Pound net project, the net scale and net type were determined and the net height was set at 1.5 m to allow for operation by a small number of fishermen without the use of fishing boats. The project also used locally available fishing materials such as wooden stakes and wooden anchors.

JICA expert provided the following assistance for the project.

- 1) Lecture: General information on Set-net fishing, fishing grounds, fishing gear configuration, and fishing methods.
- 2) Materials: Those materials that cannot be procured locally were purchased in Japan and constructed locally through practical training.
- 3) Pound net construction: PIU team constructs the Pound net in the MMR facility through hands-on training.
- 4) Operation: Practical training on how to determine fishing grounds, operation methods, management of fishing gears, and fish handling methods.

The project planned to organize the working group (WG) in each village for conducting the pilot operations and collect data, while the PIU team will provide support the WG and prepare the reports.

(3) Outline of the project implementation

This pilot project was initiated by the PIU team and the JICA expert in cooperation with the fishermen in the villages of Hirgigo and Zula. In November and December 2021, prior to the start of the project, the project meeting was held and agreed upon in both fishing villages where the Pound nets will be installed. At the same time, the members of the WG were appointed in Hirgigo before the project started. After that, the Pound net fishing gear for Hirgigo was constructed in cooperation with a JICA expert and the PIU team at the MMR facility in Massawa.

Then, in February 2022, the PIU team constructed the Pound net by themselves for Zula by making the necessary calculations and cutting the net based on the design paper. Through these net making activities, the PIU team proved their high level of knowledge and technical skills.

(4) Activity in Hirgigo village

(a) Pound net construction practice

According to the design prepared by the JICA expert and under his guidance, the Pound net construction was carried out at the MMR head-quarter from 02 to 16 December 2021. After learning about the Set-net fishery through the workshop, the MMR staff and the PIU team started the practical training of Pound net making according to the work plan. This net making was conducted with explanations of basic calculations for net construction, net cutting methods, and design features. It took about two weeks to complete the Pound net fishing gear by 7 members a total of MMR staff and PIU team.



Fig 6-25 Discussion on the Pound net design



Fig 6-26 Net cutting practice

(b) Working process of the Pound net

- 1) Inspection of fishing gear materials, preparation of materials, and revision of the net design

- 2) Learn about net fishing gear materials and Set net fishery in the workshop
- 3) Making anchor ropes and frame ropes and designing anchoring tools
- 4) Learning how to cut the net mesh and cut out the required net parts
- 5) Making of the leader net (attaching the head rope and sinker rope) and procuring the PVC frame for the pocket net
- 6) Cutting out the pocket net parts, reinforcing the net edge, and practicing the method of diagonal net cutting method
- 7) Cutting out the playground net parts, reinforcing the net edge, calculating and practicing the diagonal net cutting by the participants
- 8) Attaching PVC frames to pocket nets, assembling of playground nets (attaching of head ropes and sinker ropes)
- 9) Connecting three pocket nets to the playground net, preparing wooden stakes and wooden anchors
- 10) Preparation of other materials and necessary tools for Pound net deployment work at sea

(c) Pound net deployment and operation survey

In the early morning of December 16, 2021, prior to the installation of the Pound net, a suitable fishing site was selected in agreement with the Hirgigo WG. The day after the appropriate fishing grounds were determined, the installation work of the Pound net took place at 6:00 a.m., the time of low tide.

The sequence of the main parts included;

- 1) Setting the wooden stake with its frame rope.
- 2) Setting the wooden anchor in diagonal line from the wooden stake.
- 3) Adjusting the entire frame.
- 4) Attaching the pocket net unit on the offshore side from the outside of the frame rope.
- 5) After the entire net attachment to the frame, the three pocket nets were extended to the outside.
- 6) The leader net is stretched from the offshore side to the land side and the end of the land side of the net is secured with a wooden anchor.
- 7) Finally, whole net parts were adjusted.

Next day after installation, the PIU team visited to the site, for checking the situation of Pound net and its catch. The net that PIU team found in good manner as per it installed. Regarding the catch in the first day of fishing, they harvested around 4kg mainly barracuda.

(d) Pound net fishing operation in Hirgigo

After deploying the Pound net, the WG recorded 4kg, 3kg, 2kg and 2kg of fish catch respectively in the given data sheet during the first four days. The PIU team supported the project activity and

provided the necessary tools such as cooler, baskets and scale. Later on, this fishing ground was changed by consensus of the WG and PIU team due to low catch as well as seaweed and marine algae problem.

In mid-January 2022, the net was moved to another deeper position by PIU team and WG for better catch. Unfortunately, one week later, the net was completely destroyed by the current and covered with seaweed and algae. So the PIU team discussed with the WG members for better solution. During the discussion, the WG expressed the following opinions:

- Very low catch, difficult to stay long without profit
- The fishing ground is far from the coast, and the intertidal zone is poor in fishery resources.
- This type of fishing gear would be efficient around the coral reef area, but this coast is muddy all around.

Ultimately, the PIU team decided to retrieve the Pound net completely.

A key to the success of the Pound net operation depends on the fishing ground and willingness of the WG for proper care of the net. So, the PIU team discussed with the village administrator for better operational measure whether to replace the WG member or to change the operation site.

(e) Pound net redeployment in Hirgigo

Replacement works of the Pound net were carried out on January of 2022. However, the activities were hampered by wave that damaged to wooden stake and negligence of WG. In countermeasure of the problems faced, the replacement of the WG member was implemented and net deployment was undertaken on 23-24/11/2022 for test operation.

Accidentally, one day after the net deployment, the net was damaged by strong current and wave action and most of the wooden stakes that holding the net was broken and lost. Consequently, all parts of the Pound net were retrieved by PIU team and WG. As for the problems related to the fishing site, the nature of the bottom material is mostly sand and the location is exposed to wave action. Therefore, the site may not be suitable for setting this type of fishing net. But the Hirgigo WG has a will to try again and is ready to find another suitable site.

	
Fig 6-27 Project meeting at Hirgigo	Fig 6-28 Completion of the Pound net deployment

(5) Activity in Zula village

(a) Pound net construction practice

The key points of the net construction are the design. The Zula Pound net was constructed from early January to mid-February 2022 by the PIU team without the assistance of the expert. This indicated that the PIU team had acquired sufficient skills and knowledge of the Pound net construction. Because of this net consists of many different works such as diagonal net cutting and assembling the net for desired design.

The process of net construction and installation of the Pound net is the same as in the aforementioned Hirgigo village.

	
Fig 6-29 Slope net cutting practice by C/P	Fig 6-30 Net attachment work to PVC frame

(b) Pound net deployment and operation

The Pound net deployment work in the coastal waters of Zula was carried out by the PIU team and other relevant members in cooperation with the Zula Pound net WG from 14 to 19 March 2022.

Prior to the deployment of the Pound net, the following procedures were performed. On March 10, 2022, before the site selection, the PIU team instructed the WG on the overview and characteristics of

the Pound net. Then, after discussing and sharing enough information about the Pound net, the WG and PIU team agreed to deploy the net in the east of Zula village, which is a bit exposed to wave action and current. Considering the problems encountered in Hirgigo, the PIU team decided to deploy only the leader net. After two days, on March 16, 2022, the leader net was found to be dismantled by wave action. Therefore, the PIU team and the WG held a meeting to resolve the difficulty of deploying the nets in this location. So, after discussion and agreement between the two groups, it was decided to change the fishing site and relocate the leader net to the southeast of Zula where it would be protected from waves and currents. After two days of relocation, the deployed leader net was found to be fixed and stable, and the groups then decided that the location was suitable for Pound net. On March 18, 2022, the Pound net was deployed by the PIU team and Zula WG in the early morning at low tide.

(c) Pound net fishing operation in Zula

After the installation of the net, the PIU team briefed the WG on the importance of daily operation and catch data recording etc. In order to verify the effectiveness of this net, one record sheet was prepared and given to the WG. The net started catching fish from the first day of operation. Mainly the following fish were caught, Indian Mackerel, Guitar Shark, Small Talang Queen Fish (local name - Alsan), Barracuda, Marbled Spinefoot, Cobia etc. According to the good result of this demonstration, this type of net is quite important for the coastal fishing community to acquire daily fish for subsistence and income. Currently, the members of the WG share the catch among themselves for their daily household consumption. Once the supply of ice and cold storage is prepared in Zula, it will help them to sell their catch to villagers or Foro town.

(d) Redeployment of the pound net in Zula

The re-deployment work of the Pound net was agreed with Zula WG. According to the deployment plan, the PIU team visited Zula (01/11/2022) to check whether all materials of Pound net are available or not. The materials were pre-checked together with WG and confirmed that some materials were missing or broken like wooden stakes. So the PIU team ordered the WG to prepare the missing materials. One week later, on 08/11/2022, the Pound net was deployed in the same fishing ground that was previously deployed in the east of Zula village.

The characteristics of the Pound net are as follows:

- Daily operation time is short
- High initial cost of materials for construction
- Difficult to construct and install, especially for fishermen
- Easy to operate once set up in the sea, even women or elderly can operate it.

- Fish caught alive, so it has high quality.
- Operation and catch are greatly influenced by fishing ground.
- Important source of income for rural foot fishermen.
- High potential of dissemination to subsistence fishermen.

	
Fig 6-31 Training for fishing operation	Fig 6-32 Catch data recording

(6) Input materials for the project

Fishing gear materials used in this Pound net project were procured from Japan, including polyethylene (PE) nets and polypropylene (PP) ropes, which were difficult to purchase locally. Used floats and lead core ropes for sinkers were purchased from an MMR subsidiary in Massawa. To reduce project costs, wooden stakes and wooden anchors were procured in Asmara, and iron tools for setting the net frame into the seabed were ordered to one division of MMR.

(7) Result and evaluation of the Pilot Project

The Pound net project in Hirgigo started in December 2021, but the fishing gear was damaged due to the miss selection of fishing grounds, and the inflow of seaweed caused to low catches. As the WG lost motivation to work, the PIU team continued to support the pilot project but eventually made the decision to suspend operations and retrieve the fishing gear from the sea.

On November 23, 2022, after the restart of the pilot project with new Hirgigo WG, the PIU team worked with them to deploy the net in the sea. However, the fishing net was damaged by unexpected stormy weather in night and the operation was suspended.

The Pound net project in Zula started operation after the WG and the PIU team jointly conducted a fishing site survey in March 2022. The Pound net operation in Zula had good results, which verified that the Pound nets in the coastal area targeting subsistence fishermen are effective when appropriate fishing grounds are selected. However, the wooden anchors are not strong enough to hold the nets in place when the sea is rough, so some improvements are needed such as strengthening the fixing power of wooden anchors.

On November 8, 2022, the deployment of Zula Pound net was completed and the WG continued the operations. And later, in January 2023, the WG retrieved the Pound net for maintenance and now it is on its way for redeployment.

The catch data represents 12 days of operation of the Zula Pound net in March 2022, with a total catch of 255 kg, or an average of 21 kg per day. The catch was good despite the net depth of 1.5 m.

(8) Conclusion

As it is known, the Pound net is a stationary fishing gear that is used in the intertidal area. And it would create a favorable atmosphere for coastal communities. Before deploying the Pound net, some conditions are required such as the sea bottom should be muddy, protected from waves (calm sea condition) and close to coral reef area or fish habitat.

There are many differences between the two villages that implemented the Pound net project for subsistence fishermen, including the fishing grounds and where the catch is sold, as well as the attitude of the WG towards the project.

In the case of Hirgigo village, it is located near Massawa city and many villagers commute to work. In terms of fishing, fishermen engage the small scale gillnet fishing and hand line fishing by Styrofoam float and the catches are sold at a relatively good price. However, there is a problem of suitable fishing grounds for the Pound net project.

On the other hand, operations in Zula remained stable after the net was transferred to a suitable fishing ground in March 2022. This village is located 1.5 hours away from Massawa by car, and the price of the fish is low. Furthermore, it takes more than an hour to walk to the fishing ground.

In addition, the living conditions in Zula were assumed to be more difficult than those in Hirgigo because there are only a few places to work near Zula. Under these circumstances, the Pound net project was expected to be a new source of income. The positive result of the project was probably led by the motivation of the WG in Zula.

From the results obtained in these two fishing villages, the following requirements and characteristics of Pound-net fishing in the coastal areas were clearly identified.

- Good fishing grounds are in small bays or coves where the less effect of wind and waves.
- Deploy the leader net for intercepting the way of migratory fish.
- The seabed should be muddy and suitable for holding wooden anchors in place.
- Fishing grounds should be located as close as possible to the village.

- Daily operation time is short as 1 to 2 hours, therefore, fishermen can engage in other work after the operation.
- Seaweed and floating debris must be removed in each operation. The nets should be taken out from the sea every three weeks for maintenance.
- Fish caught are live and fresh. If live fish are kept in fish cages, the sales and consumption can be adjusted.
- If the fishing grounds are located near coral reefs, there is a possibility of catching more fish.
- This fishery will be one of the fishing methods of fish production for the coastal fishermen in Eritrea.

At the October 2022 activity plan meeting in Zula, the WG requested additional Pound net fishing gear, which is also likely to be effective for local fishermen. The PIU team has already constructed one Pound net for Zula, so it is possible to construct another one if they have enough materials. In addition, the Zula Pound net WG has requested a workshop on net repair, then the PIU team had held the workshop at Zula village in April 2023.

(9) Development Strategy and Recommendations

Currently, the abundant sardine resources in the coastal areas of Eritrea are underutilized. Therefore, the Eritrean government is currently researching ways to process and distribute these resources, but effective fishery production methods have not yet been established.

At present, this stock of sardines is caught by beach seine nets in the southern coastal areas of Eritrea when they migrate to the coast during the low sea temperature season. However, sardines need to be handled with ice because their freshness declines quickly after being caught. On the other hand, live sardines are caught by Choko-ami which is one of the Set nets in Japan. This net can keep live fish in the net, and the selling amount and date of landing can be adjusted by using the fish cage.

Considering the current fishing environment in Eritrea, a suitable scale of the Choko-ami for catching sardines would be set in waters 5 to 8 meters depth. Of course, there are issues to be solved in this fishery, such as the purchase of necessary equipment and materials, the number of fishermen engaged in the fishery, management rules, etc. But it is worth considering as an alternative fishery to beach seine nets.

6-1-6 Other technical verification

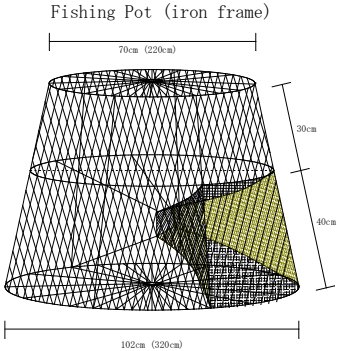
(1) The Pot fishing

Pots (baited traps) are a fishing technology that typically has lower impacts to the nature than many other industrial fishing gears. In this study, JICA expert designed pots with MMR counterparts. Pots

(also commonly referred to as traps) are stationary fishing gear widely used in commercial fisheries around the world. Pots are transportable and typically use bait to attract target species, with retention devices to prevent escape. The benefits of using pots include lower by-catch rates, minimal impact on marine habitats, and a reduced contribution to ghost fishing (when constructed with biodegradable twine) compared to gill-nets. Pots have also been classified as Low Impact and Fuel Efficient (LIFE) gear because they require less fuel to catch fish than other fishing gear. In addition, fish caught in pots remain alive until the gear is retrieved. As a result, the flesh quality of fish caught in pots often exceeds that of other types of fishing gear. In addition, un-targeted species can be returned to the water with a high probability of survival.

During the pilot project, the PIU team conducted a test operation using pot fishing gear to investigate its potential as a new fishing method to catch bottom fish in coral reef areas. The results of the surveys using two types of pot fishing gear, good gear selection can reduce gear damage and allow for efficient fishing in coral reef areas. This fishery is easy for even small-scale fishermen to engage in, and will be effective in developing a variety of fisheries in the future. In addition, the pots constructed by MMR are designed to be stacked on board and occupy little space.

In the future, the PIU team expect to collect appropriate information through test operations of the pot fishing gear in order to promote the pot fishing industry. The following photos are pot fishing gears used in the test operations.

	
Fig 6-33 Collapsible type of Pot	Fig 6-34 Stackable type of Pot

(2) Fisheries training materials and technical reports

For the development of the Eritrean fishing industry, existing fishing gears and methods need to be improved by introducing more efficient fishing techniques. This requires training to improve the skills and knowledge of fishermen, including newly recruited fishermen. To achieve these objectives, the PIU team also worked to develop effective fisheries education materials, including textbooks and videos that introduce new fishing methods.

In this activity, the PIU team assigned a person in charge to develop each educational text and gave them the opportunity to improve their knowledge of fishing techniques through the preparation of training materials. In addition to this, the PIU team completed a technical report based on the knowledge and experience gained from the pilot project.

The PIU team completed the following fishery training materials and pilot project introduction video in the local language (Tigrigna).

- 1) Set net pilot project introduction video
- 2) BASIC FISEHRY 1
- 3) BASIC FISHERY COMPREHENSIBLE
- 4) Basic knowledge of fishing gear material & basic calculation in connection with fishing gear
- 5) BASIC WORKS ON ROPE & NET

(3) recommendations for coastal fisheries development

Lessons learned through the pilot projects in the fishing gear and method sector and recommendations for future dissemination are summarized below.

- Continuously exchange information with fishermen and build a strong relationship with them through the dissemination of fishery technologies.
- The MMR need to consider and implement practical measures to strengthen the technology dissemination system.
- The MMR should have technical expert in fishing gear design as it is a cornerstone for fisheries development.
- The MMR will contribute to the development of the fishery industry in Eritrea by effectively using the data and materials accumulated through the pilot project, including the knowledge and experience (lessons learned).
- The MMR will take the leadership in extension activities, while assuming the sense of responsibility and independence of the fishermen.
- Focus on economic aspects such as fishery income and expenditure for sustainable fisheries management.
- Ensure that fishermen can locally procure appropriate fishing gear (nets, buoys, ropes, etc.) and fishing boats for the development and expanding of fisheries production.
- Expand support services for fishing activities through the preparation of fishery-related facilities.
- For tender documents, specifications such as material lists should be reviewed and prepared for procurement.

- The pilot project was designed and implemented as a practical approach and obtained all information should be used effectively as a guideline.
- MMR will continue to produce fisheries education materials and technical reports in line with the actual situation of fisheries for the development of fisheries in Eritrea.
- For the reason of easy net making, measuring stick for easy marking on the net is useful.
- Provide tools and specific example to fishermen which are more convenient and efficient.
- Support the improvement of fishermen's livelihood by increasing fishery production and income.
- Prepare attractive measures to promote fishing to young generations.
- Provide various supports to fishermen living in coastal areas (foot fishermen).

6-2 Pilot Projects for Fishing Community Development

In the area of fisheries community development, pilot activities aimed at improving the livelihoods of fishing communities through the development and distribution of fisheries products were conducted in the villages of Hirgigo, Massawa sub-zoba and Zula, Foro sub-zoba in the Northern Red Sea zoba, where the baseline study was conducted. The Fishing Community Development PIU that implemented the project consisted of 13 counterparts (C/P) appointed from divisions related to the development and distribution of fishery products, such as Food processing, Quality control, and Socioeconomics at the MMR. As the activities progressed, the content of the PIUs changed, and once the project entered the implementation phase, five C/Ps became core members, and the project was carried out in collaboration with different divisions of the MMR. These pilot activities, from project formulation to implementation, are summarized over a three-year period from approximately June 2020 to June 2023.

For the pilot activities, the following three pilot projects (PPs) were formulated, targeting the improvement of small fresh fish distribution, the development of processed fishery products, and the development of new markets, among the priority issues selected in the previous chapter.

- 1) Pilot project for improvement of small fresh fish distribution (PP4).
- 2) Pilot project for development of processed fishery products (PP5).
- 3) Pilot project for new market development (PP6).

In order to implement the pilot project, fishery cooperatives were first formed in the villages of Hirgigo and Zula to serve as the main implementers in the fishing communities, and capacity building was conducted for their members. In parallel, Community Fishery Center (CFC) was constructed in each village to serve as a base for project activities, and equipment necessary for the distribution of fresh fish and the development of processed fishery products was procured, installed, and trained. Then, the distribution of fresh fish from Zula to Foro, the development of new processed fish products, and training and workshops for members were conducted in each of the villages of Hirgigo and Zula.

As of the end of June 2023, when this paper was drafted, PP4 had been partially implemented, PP5 had been completed and PP6 had not yet been implemented, although the efforts to resolve issues in these pilot activities are described in a step-by-step manner. For more information on this pilot activity, see Annex 4 “Pilot Project Activity Report of the Fishing Community Development Project Implementation Unit”.

Those pilot project were implemented by the Fishing Community Development PIU team as below.

Table 6-2 The team members of the fishing community development PIU

No.	Photo	Name	Position
1		Selomon Brhane	PIU Team Leader, Monitoring & Evaluation
2		Yohana Negassi	PIU Team Sub-leader, Quality Control Laboratory
3		Aklilu Rufael	PIU Team Member Wood work technician
4		Kibrom Issak	PIU Team Member Metal work technician
5		Beraki Haile	Extension Officer (Hirgigo)

6-2-1 Identification of Issues for Pilot Project Formulation

In forming the pilot activities, fishing community development issues in the villages of Hirgigo and Zula were first identified and selected. The baseline survey identified problems and constraints that need to be solved to improve production and distribution in the fishery. These included constraints related to government policy arrangements, which were excluded from the project. For example, the biggest problems cited by fish consumers in inland cities were the lack of fish supply and high prices, but this project focused on the problem of supply shortages rather than fish prices, and worked to improve catch and distribution and develop processed products. The PIU team for Fishing Gears and Methods Improvement would be working in both fishing villages to support subsistence fisheries to improve catches. The fishing community development issues identified were as follows.

(1) Challenges in Improving Distribution of Small Fresh Fish

(a) Hirgigo village

Subsistence fishers in Hirgigo sold their catch of the day at the Edaga open-air fish market in the center of Massawa city. Although it is a government-sanctioned free market for subsistence fishers, they put their fresh fish in baskets and sold them on the street without proper protection from dust, sunlight, and flies³. Transportation costs are also high because fish are transported to the market in small lots. Improving the distribution environment is essential to improve the catch and sales of subsistence fishers. In addition, from the



Fig 6-35 Hirgigo subsistence fishers selling fish at the Edaga open-air fish market.

perspective of national food security, it is necessary to meet the high demand for fishery products in Asmara and inland areas, but the government's National Fishery Corporation (NFC), the sole distributor of fishery products in the country, handles only large fresh fish and does not distribute small fish, which are not very profitable.

(b) Zula village

In the case of Zula village, demand was high within the village, but as mentioned earlier, distribution outside the village was essential to improve fishery production and village livelihoods. A promising market is the neighboring town of Foro, located along the main road. It is the sub-zoba capital and a large market is held there once a week. In order to target this market, ice is essential to maintain the quality of the fish, but it is not available in Zula or the surrounding area, so ice from Massawa was transported over many hours, paying more than three times the price. Minimizing these costs and improving the quality of fish in distribution was a major challenge for improving the economics of subsistence fisheries, and would become more important as catches increase in the future.



Fig 6-36 Zula subsistence farmers selling fish on the roadside in the town of Foro. Camels are the means of transport.

³ During the implementation of this project, the Edaga open-air fish market was closed by the city of Massawa due to sanitary problems, and a new open-air fish market was designated a short distance away as a free market for subsistence farmers

(2) Challenges in Developing Processed Fishery Products in Fishing Villages

The key to improving household income is to create opportunities for women to earn income from fisheries, and the development and distribution of marketable processed fish products has been a challenge for this purpose. As many coastal fishing villages have no electricity and refrigerators are hardly prevalent, processed fish products that can be stored at room temperature are preferred. Extending the shelf life of processed products is also an essential issue for product development. MMR has attempted to develop processed fish products, but so far has not been able to demonstrate the development of a product that would allow small fish to be widely consumed. Fishing villages have traditionally had the skills to make salted and dried products, but lacked the knowledge to commercialize them with the market in mind.

(3) Challenges in Developing a Market for Small Fish in Inland Areas

As mentioned above, from the perspective of national food security, it is necessary to meet the high demand for fishery products in inland areas, but currently the only fish consumed in Asmara and other inland areas are large fish caught by artisanal fisheries, such as Spanish mackerel, queen fish, grouper, snappers, and catfish, which are distributed by the NFC. These fish are a substitute for livestock meat for inland consumers, who prefer fish with more edible meat parts and have limited cooking methods. Therefore, it seemed necessary to advertise the nutritional and economic value of small fish caught by subsistence fishers such as mullet and Indian mackerel, including the cooking methods used by coastal people, in order to promote consumption of these small fish.

6-2-2 Formulation of Pilot Projects

Three pilot projects were developed to address the above three priority issues. The projects are described below. The project numbers are sequential numbers from the Fishing Gears and Methods PIU team.

(1) Pilot project for improvement of small fresh fish distribution (PP4)

This pilot project aimed to improve the distribution of small fresh fish in the villages of Hirgigo and Zula. To improve distribution, it was necessary to examine the following three topics: quality of fresh fish, transportation, and storage. For this purpose, (a) ice for quality maintenance, (b) cooler boxes for transportation, and (c) freezers for fish storage were needed. Distribution from the village of Hirgigo to Massawa was targeted at the Edaga open-air fish market (later changed to the Sigalet open-air fish market prepared by the city of Massawa). Distribution to Asmara and inland areas had no other way than through the NFC, which had the sole right to distribute fishery products, and had to negotiate to be placed on the distribution route of the said fishery corporation.

(2) Pilot project for development of processed fishery products (PP5)

In order to develop new fishery products in fishing communities, a small fish processing manual and processing facilities and equipment were needed. In preparing the processing manual, it was discovered that fish preservation and processing were traditionally practiced in coastal fishing villages after the baseline survey was conducted, and this information needed to be collected and added to the manual. Equipment and utensils for processing should be prepared with locally available materials, depending on the fish products to be produced. It was also necessary to have a place in the fishing village where fishers could process fish and sell their products.

(3) Pilot project for new market development (PP6)

In order to develop and expand the market for small fish in inland areas such as Asmara, it was necessary to promote the consumption of small fish, which were unfamiliar to inland populations, by introducing them to the high nutritional value and low-cost small fish recipes practiced by people in coastal communities. Recipes could include not only small fresh fish, but also processed fish products developed by fishing communities. The only precondition was that, firstly, once PP4 had progressed and the distribution of small fish from Hirgigo had started, cooking and tasting demonstrations (PP6) of these small fish would be organized in Massawa and Asmara.

6-2-3 Implementation of Pilot Projects

Each of the pilot projects has many overlapping areas of content and has not been implemented individually and independently. Therefore, the description here follows the phases in which they were implemented as a whole. Then, at the end of the description, a summary of these project activities was provided for each pilot project. The main contents were as follows.

- 1) Formation of cooperatives and capacity building.
- 2) Preparation of equipment, manuals and workshops for fisheries processing.
- 3) Procurement of equipment overseas.
- 4) Construction of a Community Fishery Center (CFC).
- 5) Distribution of fresh fish by Zula Fisheries Cooperative.

(1) Formation of Cooperatives and Capacity Building in Zula and Hirgigo Villages (PP4, PP5, PP6)

From the time Zula and Hirgigo villages were selected as the target fishing villages for the project, the main objectives of the project activities have been explained from time to time, not only to the village chiefs and village officials, but also to subsistence fishers and women's groups. In order to start the pilot project, it was necessary to define and organize the target group in both fishing communities and discuss the division of roles and processes for the specific objectives of the project. The aim was

therefore to create a structure that would ensure smooth implementation of the project and foster a driving force for the continuation of the activities in the future.

(a) Holding consensus workshops

In November 2021, prior to this workshop, all members of the project, including the MMR project director, project manager, extension advisor, Fishing Gears and Methods PIU team, Fishing Community Development PIU team, and JICA experts visited both fishing villages. In each village, project members explained the history of the project and its future implementation plan to the village chief, fishers, and women's groups, and informed them that the pilot project would start in their respective villages and obtained their agreement.



Fig 6-37 Meeting with all project members and the village chief, fishers and women's representatives of Zula village

This briefing meeting was the first meeting after the 18-month travel restriction following the COVID-19 outbreak in March 2020, in addition to the change of two project representatives in the MMR, and was an important meeting to reaffirm the will of the community to implement the project and to deepen understanding among all parties involved.

Two weeks later, the Fishing Gears and Methods and Fishing Community Development PIU teams held consensus workshops in the villages of Zula and Hirgigo to prepare for project implementation. First, both PIU teams gave a detailed description of each pilot project and its implementation plan, using flip charts and samples. In Zula village, 20 subsistence fishers, women's representatives and the village chief were present, while in Hirgigo village, 19 subsistence fishers and women's representatives, including the village chief, were present. The moderator was the MMR extension officer responsible for each village. The main content of the meeting was as follows.



Fig 6-38 Consensus Workshop in Zula Village

- 1) Presentation by the Fishing Gears and Methods team: Introduction of small-scale bottom long-line fishing (PP2) and introduction of pound net fishing (PP3) were explained, especially PP3, which was explained in detail with charts and tables.
- 2) Presentation by the Fishing Community Development team: Improvement of small fresh fish distribution (PP4), development of processed fish products (PP5), and development of new

markets (PP6) were explained. The proposal to install ice machines, introduce fish handling, processing, and preservation methods, and build a working facility in the village (Community Fishery Center, CFC) was then explained in detail, as well as the schedule for these activities.

- 3) Presentation by MMR Cooperative Division staff: The staff explained that the establishment of a fishery cooperative was necessary to implement these pilot projects, and explained in detail the conditions for membership, rules of the cooperative, and various procedures established by the MMR

During the question-and-answer session that followed these presentations by MMR staff, participants asked many enthusiastic questions, and the contributions of the community were also discussed, indicating that the meeting fostered community preparedness and ownership. Such meetings were held several times thereafter in each fishing village as needed.

(b) Formation of fishery cooperatives

One week after the above consensus workshop, a meeting was held in each fishing village to establish a fishery cooperative. 15 members were selected in each village prior to the meeting according to the MMR membership criteria, and officers such as a leader, secretary, accountant, and two committee members were elected at the meeting by a majority vote of those present. Each officer and member then applied for registration as a cooperative and a member according to the MMR form.

After this meeting, these applications were approved by the local government (sub-zoba administrator) having jurisdiction over the village, and after further review by the MMR, the establishment of the fishery cooperative was approved as an official fishery cooperative. According to MMR's membership criteria, priority is given to female-headed households and households with physically challenged members. In addition, the election of cooperative officers and the establishment of rules and regulations are done by a majority vote of the members. Since most of the participants in the baseline survey (fishermen household survey) were different from the members of the cooperative that was established, it would be desirable to conduct the fishers' household survey again targeting the new members.



Fig 6-39 Board members are elected by majority vote in Hirgigo, with the village chief looking on.



Fig 6-40 At the end of the meeting in Zula village, each member fills out and signs a registration form.

Table 6-3 Cooperatives formed in the villages of Hirgigo and Zula

Item	Hirgigo village	Zula village
Cooperative Name	Dekhano Fishing and Fish Processing Cooperative	Kelij Zula Fishing and Fish Processing Cooperative
Address	Northern Red Sea zoba, Massawa sub-zoba, Hirgigo village	Northern Red Sea zoba, Foro sub-zoba, Zula village
Number of Members	15 (male 6, female 9)	15 (male 7, female 8)
Formation Date	16 December 2021	15 December 2021
Aim of the Cooperative	To fish, process and sell of fish at fair price to the community	To fish, process and sell of fish at fair price to the community
Leaders	• Manager: Mahmud Musa Said • Secretary: Zahra Saleh Mahmud • Cashier: Ahmed Saleh Abubeker	• Manager: Ibrahim Omer Talte • Secretary: Saleh Mahmud Jabera • Cashier: Asha Osman Hassen
Approved by	• Hussen Kater Ahmed, Artisanal and Industrial Division, MMR • Haile Asfeh, s/zoba Administrator • Halima Osman, Hirgigo Administrator	• Hussen Kater Ahmed, Artisanal and Industrial Division, MMR • Osman Arefa, s/zoba Administrator • Omer Abrhum Tsaeda, Zula Administrator
Note	Number of members can increase or decrease based on the by-law	Number of members can increase or decrease based on the by-law

(2) Preparation of Fishery Processing Equipment, Manuals and Workshops (PP5)

For the processing equipment for drying and smoking fish, the C/P team prepared prototypes using locally available materials, together with the MMR Engineering Division staff, and each prototype was tested and the best one was selected. Manuals for the production of salt-dried and smoked products were also prepared and presented to the members at their respective fish processing training sessions. After the training, the members cooked their own products based on the results they had learned and tasted them to confirm the market value of the processed products.

(a) Preparation of fish dryer and manual

The objectives of this activity were to (a) identify processing methods for small pelagic fish and sharks, (b) compare sun-dried products with and without salt, and (c) compare the performance of five different dryers and select the best dryer for the fishing village.

Prior to this, the C/P team conducted another round of interviews to learn about the traditional fish processing methods in each fishing village that were discovered after the baseline survey, and in addition to processing methods, they also investigated how to cook with them. Based on the results, the C/Ps in charge of food processing and quality control at MMR added their expertise and developed a “Small Fish Processing Manual.” This manual was finalized after practicality was verified through trial use of a dryer.

Three types of fish were used in the test: sardines, Indian mackerel, and sharks. Three methods of sun-drying were used: soaking the Indian mackerel in salt water for 5 minutes before sun-drying, sun-drying the sardines and Indian mackerel as they were, and sun-drying the shark fillets after sprinkling them with salt. The dryers used were (a) a bed net-type, (b) a 4-layer shelf net-type, (c) a plastic tent-type, (d) a hanging net-type, and (e) an oven type. It was therefore decided to manufacture these dryers at the MMR Engineering Division and implement the pilot project (PP5) in the villages of Hirgigo and Zula. The manual was also appreciated by fishers as it was developed based on community information.



Fig 6-41 Resurvey of baseline survey on fish processing method in Hirgigo village.



Fig 6-42 Bed net-type dryer



Fig 6-43 Four-layer shelf net-type dryer



Fig 6-44 Hanging net-type dryer

(b) Preparation of smoking kiln and manual

To produce smoked fish, the C/P team built a model of a smoking kiln with two layers of wire mesh shelves mounted inside a small drum and made a prototype smoked product using 5 kg of mullet. The fish were filleted, soaked in a solution of red pepper powder (berbere), the most popular spice in the country, and placed on the wire mesh shelves of the smoking kiln.

The first attempt was too intense and the surface of the fish was blackened and charred after about 30 minutes of smoking. Then, the fish was smoked for more than an hour and a half, carefully producing only thin smoke without flames. The result was a brightly colored smoked product that tasted better than expected. One reference also states that "Keeps the smoke white and thin for three hours." The wood chips used as fuel were well-dried "mesquite trees" (local name Temri Musa). This tree is an invasive species that grows in coastal areas and is allowed to be cut down freely because of its prolific growth and its propensity to dry out the land. After the test was completed, the MMR Engineering Division built two large smoking kilns using regular-sized drums and distributed them to the cooperatives of Hirgigo and Zula.

The fish smoking manual was developed after a literature review and several trials and errors. Furthermore, fish meatballs, a paste product, were also developed by the C/P team as a marketable fish product.



Fig 6-45 A model smoking kiln using small drums

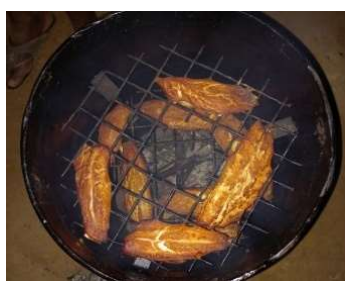


Fig 6-46 Successfully smoked mullet at the second attempt.



Fig 6-47 Full-size drum smoking kiln

(c) Conducting training and workshops on fishery processing (PP5)

After developing fishery processing equipment and manuals, the C/P team conducted fishery processing training in both villages to help members produce marketable processed products. During the two-day training, cooperative members learnt basic knowledge of fish processing (hygiene, quality control, etc.) and how to produce processed products. A workshop was then held by the cooperative members, where they demonstrated the techniques they learned for manufacturing processed fishery products and cooking with processed fishery products.

The training and workshops were held in each community for a total of five days, in Zula in November 2022 and in Hirgigo in February 2023. Thanks to the cooking demonstrations with the processed products, the cooperative members seemed to have gained confidence in their products. In the future, the production of fish meatballs, a fish paste product, will be introduced to the cooperative.



Fig 6-48 Zula village, C/P lecture on sanitation and quality control



Fig 6-49 Hirgigo village, salt-drying racks and smoking kiln practice.

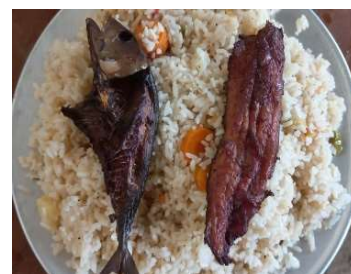


Fig 6-50 Zula village, fried and smoked prototypes

(3) Selection and procurement of equipment for the pilot project (PP4, PP5)

Procurement of equipment needed for the pilot project was discussed. The most needed equipment identified in the baseline survey was ice making equipment to produce ice for the cold chain. This seemed essential to maintain the quality of fish captured for expanding the distribution of fresh fish. Therefore, a solar-powered ice making machine (300 kg (60 pieces/5 kg) of ice per day) was selected for the village of Zula and a solar-powered ice making freezer (380 kg (200 pieces/1.9 kg) of ice per day or 2 days) for the village of Hirgigo. Different ice making equipment was chosen to compare the suitability of the two pieces of equipment in a severe coastal heat environment.

The ice making machine was originally powered by 380V 3-phase electricity. Therefore, information on the latitude of the installation site (15 degrees north latitude) and the average monthly maximum temperature was sent to the manufacturer, who was requested to design a solar power system that would enable ice block maker to operate even in extremely hot sites such as Zula village, where electricity was not available. The ice freezers, on the other hand, were of the ordinary, home-use, versatile, and easy-to-use type. In addition, these solar-powered ice making machine and ice making

freezers are designated as the tropical type (type T, 18°C – 43°C), which is the highest operating ambient temperature category.

Furthermore, a solar-powered freezer for freezing and preserving fish (410-liter capacity, same specifications as the ice making freezer), fish meat-bone separator, vacuum packer, hand mincer, cooler box, and stainless tray, etc. were also added to the list. These devices seemed capable of meeting the three challenges of quality, transportation, and storage in fresh fish distribution (PP4). In addition to this, some smaller equipment, such as kitchenware and household items, were procured locally. A list of these items and their procurement costs are provided to MMR for reference. The table below shows the specifications of the main equipment procured overseas and their distributed sites.

Table 6-4 List of equipment for CFC procured abroad

s/n	Item	Specification	Qty.	Unit	Distributed
1	Solar Ice Block Machine	OMT Co. Model DOTB10, Capacity 1,000kg/24hrs, 1 batch/3hrs/30 blocks, Ice block size 100x95x500mm(4.4kg), Refrigerant HFC(R404a), Ambient temp. max.43°C, Total power 5.2KW, Electricity connection 380V/50Hz/3P. Tropical type, Air cooling, Size L;1800 x W;1100 x H;1200mm,	1	pc	Zula: 1 set
	Solar Power System	Model: OMT, 3 Phase inverter 30KW, Controller MPPT 100A, Solar panel 275W x 32 sheet, Battery 12Vx150Ax16pc,	1	set	
2	Solar Chest Freezer	FREECOLD Co.Ltd., Model PCSI 410L, Type SN-T (10°C - 43°C), Refrigerator/Freezer, 800W/h, 180W-24V, Size 88x156x71cm, 57kg	4	pc	Zula: 1 set, Hirgigo: 3 sets (2 for Ice machine, 1 for freezer)
	Soler Power System	MPPT Controller, Solar panel 2x330Wp, Battery; 2x210Ah AGM,	4	set	
3	Fish Meet-Bone Separator	Luohe Quality Mechanical Equipment Co., Model QT-A11, Capacity 180kg/h, Power 220V-2.2kw, Size 800 x 550 x 800mm, Weight 180kg,	2	pc	MMR: 1 pc Hirgigo: 1 pc
4	Vacuum Sealer	Model Vacuum packed premium, Power AC 100V, Power use 130W, Size 40x19.4x11cm, Weigh 2.8kg,	2	pc	MMR: 1 set Hirgigo: 1 set
	Power Transformer	Model PAL-350E, AC220V-AC100V, 350VA, 3.7kg	2	pc	
5	Cooking Scale	TANITA, 2kg KW-001 WH, Weight 2kg, Waterproof	3	pc	MMR: 1 pc Zula: 1 pc Hirgigo: 1 pc
6	Hand Mincer	Model MT-32, Size 320x160x205mm, Weight 8kg, Plate 4.5mm, Stainless Steel & wood	2	pc	Zula: 1 pc Hirgigo: 1 pc
7	Cooler Box	Coleman USA, Model Polylight 48QT, Capacity 45 L, Ice retention 3 days, Size 63x33x39.5cm, Weight 4.1kg	20	pc	MMR: 2 pc Zula: 9 pc Hirgigo: 9 pc
8	Plastic Container for Ice Making	Plastic container with lid, Size; 1900ml	200	pc	Hirgigo: 200 pc
9	Stainless Tray	Stainless Steel, Model T-QB-4, Capacity 11L, Size 476x332x82mm	50	pc	MMR: 10 pc Zula: 20 pc Hirgigo: 20 pc
10	Ice Pick	Pilot ice pick single, L=240mm	6	pc	Zula: 3 pc Hirgigo: 3 pc
		Pilot ice pick single, L=135mm	4	pc	Zula: 2 pc Hirgigo: 2 pc

(4) Establishment of Community Fishery Center (CFC) in Zula and Hirgigo (PP4, PP5)

In the process of formulating the pilot project, it was suggested that a building was needed in Zula and Hirgigo to house the aforementioned equipment. In addition, it was also discussed that a place for project activities using these equipment, such as ice production, processing and marketing of fishery products, preparation for distribution, and meetings of cooperative members, would also be needed. A facility with these functions could become a core facility in a fishing community, a place that generates the vitality to nurture and advance the community's fisheries activities. This idea was introduced to and discussed in both villages at the December 2021 Consensus Workshop. Both village chiefs and cooperative members were convinced by the concept of this core facility and agreed to give priority to finding a facility that could be applied to it in their respective villages. This facility was named the Community Fishery Center (CFC).

(a) CFC designing

It is preferable for the CFC to be able to convert existing facilities due to budget constraints, but if this is not possible, it will be necessary to take measures such as constructing new buildings. In the village of Zula, a village-owned facility was conveniently provided, but in the village of Hirgigo, no suitable building could be found, and it became necessary to construct a new one. It was decided to consider the best solution for the convenience of each village.

i) Zula CFC (Type 1)

In the village of Zula, the school building and land of a former village-owned Arabic elementary school were provided. The building, with a floor area of 5m x 15m, was long from north to south and consisted of concrete block walls and a tin roof, with the interior divided into three rooms (5m x 5m) by block walls. Then, it was thought that if the tin roof, which was partially rusted and damaged, were replaced, windows and doors were repaired or added, and reinforced concrete were poured on the floor, the facility would be fully usable as a CFC.

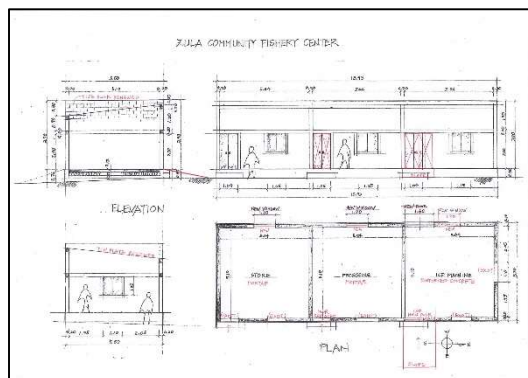


Fig 6-51 Zula CFC, renovation of former Arabic school

The distance to the village water tower, which is the source of water, is about 120m, and a vacant lot was secured around the building to install 32 solar panels to power the ice block machine. The cooperative also offered to provide labor for the repair work, and it appeared feasible to renovate the building into a CFC by procuring materials by the project and hiring a few additional technicians for special tasks.

ii) Hirgigo CFC (Type 2)

The village of Hirgigo could not find an existing building that could be converted to a CFC. Therefore, the village chief and cooperative leader proposed that a new building be constructed with concrete and block, similar to the government building in the village. However, according to estimates, the construction cost of the CFC far exceeded the total budget for the CFC. Then, the project team proposed a CFC using cargo containers. This CFC was to be constructed by installing cargo containers on vacant land around a water station in the center of the village and connecting a water supply system.

The project team visited EriFish's new office in Massawa, a two-story building consisting of 10 containers of different sizes, and received advice from the company manager. Based on this, a design was proposed in which two 20-foot containers were placed in parallel, with a space of about 3m between them covered with a tin roof to create a working area. Since the CFC is a new building, it is necessary to apply to the Massawa sub-zoba government for a permit to occupy the land where the CFC will be built.

Later, the Hirgigo CFC was changed from the original design of two containers in parallel (floor area of 46m²) to one container with eaves (floor area of 29m²), because the ice making method in Hirgigo village was different from that in Zula village, and the CFC did not require the same size of floor space as the Zula CFC, and even if its size was reduced from two containers to one, the CFC would retain its originally planned functions. On the other hand, the project was at this point facing a crisis of substantial construction cost overruns and significant process delays. Simplification of the CFC structure would be a way out of this crisis, and it was also preferable for MMR to have a simpler, less costly structure in anticipation of future expansion of the CFC to other fishing villages.

Once the structure of the CFC was finalized, the C/P team worked with MMR's civil engineer to design the CFC and estimated the required materials. Local procurement of all construction materials was preferred and deemed possible. As a result, the total cost of the two CFC constructions would be roughly within the originally planned budget.

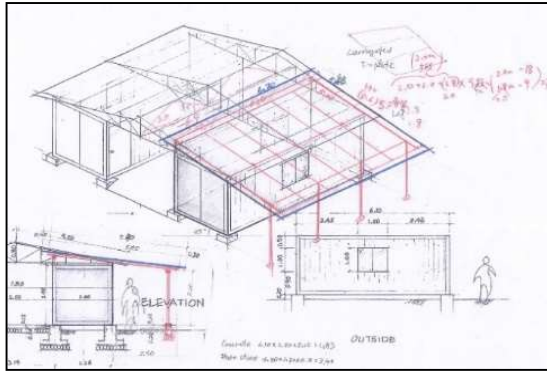


Fig 6-52 Hirgigo CFC, redesigned from two containers to one.

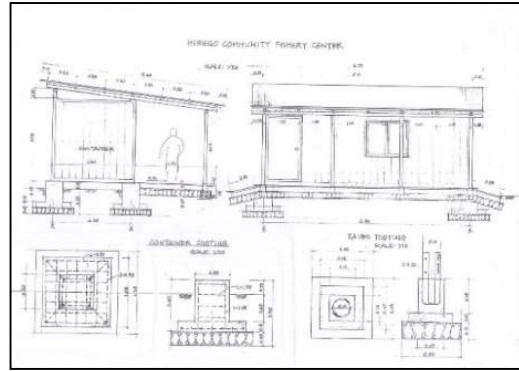


Fig 6-53 Hirgigo CFC, final design of detail drawing

(b) Procurement of CFC construction materials

The major construction materials were to be procured domestically through the government corporation. However, MMR proposed procurement from overseas (UAE, Dubai) due to the complicated government procedures, unpredictable time frame, and high unit cost for domestic procurement. So, we decided to procure from overseas through MMR's Procurement Division, but there was no progress at all for about two months. Then, we ended up going back to domestic procurement, which was completed much more quickly than we had anticipated.

The government procurement agent was Red Sea Cooperation (RSC), and the main items procured were rebar, L-shaped steel, square lumber, roofing tinplate, and water piping materials, at prices considerably lower than market prices. Cement was then procured from the government plant, Gedem Cement Factory, which was also quite cheap, 10-20% of the market price, and of good quality. Other small materials were procured directly from private building material stores in Massawa and Asmara.

The MMR Engineering Division already had experience with prototype fish dryers and smoking kilns. Therefore, the CFC windows, doors, water tower, and CFC cargo container modifications would also be fabricated and installed by the Division using materials procured for the project. However, the C/P team was concerned about delays in some of the work at the Engineering Division that they had experienced previously. Therefore, they decided to request a private wood workshop in Massawa to fabricate windows (5pc) and doors (3pc) for the CFC by providing materials. The fabricated woodworks were installed in the CFC by the staff of Engineering Division and field workers hired by the project.

(c) Construction of CFC

Construction of the CFC was planned to employ a site foreman and several workers, with all construction materials procured and provided by the project and under the supervision of the MMR

civil engineer and C/P team. By the end of August 2022, construction of the CFC began first in Hirigigo, after all construction materials had been delivered to the site and procurement was completed. The construction of the Zula CFC, which started later, was completed first, and after the installation and commissioning of equipment was also completed, the Hirigigo CFC was completed.

i) Construction of Zula CFC (Type 1)

The improvement works at Zula CFC involved the renovation and reinforcement of the roof and floor, while the concrete and block walls of the old school building remained intact. Construction work began in September and involved the following process.

- 1) Re-roofing and painting of the tinplate roof.
- 2) Reinforcing the floor of the machine room (reinforced concrete) where the ice block making machine is installed, and leveling the floor of the fish processing room and warehouse with mortar.
- 3) Installation of three additional windows, replacement of one door, and expansion of one door.
- 4) Installation of drainage pipes and a sewage treatment tank.
- 5) Installation of a water tower and a water storage tank.
- 6) Installation of 120 m of water pipe and connection to the village water main.

Of these, 1) through 4) were done by field workers, 5) by MMR Engineering Division staff and the C/P team, and 6) excavation was done by volunteer work of Zula Cooperative members, while the water pipes were connected by field workers. Subsequently, the installation of the solar-powered ice making machine (1 unit) and the solar-powered freezer (1 unit) was carried out according to the following procedure.

- 1) Installation of solar panels for ice block maker (32 panels), solar panels for freezer (2 panels), and solar panel site protection fence.
- 2) Installation of batteries for ice block maker and freezer (16pc + 2pc), and wiring of controllers.
- 3) Installation of ice block maker and freezer.
- 4) Installation of cooling tower for ice block maker and water supply piping.

Of these, the foundation work for 7) and 10) was done by field workers, while the rest was handled by MMR Engineering Division staff and the C/P team. All construction was then completed in November 2022.



Fig 6-54 Reinforced concrete being poured in ice block machine room floor.



Fig 6-55 Restoring and extending windows and doors



Fig 6-56 Roof replaced and painted, 3 new windows on rear exterior wall

ii) Construction of a Hirgigo CFC (Type 2)

Construction of the Hirgigo CFC began in August, shortly after the procurement and delivery of concrete materials were completed. The process was as follows.

- 1) Construction of concrete foundation for container installation.
- 2) Concrete pavement of the floor in front of the container.
- 3) Modification, transportation and installation of containers.
- 4) Installation and painting of container roof and eaves.
- 5) Installation of water tank with block foundation.
- 6) Installation of 20m water pipe and connection to village water pipe.

After the construction work described in 1) above was completed, work on the Hirgigo CFC was suspended here and work on the Zula CFC started, due to the need for a period of curing of the foundation concrete and procurement and modification of the containers. Then, after the completion of the Zula CFC, the work from 2) to 6) above was finished and the installation of the following solar-powered freezers (3 units) and water supply work proceeded from December onwards in the following process.

- 7) Installation of solar panels (6pc) for freezers and solar panel protection fence.
- 8) Installation and wiring of freezer batteries (6 pc) and controllers.
- 9) Installation of freezer and water supply piping.

Of the above, 1), 2), and 5) were mainly done by field workers, while Hirgigo Cooperative members volunteered to do the excavation work for 6), and most of the rest was done by MMR Engineering Division staff and the C/P team. The construction was then reported to be completed in December 2022, but later on, uncompleted sections were identified and the project was eventually completed in March 2023.

Since the village of Zula is 56 km from Massawa, an hour's drive away, the construction work at the site took longer than expected. Initially, two CFCs construction was scheduled to be completed around April 2022, and the distribution of fresh fish and processed fishery products was to begin during the peak fishing season from mid-October onward, but this did not go as planned. The completion of the Zula CFC was in November 2022 and the Hirgigo CFC was in March 2023, resulting in the 11-month delay. In addition to delays in procuring equipment and materials, both the MMR Engineering Division staff and the C/P team faced many challenges that they had never experienced before and had to deal with them through trial and error. On the other hand, however, many valuable lessons were learned.



Fig 6-57 Concrete foundation for container installation



Fig 6-58 Installation of the modified container by MMR Engineering Division staff.



Fig 6-59 Front of the CFC with eaves and concrete poured to create a working area.

(d) Installation and commissioning of CFC equipment

i) Zula CFC (Type 1)

The installation of the solar-powered ice block maker in Zula village, described in the previous section, was originally scheduled to be performed by local electrical engineers (MMR Engineering Division staff), with the final inspection and training of operating technicians to be performed by the engineer dispatched by the Chinese manufacturer. However, when the COVID-19 infection was at a low ebb, we repeatedly urged the manufacturer through the Japanese procurement agent to dispatch the engineer, but they ignored our requests. It also became apparent that after the ice block maker and freezer equipment were delivered to the site, there was a lack of accessories and small items for those solar systems. In response to these problems, MMR Engineering Division decided to not only install the ice block maker, freezer, and solar system, but also commission them and train local technicians. Detailed installation documents and operating manuals were obtained from the manufacturer, equipment was installed accordingly, missing items were procured from electrical shops in Massawa and Asmara, and the few accessories that were still missing were made in the workshop in the MMR.



Fig 6-60 Solar-powered freezer installed in Zula CFC for fish storage



Fig 6-61 Solar panels for ice machine and freezer, surrounded by protective fence facilities



Fig 6-62 Trial run of the ice making machine, 30 ice blocks made at one batch.

After installation and commissioning were completed in December 2022, the Engineering Division staff provided a week of training to the Zula cooperative's technicians responsible for the operation and maintenance of equipment in CFC.

ii) Hirgigo CFC (Type 2)

After the completion of the Zula CFC, three freezers and solar systems were installed at the Hirgigo CFC in December 2022, and commissioning of these equipment and training of operating technicians were scheduled, but at the Hirgigo CFC, the water supply system was found to be incomplete, then, additional work was first performed on it. Subsequently, in March 2023, the freezers were commissioned by MMR Engineering Division staff, but all three freezers installed did not work properly and failed to produce sufficient ice. Around the same time, the freezers installed at the aforementioned Zula CFC were also reported to have stopped operating, leaving all four freezers procured for the project to be out of commission.

As this equipment was still under warranty, we first approached the French freezer manufacturer from whom we procured the equipment through a Japanese procurement agent to see what could be done. However, after a period of inability to contact the company, in April we received a call from the JETRO office in France, which informed us that the manufacturer had already gone bankrupt and had been sentenced to the opening of judicial liquidation in October 2022.



Fig 6-63 Solar system for freezers installed inside the fence.



Fig 6-64 Three freezers installed in the Hirgigo CFC



Fig 6-65 Preparation of ice making and freezer commissioning

The PIU team had no choice but to order a local solar freezer technician to inspect and repair the four solar freezers in question. As of July, according to the local technician, the procured equipment appears to be flawless, and two of the four units have begun to operate again, and the remaining two units are expected to be able to resume operations after parts replacement. Therefore, these tasks are underway at the site.

(e) Comparison of two CFCs

The two CFCs in the villages of Zula and Hirgigo were of different types/designs for the pilot. Upon completion of construction, the differences between the two types of CFCs were compared. First, the construction and equipment procurement costs for both CFCs were as shown in the table below.

Table 6-5 Costs of CFC Construction and Equipment Procurement (USD 1.0 = JPY130)

Item	Zula CFC	Hirgigo CFC	Sum
Construction, Local Cost	10,214.93	11,792.00	22,006.93
Equipment (FOB)	34,250.38	13,417.23	47,667.62
Shipping Cost	18,647.90	7,305.12	25,953.02
Total (\$)	63,113.22	32,514.35	95,627.57

1) Zula CFC (Type 1), floor area 77m²

- CFC renovated from old school building. Mainly roof, floor, windows, doors, plumbing and drainage, etc. were renovated and newly constructed.
- Construction cost per unit floor area (locally procured) is \$133/m² (\$10,214.93 ÷ 77m²)
- The village provided a building that was considered optimal for the CFC in terms of size and location. Thus, construction costs were kept low.
- It is relatively close to the water supply point at 120m.
- There are three independent rooms, divided into an ice machine room, a fish processing operation room, and a warehouse. It could be used for training and lodging.

2) Hirgigo CFC (Type 2) floor area 29m²

- CFC with container modified; windows and doors mounted on container, outdoor workshop under eaves.
- Construction cost per unit floor area (locally procured) is \$407/m² (\$11,792.00÷29m²)
- New construction allowed flexibility in site selection. However, construction costs are approximately three times higher than in Zula (Type 1).
- Located in the center of the community, 20 m close to the water supply point.
- Inside the container house are for 3 freezers and a warehouse. Fish processing operations are on concrete floors under the eaves (outdoor workshop).
- In the future, it can be remodeled relatively freely, for example, by adding more eaves for working spaces.
- During the daytime in extremely hot weather, indoor temperatures become quite high if container windows and doors are kept closed (room temperature can be checked with the controller of the freezer).

Whereas the above is mainly a comparison of the building and installation environment of the CFCs, the equipment installed in the CFCs will need to be verified and evaluated with pilot activities after a suitable period of time. In particular, regarding the ice makers, both are solar-powered and there is not much difference in the amount of ice produced, but there is a difference in the ice making method: the Zula CFC is an ice block making machine and the Hirgigo CFC is a home-use ice freezer. As for other equipment, both CFCs have the same items and the same quantities, although a fish meat-bone separator has been installed in Hirgigo CFC (at the Hirgigo Training Centre).

(f) Organizing preparatory meetings and workshops for the operation of the CFC

Briefings and workshops have been held for each new phase of the project, and in March 2022, the C/P team and the MMR civil engineer presented the design and implementation plan for the CFC, discussed what the cooperatives in each village would be responsible for, and began construction of the CFC. The problem of members who are absent from cooperative events was also discussed and it was decided to take advantage of this opportunity to replace members by, for example, amending the cooperative's bylaws through the MMR's Cooperative Division. In this way, the cooperative's organization was strengthened and its members became more aware toward the completion of the CFC.

In October of the same year, as the CFC was nearing the end of its equipment installation, the C/P team held a meeting with cooperative members to create an operational structure for the CFC and discussed preparations for the following:

- 1) Appointment of technicians to operate and manage solar ice making machines, etc.
- 2) Set sales rules and prices for ice, fresh fish, and processed products.
- 3) Start recording in logbooks and accounting books.
- 4) Establish CFC management and operation systems.
- 5) Periodic monitoring by MMR extension officers.

These issues were to be reviewed for readiness by the C/P team and extension officers once the equipment was commissioned and operating technicians were trained and the CFC commencement workshop was held.

6-2-4 Summary of pilot project activities

(1) Pilot project for improvement of small fresh fish distribution (PP4)

(a) Distribution of small fresh fish by Zula cooperative

After the completion of training on the CFC's ice block maker and other equipment and facilities, the Zula cooperative began planning to produce ice blocks and use them to sell small fresh fish caught in the village to the town of Foro and the village of Afta (a neighboring village). The cooperative agreed to give the Zula fishers blocks of ice and loan them cooler boxes for fishing. The cooperative also agreed to receive a quarter of the proceeds from the sale of fresh fish from the fishers. In the first attempt in March 2023, the catch was 73.5 kg, of which 59.5 kg were sold at 40 ERN/kg, for a gross profit of 2,010 ERN. More information can be found in the appendix of Pilot Project Activity Report. The cooperative will continue this arrangement with the fishers in Zula until it receives a small boat and fishing gears from the Northern Red Sea sub-zoba branch of the MMR.



Fig 6-66 Fresh fish caught in Zula



Fig 6-67 Fish transported to Foro town in a cooler box with ice

The MMR tentatively set the sales price of an ice block in the village of Zula at 5 ERN/5 kg/piece. The MMR Cooperative Division then prepared a business plan to formalize the ice price with the assistance of an FAO expert who was on the mission, and calculated the costs of equipment depreciation, CFC maintenance, water, building rent, operating technician and security guard salaries,

and insurance costs. Then, assuming a daily (7-hour) ice block production rate of 60 pieces (two batches) and 22 operating days per month, the ice block sales price was calculated to be about 17 ERN per piece. MMR plans to use this as the basis for an official ice block sale price after a trial period.

In the final stage of the project, a former member of a cooperative in Zula revealed that a small fish market had in fact been built in Foro town, and that the former Zula Fishery Cooperative had transported and sold fresh fish for a short period of time. This was not recognized by any of the MMR staff, and when the baseline survey was conducted in Zula village, the distribution and consumption survey should have been conducted in Foro town, which is the same consumption area as Massawa, but unfortunately this was overlooked. The building was located beside a valley a little off the main road to the east, and with some repairs, it was thought that it could be used as the fish market again.



Fig 6-68 Exterior view of the former fish market in the town of Foro



Fig 6-69 Interior of the building, fish sales table

(b) Distribution of small fresh fish by Hirgigo cooperative

Distribution of fresh fish from the Hirgigo CFC has not been implemented as of end of the project. The delay is due to the fact that the solar-powered ice freezers were not working properly and could not produce ice for fresh fish preservation. However, in July, two of the freezers in question are now in operation. Fishers in the village of Hirgigo continue to use small bottom long-lines even during the hot season, and it is believed that the CFC ice is being used for this and other purposes.

In any case, once the CFC freezer issue is resolved and the training of the Hirgigo CFC equipment technicians is completed, Hirgigo cooperative will transport fresh fish to the newly opened Sigalet open-air market in Massawa city for sale. The cooperative will also start distributing small fresh fish to the Markato market in Asmara, accompanying NFC's cold fresh fish transport trucks.

(2) Pilot project for development of processed fishery products (PP5)

The project aimed to develop marketable processed fish products by village cooperative members, especially women members. The C/P team first had collected traditional fish processing and preservation methods in the target villages, on the basis of which a fish processing manual was

developed. In addition to the traditional processed salted and dried products, smoked fish and fish meatballs, a paste product developed by the C/P team, were also added.

Processing equipment such as fish driers and smoking kilns for the production of processed products were developed by the C/P team together with the MMR Engineering Division staff, and the best equipment was selected through performance tests. Based on the results, two salt-drying racks and two smoking kilns were manufactured and one of each was distributed to the cooperatives in both fishing villages. These were used to provide training on fish quality control and processing for cooperative members in each village. This was followed by a practical workshop where they demonstrated what they had learned to each other, and a tasting of the dishes prepared by the cooperative members using the processed products. This seems to have fostered a certain degree of confidence among the cooperative members regarding the marketability of the processed products made in the village.



Fig 6-70 Traditional dish,
deep fried whole fish



Fig 6-71 Smoked fish, new
products of cooperative
members



Fig 6-72 Tasting fish dishes
at the workshop

(3) Pilot project for new market development (PP6)

The project was to promote the consumption of small fresh fish in urban areas by holding cooking and tasting events of small fresh fish and its processed products in Massawa and Asmara. The small fresh fish were to be provided by the Hirgigo cooperative, but due to problems with ice freezers at the Hirgigo CFC which were not possible to produce ice, and the project could not be implemented during the project period.

According to the MMR, since last year, an exhibition for women has been held once a month for three days in Asmara, co-sponsored by the MMR, the Ministry of Agriculture, and the Ministry of Tourism. Therefore, the members of the cooperative from the villages of Zula and Hirgigo could participate in this event and conduct a cooking and tasting of small fish. This event is under the COMESA's Empowering Women program, where "Small and Micro Entrepreneurs Training" is also being offered to women's organizations in the MMR and the Ministry of Agriculture, and this seems like a great opportunity for both cooperatives.

(4) Summary

The pilot activities summarized here were undertaken with the objective of developing the strategic approach to improving the livelihoods of fishing communities, one of the priorities of the MMR Strategic Plan (2018-2023). The activities, which were led by the Fishing Community Development PIU and worked together with the participation of various MMR divisions, included understanding of community problems, identification of challenges and constraints, formulation of pilot projects, formation of cooperative structures and capacity building, construction of CFCs, implementation of pilot project activities and evaluation.

Since this was a pilot project, its activities were literally implemented in a pilot way to explore new possibilities for the community, always looking for the best solution for the coastal community. On the other hand, its implementation involved a lot of trial and error, and the PIU team sometimes faced unimaginable difficulties in order to maintain the schedule. As a result, as of the end of the project, some parts of the pilot projects were not completed as planned and are ongoing after that. Nevertheless, the process from conception to implementation of the projects strategically undertaken to date has been scrutinized and evaluated by the PIU team on a step-by-step basis, and the lessons learned and recommendations made have been documented for the realization of better fishing community development in the future.

6-3 Pilot project for Coastal FAD by Artificial Seaweeds

6-3-1 Background and Context

Much of Eritrea's coastline is dominated by sandy beaches, with most of the shallow-water areas being sandy and muddy, with only a few areas occupied by reefs and coral reefs. The same is true in the pilot activity sites of Hirgigo and Zula villages, where many fishermen fish for mullet with bottom gill nets on foot or by going offshore in Styrofoam rafts to hand-fish, mainly for small floating fish. The rafts are not powered, so they have to be rowed out to sea by hand, which is quite hard work, and they cannot be operated because of the risk of being swept out to offshore when the wind and waves are strong. However, if fishing grounds could be formed in shallower waters, more efficient operations would be possible and working conditions could be improved.

This idea led the project to test the construction of Fish Aggregating Device (FAD) in the shallow water areas of in front of the fishing village. On the initiative of Dr. Ishikawa, the FADs were to use the artificial seaweed 'C-lant'. C-lant is a FAD material mainly for sandy and muddy waters. It was jointly developed by Sekisui Chemical Co., LTD. and Kiso Industry Co., LTD. and is marketed by TEQUANAUTS Co., LTD. The structure consists of strips of polyethylene foam connected to sandbags, which has the effect of artificially creating an environment similar to a kelp field. TEQUANAUTS has demonstrated its

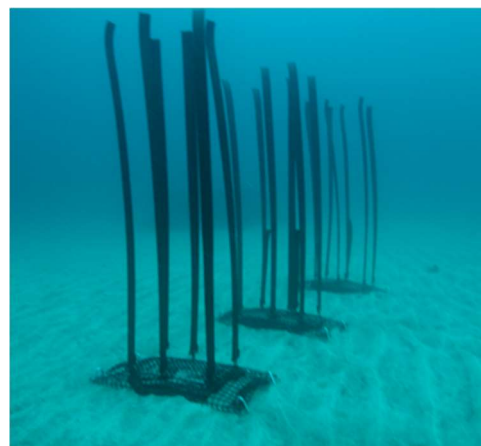


Fig 6-73 Artificial seaweed 'C-lant'

(Picture: TEQUANAUTS Co., LTD.)

effectiveness in various parts of Japan and has proven to be highly effective in attracting fish. In addition, it was considered to be the most suitable FAD material in Eritrea as it is more difficult to sink into sand than concrete FADs, and its light weight makes it easy to transport.

For more information on this pilot activity, see Annex 5 "Pilot Project Report of Examination of Coastal FAD by Artificial Seaweeds".

6-3-2 Installing the artificial seaweeds

The C-lants transported to Eritrea consisted of 84 pieces, each 200 cm long and 5 cm wide, and 15 sets of sandbags as substrate and plastic mesh to cover them. All these materials were donated by TEQUANAUTS.

The C-lant's FAD installation work was carried out in time for Dr. Ishikawa's trip to Eritrea in April 2022. The installation was carried out from 20-25 April, from preliminary inspection and

selection of the installation site, to the installation of the C-lants by divers and checking the situation a few days later. An underwater camera was also installed and time-lapse⁴ filming was attempted.

The FADs installation is located on the coastal area in front of Hirgigo village, where the water depth drops off from the mudflats, with a depth of approximately 3 metres at high tide and 2 metres at low tide. The area of falling water depth was considered to be suitable as a fishing ground because of its good tidal passage and the large number of fishes wandering along the coastline, which could be expected to attract fishes.



Fig 6-74 C-lant installing operation and it's installed on the seabed.

6-3-3 Monitoring

Monitoring of the FAD constructed by C-lants was carried out from May to September 2022. The monitoring was carried out by installing underwater camera for approximately one week in every month and taking time-lapse visual material of the area around the FAD during the daytime at 10-second intervals. The dates and status of the monitoring are as follows.

⁴ Method of continuously capturing still images at regular intervals. Compared to video recording, this method requires a smaller file size and is superior as a material for visual analysis.

Table 6-6 Date and status of monitoring of the FAD

Date	Sea condition	Note
May 17 – 23	Good	
June 14 – 21	Slightly cloudy	About half of C-lants collapse under the weight of attached organisms.
July 13 – 19	Strong turbidity	ditto
August 12 – 18	Slightly cloudy	The camera falls over in the middle of the filming process.
September 22 – October 4	Strong turbidity	

Monitoring results showed that fish were attracted to the area for almost the entire period of the monitoring. The time-lapse video shows a dominant school of dory snapper (*Lutjanus fulvivflamma*), with other species such as Indian mackerel (*Rastrellinger kanagurta*) and a species of barracuda (*Sphyræna sp.*) also forming a school, although the details await the results of quantitative analysis. Some of the underwater camera images are shown below.



June 6, 2022



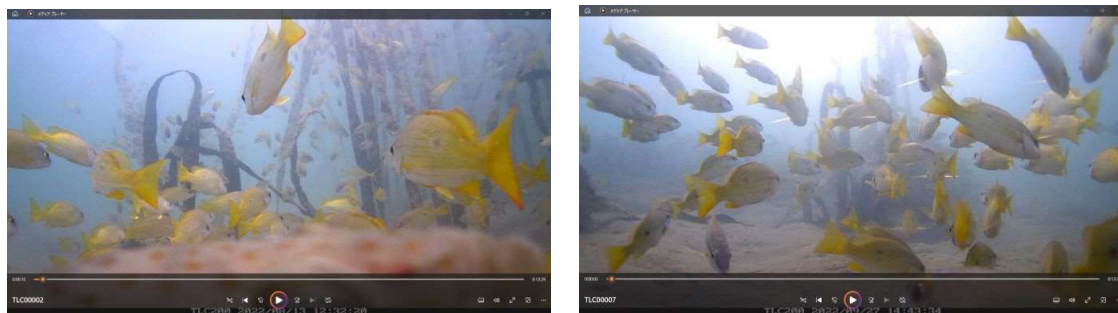
July 17, 2022



July 17, 2022



July 18, 2022



August 13, 2022

September 27, 2022

Fig 6-75 Images of artificial seaweed's FAD from a fixed-point underwater camera

Since June 2022, many sealants have collapsed under the weight of attached organisms, but there is no indication of a significant loss of attracting effect.

6-3-4 Analysis of the results

(1) Analysis methods

A time-lapse camera was set up to take one snapshot every 10 seconds after the installation of the FAD with C-lant. Taking images using this time-lapse camera took place from May 16 to 23, June 13 to 20, July 11 to 18, August 8 to 15, September 5 to 12, and October 3 to 10. Installation and recovery of the camera were conducted by MMR staffs. The captured image data were sent to Japan and image analysis was performed.

The captured images were divided into individual files using Free Video to JPG Converter. After that, the still images were enlarged using Adobe Photoshop, and the number of fish was counted for each still image. Also, it is calculated for the average number of fish per one image for each day. And the percentage of still images showing fish for each day was determined. In addition, we recorded the condition of the C-lant being filmed and the characteristics of the fish that gathered.

(2) Results

A total of 839 images were used for analysis. There were 501 Appearance (Photo with fish images). Both Appearance and Average number of fish increased from April 23rd to May 14th. This indicated that fish were gathering around the FAD immediately after it was set up on April 22nd. However, images in April did not cover the entire outside of the FAD because the time-lapse camera was not installed properly. Therefore, the numerical values of Appearance and Average number of fish would be underestimated from the actual gathering state of fish.

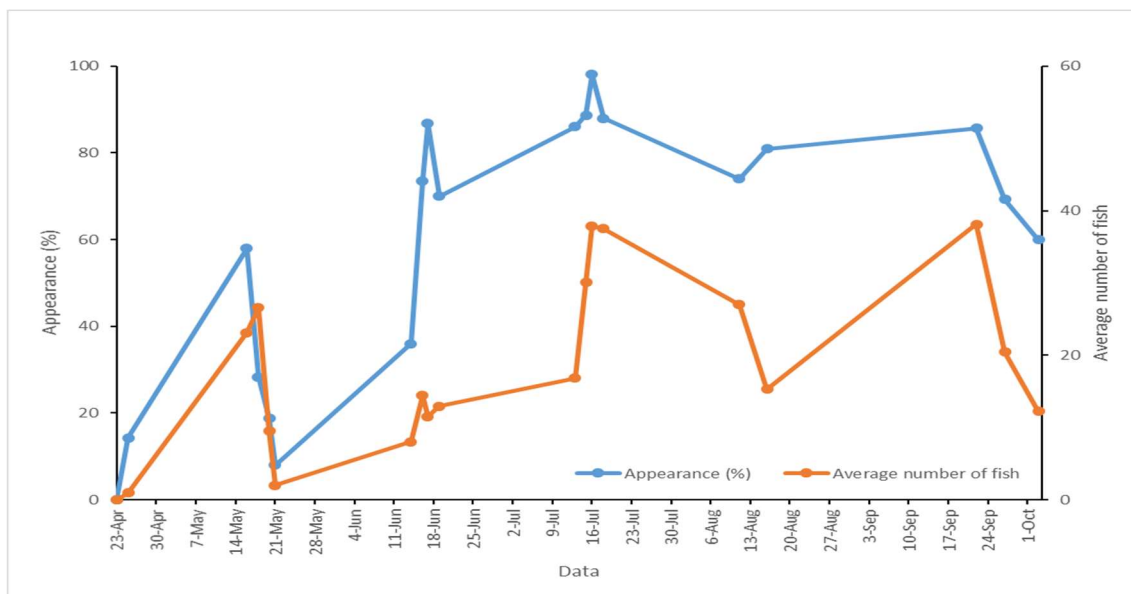


Fig 6-76 Average number of fish and Appearance percentage of Time laps Photos.

The May image captured the entire FAD, and we were able to see the effect of fish gathering. It turned out that a large number of Indian mackerel gathered around the FAD in May. In addition, it can be determined from the image that the fish gathered around the seagrass bed are taking predatory behavior. For this reason, it can be inferred that the FAD and their surroundings serve as feeding grounds for fish.



Fig 6-77 School of fish taking predatory behavior

Around May 20th, Appearance and Average number of fish decreased temporarily. This is largely due to the unclarity of the image. In particular, the images from May 20th to 23rd were unclear and almost impossible to analyze. However, it is certain that fish were gathering around the FAD



Fig 6-78 An image showing fish shadows on May 20

even during this period, as there were images in which fish shadows could be confirmed.

After June 11th, although there were some fluctuations, fish were always gathering around the seagrass bed. In mid-June, some C-lants were sinking to the sea bottom due to the weight of their

attached organism. However, even after such a subsidence phenomenon occurred, fishes could be maintained around the FAD.

Fish species that could be confirmed around the FAD, batfish and others often appeared between April and May. Around June, barracudas, rabbitfish, Indian mackerel and emperor fishes appeared. In July, large fish such as striped bonito began to appear. In addition, swimming crabs in June and sea turtles in August were also appeared.



The artificial seaweed's FAD examination on the coast of Eritrea using C-lant revealed that it has the function of fish aggregating in a short period of time after installation. It was also confirmed that this fish aggregation effect continued at least for half a year after installation. However, it was confirmed that organisms adhered to the surface of C-lant in three months after installation, causing C-lant to lose its buoyancy and sink to the sea bottom. Although the effect of fish aggregation was maintained even after subsidence, some kind of treatment will be necessary in order to maintain the FAD function in the long term.

Fig 6-79 Part of C-lant sinking (taken on June 20)

6-3-5 Issues for the future

The MMR side is well aware of the effectiveness of this artificial seaweed's FAD in attracting fish, but there are issues to be addressed for its future popularization.

The first is the issue of costs. It would be desirable to install them on the foreshore of each fishing village scattered along the Eritrean coastal zone, but it would require a lot of budgetary measures to introduce enough FADs to cover a certain area as a fishing ground.

The second point is the issue of maintenance. In this demonstration, much of the C-lant collapsed under the weight of attached organisms. According to TEQUANAUTS, the C-lant supplier, demonstration tests in Japan have shown that attached organisms are periodically dropped by waves and other factors to restore buoyancy, but no such phenomenon has been observed in Eritrea. MMR monitoring staff attempted to remove attached organisms in the sea, but it was not easy. Although there is no significant loss of attracting effect when the sealant is collapsed, there is some concern about long-term installation. The establishment of this maintenance method is a prerequisite for the widespread use of C-lants as the FAD material.

On the other hand, regular care and maintenance of the FAD could be undertaken by the fishermen themselves to ensure sustainable use of the fishing ground. In other words, awareness of fishing grounds and resource management could be raised through this action. The provision of FADs could also be an incentive for fishers to organize and establish monitoring systems.

Chapter 7: Other capacity-building activities

7-1 Teaching Materials for the Training of Sustainable Coastal Fishery Development

In the original plan, Professor ISHIKAWA Satoshi of Tokai University who is the expert of Fisheries Development to support sustainable fishery development for the fishery community would have been dispatched in April or May in 2020 to the State of Eritrea, and he could have conducted TOT training of “Fisheries resource managements in coastal zone” for staff of MMR.

However, dispatches of all JICA experts have been postponed due to the global pandemic of COVID-19. Then, the production of training materials was carried out in advance from July to September in 2020, which are shown as Annex 6 “Resource Management Textbook for Coastal Fisheries in Eritrea” and Annex 7 “Coastal Fisheries Managements under Climate Changes with SDGs”.

“Resource Management Textbook for Coastal Fisheries in Eritrea” contains latest theory of fisheries managements referring to several important topics for sustainable development of fisheries with attentions to actual situations of the fishery in Eritrea. In addition, this textbook shows concrete methods of surveys and data analysis, and recommendations of legislations. So, this textbook can be used widely in the training of governmental staff who are working in fisheries management sites. On the other hand, “Coastal Fisheries Managements under Climate Changes with SDGs” comprised of 70 slides will be used in the training and seminars. This material explains several methodologies how to tackle problems to realize sustainable fisheries in collaboration of administrations and fishers by presenting several examples in Japan in the context of recent global climate changes and environmental issues related to fisheries sectors.

These training materials were used not only in the training for C/Ps by Prof. Ishikawa after the resumption of dispatch of JICA experts, but also it will be used in the seminars and/or trainings conducted by C/Ps for fishers and local staff.

In Eritrea, the lack of the basic information on fishery resource organisms and fishery resource management should be a big issue to be solved to achieve sustainable fishery development. It seems that basic information of fishing gears, fishing regulation and species identification methods are given at college education, etc., but the materials related to the classification of resources along with its biological features and population fluctuations, which are necessary for sustainable fisheries management, are quite limited. On the other hand, the general information of the “responsible fishery” comprised of the stock evaluation and regulation are provided. It is based on Maximum Sustainable Yields (MSY) theory promoted by FAO after 1995 that had been used in several international management bodies treating economically important fish targets

including tuna species. Application of the MSY theory to the responsible fishery requires several conditions on the target resources and these are; 1) the life time of the target species is long (more than 5 years), 2) no recruitments from other areas and/or populations, 3) main factors of death are fishery activities, etc. Therefore, this approach might be effective for the resources of higher predators in the ecosystem like tuna species, and sometimes it might not be effective for the resources of small pelagic species distributing in coastal area in tropical zone. Many species along coastal area, spawn a lot of eggs with high mortality, so stock sizes of daughter population are usually decided by environmental factors which influence mortality of eggs and larvae. In this regard, regulating fish catches of small pelagic species might not be effective fishery management toward sustainable development. This mismatch between biological features of coastal area in tropical zone and the regulation of fish catch may not be well understood in many developing countries. In this project, the training textbook was prepared aiming to learn basic theory of sustainable utilization of fishery resources referring to their biological features. In addition, this textbook shows practical methods to evaluate the stock status under the current situation of fishery statistics of Eritrea. The contents of “Resource Management Textbook for Coastal Fisheries in Eritrea” are as follows;

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Introduction

Chapter 1 Change in the Way of Thinking about Resource Management

(from fishery regulation to environmental conservation and resource care)

Chapter 2 Three Issues Related to Sustainable Use

1. Securing parent fish resources,
2. Conserving spawning environment,
3. Securing habitats

Chapter 3 Environmental Conservation Indispensable for Sustainable Use of Fishery Resources

Chapter 4 Understanding Distribution / Resource Structure

(Importance and Method)

Chapter 5 Understanding the Spawning Ecology

Chapter 6 Cohort Analysis

Chapter 7 How to Grasp the Amount of Resources

1. Grid survey line census method
2. Mark recapture method
3. Spawning survey method

Chapter 8 Use of Fisheries Statistical Data

1. Resource quantity estimation (VPA analysis and resource characteristic values)

2. CPUE (DeLury method)

Chapter 9 Creation of Resource Management Law

1. Co-management
2. Feedback management
3. Area capability approach

Conclusion

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Trainings and seminars using this textbook will include the introduction of the “Area-capability Approach” which provides a framework to promote monitoring of fisheries resource condition and environmental situation by local residents who are utilizing the local fishery resources in their works. The Area-capability Approach will be linked not only to the installation of new fishing methods including small size set-net fishery by local community, but also to the improvement of processing of small pelagic fishes. In addition, because the wide tidal flats in coastal zone of Eritrea are not used effectively, Area-capability Approach could also be applied to strengthen a blue-carbon strategy using an artificial seaweed in the tidal flats by local communities.

7-2 Seminar for the sustainable coastal fisheries development

A seminar was conducted by Dr. Ishikawa with the aim of building the capacity of Eritrean stakeholders in the preparation and implementation of the “Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea”.

The seminar was conducted on 27 April 2022 at MMR conference room, with the training material "Fisheries Management for Rural Community Development" (see to Annex 8), which includes the need and concept of fisheries management to achieve sustainable coastal fisheries development, the theory of area capability as a practical approach and its case studies. The seminar attracted a high interest within the MMR, with a total of 30 participants included PD, PM and counterparts of the project and other departments involved. The following is a copy of the resume distributed on the seminar.



Fig 7-1 The seminar with Dr. Ishikawa (27 April 2022)

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Fisheries managements for Rural Community Developments

Satoshi ISHIKAWA

JICA Expert/Professor of Tokai Univ, JAPA

Date: April 27, 2022,

Time: 8:00 AM at local time

Venue: Seminar Room at MMR, Massawa ERITORIA

Purpose of this seminar

Sustainability of fishery resources is a quite important for coastal society, because fishery is a main job for many people and fishery resources can be an important resource to ensure the food safety of them. To making sustainable fishery, fishery management has been proposed and conducted several efforts in many countries. FAO published “Code of Conduct for Responsible fishery” in 1995 as a guidebook for the fishery management. Many states follow this guidance and try to establish fishery statistics systems for collection data and information. In case the commercial fishery, in other words large scale marine fishery, this approach is indispensable to understand the stock situation and make some international regulation based on the scientific evidence. Many international committees including Indian Ocean Tuna Committee (IOTC) adopted this approach and they achieved some good results for sustain fishery resources. On the other hand, the limit and weak points of this approach were suggested by some literatures, e.g. Jacquet and Pauly, 2008 and Ishikawa and Watanabe 2015, for the small scale and coastal fishery.

In the coastal small-scale fishery has quite important roles as job allocations and food supply in many areas, however, in this activity, it is quite hard to collect the statistics data which are necessary for stock evaluation of fishery resources to make effective regulations. And because the local people cannot live without the small-scale fishery, strict regulations and limitation of fishery activities are not functioning and followed by them in some cases. Different approaches for fishery management which can make both rural development and sustainable fishery resources is required.

In this seminar, current situation and ordinal fishery management approaches will be introduced. And then, the reason of the limits of them for the coastal small-scale fishery will be explained. After understanding of the difference of the fishery and resources, Area-capability approach will be shown as a example of a framework of the collaboration with fishers and governments. Some examples of Area-Capability approach in Thailand, Japan and Philippines are also introduced. Through these examples, what kinds of action and activity have big influences to make up the community would be understood. And what kinds of activities are required for government staffs to help the local people to achieve sustainable “development” of fishery in the coastal area, will be also considered.

Topic of presentation

Current situation of Marine Fisheries Resources and Ordinal Fisheries Managements

- Ocean Crisis
- FAO Approach

Environmental Impacts on Fishery resources

- Impacts of Environmental Changes on Fisheries Resources
- History of Tokyo Bay Fishery as an example of impacts of environmental changes
- Life history and population dynamics of Fishery resources

Required Data and Information for Stock evaluation

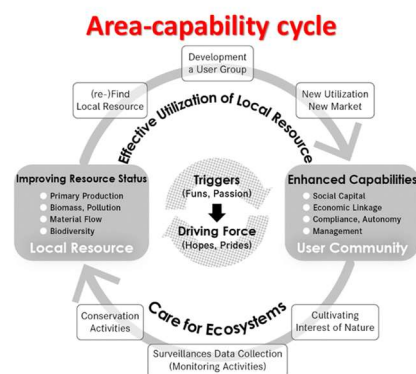
- Trend of World fishery production and Fishing Down
- Flows of fisheries stock evaluation
- Differences between Commercial and Coastal small scale fishery
- Data collection and environmental changes

Purpose of Fisheries Management

- Differences of biological features of fisheries resources
- What is an Important action for each fisheries resource?
- Purposes of the fisheries managements
- Natural and Social Data and information

Collaboration with Fishers based on Area-Capability (AC) Approach

- Big-Pie Strategy
- Area-Capability Approach
- Set-net fishery in Thailand as an Example of AC approach
- Stock Enhancements in Japan and Philippines as Examples of AC approach
- Eco-tourism in Japan as an Example of AC approach
- Target of Area-Capability approach



Framework of
1. planning of local
collaboration
2. evaluation of
community activity

AC cycles numbers =

1. No. resources,
2. No. local communities,
3. No. utilization (jobs),
4. No. cares on ecosystems

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7-3 Study Session on the Past Supports by International Organizations

Prior to the Eritrea's independence from Ethiopia and up to the present day, a number of fisheries development activities have been carried out by various partners. In particular, FAO started a project on coastal fisheries development in 1988 before independence, and has continued to provide technical assistance intermittently to date with a brief interruption during the war of independence. The “Rehabilitation of Red Sea Fisheries Project (1988-1991)” and the “Fisheries Rehabilitation in Semhar and Assab / Marine Fish Marketing Development (1993-1997)” are two most important projects supported by FAO as they contributed significantly to the foundation of the current Eritrean fishery industry. The former aimed to improve the income of fishers by improving the distribution and sales network of fishery products and the effective use of fish resources, while the latter aimed to improve the income of the post-war reconstruction, improve the nutrition of the people by spreading fishes as food, earn foreign currency by strengthening exports, and build the capacity of MMR. As a result of this series of activities, major fishing ports such as Massawa and Assab have been developed, distribution systems for inland areas have been set up, and the fish diet of the people has been popularized.

These activities included many themes that are also relevant to FSPAC project such as; the issues surrounding the fishing industry at that time, the results and lessons learned of the projects, and the remaining challenges. Those are the issues to be addressed by FSPAC project and to plan effective activities. In view of this, an online seminar was organized by JICA inviting Mr. ETO Seiichi as a lecturer who had been managing the project in Eritrea as a FAO expert at that time. The seminar was held on 29 July 2020 with 14 participants including JICA staff, project experts and Mr. Eto.

At the seminar, Mr. Eto lectured; (1) the background and history of FAO projects, (2) details of each project's objectives and activities, (3) achievements and remaining issues, and (4) trends in coastal fisheries after the projects. The lecture was followed by a question-and-answer session, during which there was a lively discussion on lessons learned from the FAO project and technical advices to the FSPAC project. In the afternoon session there was a time for free discussion between the project experts and Mr. Eto, where they exchanged more concrete ideas on the future issues.

Chapter 8: Technical Guidelines on the Practical Approaches for Coastal Fisheries Development

This chapter reports on the structure and overview of the “Technical Guidelines on the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea”. See Annex 10 for the Technical Guidelines developed. The pilot project reports, which are annexes to the Technical Guidelines, should also be referred to in Annexes 3-5 of this report.

8-1 Basic policy for the formulation of the Technical Guidelines

This Technical Guideline is the most important deliverable of the project, the first draft of which was prepared in June 2023 and finalised in August after confirmation and agreement by the Eritrean side. This Technical Guideline is based on the MMR Development Strategy, which sets out an action plan for the development of marine resources and the MMR, and organises specific methods and technologies for coastal fisheries development as an approach. In other words, it is a guide to implementing the MMR development strategy from the technical aspects of coastal fisheries development.

The technical guidelines were developed by analysing the current status of coastal fisheries and the problems and constraints based on the results of the abovementioned baseline survey and problem analysis workshop, through which priority challenges were selected, and the approaches and coastal fisheries development tools for solving these challenges were set. The practical approaches at the core of the technical guidelines are perspectives and viewpoints for solving challenges, each of which includes several coastal fisheries development tools that were considered to be effective. The coastal fisheries development tools are specific measures to solve the challenges and are mainly selected from the various technologies, equipment and facilities that have been introduced in the project and which effectiveness has been verified.

In developing this technical guideline, the overall structure was drafted by the JICA study team, and then the MMR counterparts and JICA study team had jointly writing the draft after discuss and make consensus with both sides. In particular, the participation of counterparts in the writing process was considered crucial from the perspective of fostering ownership on the part of the MMR for the technical guidelines and capacity building of the counterparts. Although an option could have been to draft the entire guideline by JICA experts and highly specialised local consultants only, priority was given to participation in the drafting process by MMR counterparts.

8-2 Outline of the MMR Strategic Plan

Part 1 of the technical guidelines outlines the MMR Strategic Plan and its position in relation to coastal fisheries development. The MMR Strategic Plan was initially developed and adopted in 2018 with a plan for 2018-2023. However, the content was subsequently updated in 2021, taking into account the impact of COVID-19, and its position has changed as a plan that will be revised and continued as necessary.

The strategic plan defines the following three Goals, under which a number of Objectives and Activities are set.

Goal 1: To Enhance Contribution of Marine Resource to Development of the National Economy and Food Security

Goal 2: To Ensure Sustainable Management of Marine Resources and the Environment

Goal 3: To Strengthen Institutional Capacity Regarding Managerial and Professional Skills

Of these, Goal 1 relates to coastal fisheries development and sets the following goals.

Objective 1.1; Develop production and increase distribution of fisheries products

Objective 1.2; Increase supply and promote consumption of fisheries products

Objective 1.3; Ensure production and supply of quality standard salt

Objective 1.4; Improve and strengthen fishing activities

Objective 1.5; Strengthen the fishing port standard and capacity improvement

Objective 1.6; Improve the livelihood status of the fishing communities

Of these six, five objectives are related to coastal fisheries development, with the exception of the Objective 1.3 on salt production, which is managed by the MMR. These goals have several activity items, but each activity is not independent and complete. They may be complementary to each other or several of them may be combined into one activity. Also, some activities only state the target number of people to be trained, and there is little description of specific activities. In particular, on the technical aspects, there is no description of the viewpoints, methodologies, technology and equipment to be deployed for solving the challenges. It is unclear what and how the activities should be carried out. Technical guidelines are therefore required to clarify these technical aspects and complement the MMR strategic plan.

8-3 Revealing priority challenges

In Part 2 of the technical guidelines, the current status of coastal fisheries, problems and constraints are summarised and priority challenges are identified. Priority challenges were selected based on the results of the baseline survey and problem analysis workshops, as well as the analysis of the current status of coastal fisheries and problems/constraints. Note that this chapter is based on the “Technical Report Current Situation, Issues and Constraints of the Coastal Fisheries in Eritrea”, which is one of the main outcomes of the project. See Annex 2 for more information.

Twelve priority challenges to be resolved in the technical guidelines were selected by Artisanal/Subsistence fisheries and by subject areas.

Table 8-1 The Revealed Priority Challenges for Coastal Fisheries Development

Classification of fisheries	Subject areas	Challenges
Artisanal fisheries	Fishing gears and methods	Improvement of the fishing efficiency by the improvement of fishing gears and methods
		Improvement of the fishing productivity in the hot season
		Effective utilization of the demersal fishery resources
	Distribution and marketing	Strengthening of landing capacity by fishing port*
		Strengthening of transportation capacity to the inland area
		Preparation of fish market/store in consuming areas
	Infrastructure and facilities	Strengthening of landing capacity by fishing port*
		Preparation of the fishing port in islands
Subsistence fisheries	Fishing production	Effective utilization of the small pelagic fishery resources
		Improvement of the fishing productivity
	Seles and marketing	Reduction of transportation costs
		Preparation of distribution environment
		Establishment of distribution system and sales methods for inland area

* Common challenges in “Distribution and marketing” and “Infrastructure and facilities”.

8-4 Selection and contents of Practical Approaches

The approaches were set out separately for Artisanal/Subsistence Fisheries as the viewpoints and perspective for addressing the above priority challenges. Part 3 of the technical guideline selects the approach, while Part 4 organises the content of the approach. Each approach was set up to encompass a single or multiple challenges, depending on the nature of the challenge.

In Artisanal Fisheries, the methods for solving challenges related to “Distribution and marketing” and

“Infrastructure and facilities” have many common aspects, so these were brought together and three approaches were set up to address the five challenges. For the Subsistence Fisheries, the five priority challenges have been grouped into two approaches that “Fishing production” and “Sales and marketing”, as the scale of production and sales per community is extremely small, and the division of labour is not well developed and interdependent.

Table 8-2 The selected Approaches

Classification of fisheries	Area of Approaches	Approaches
Artisanal fisheries	Fishing gears and methods	Approach for fishing efficiency improvement
		Approach for fishing productivity improvement during the hot season
		Approach for effective utilization of demersal fishery resources
	Distribution, marketing and infrastructure	Approach for strengthening landing capacity of Massawa fishing port
		Approach for strengthening distribution capacity to the inland area
		Approach for installation of fishery infrastructures in island villages
Subsistence fisheries	Fisheries production	Approach for fishing productivity improvement for Subsistence Fisheries
	Sales and marketing	Approach for income improvement for subsistence fishing communities

8-4-1 Approach for fishing efficiency improvement

The approach targets existing fishing methods, particularly gillnet fishing, which is the mainstay of the Eritrean coastal fishery, and seeks to improve fishing efficiency by introducing new fishing gears, materials and fishing equipment. Specifically, the introduction of multi-monofilament nets and electric net haulers is aimed at increasing catches without increasing fishing effort, improving the fishing environment and safety, and reducing operating costs.

8-4-2 Approach for fishing productivity improvement during the hot season

This approach is to improving fisheries production during periods of hot season, when daytime operations are restricted due to the extreme heat and operations are mainly conducted at night. The

aim is to increase catches without increasing effort, improve working conditions and safety, and reduce costs by introducing and improving new fishing gear and equipment suitable for night operations.

8-4-3 Approach for effective utilization of demersal fishery resources

An approach to effectively utilise demersal fishery resources, which have been under exploited in coastal fisheries to date, and to contribute to improving the overall catch of coastal fisheries. Introduce new fishing gears and methods that are less costly and easier to operate aim to increase catches and income by side operation with the gillnet fishery.

8-4-4 Approach for strengthening landing capacity of Massawa fishing port

An approach aimed at increasing fish supply and improving fishermen's incomes by strengthening the landing capacity of the Massawa fishing port, which has the highest landings in Eritrea and is a hub for the supply of fisheries products to Asmara and other inland areas.

The current Massawa fishing port has two challenges: the small size of the facility and the institutional arrangements for landing procedures, which need to be improved in order to enhance landing capacity.

8-4-5 Approach for strengthening distribution capacity to the inland area

An approach to increase inland fisheries products supply by strengthening transport capacity from Massawa fishing port to inland locations and developing sales points in consumption areas. This will contribute to overall national food security and improved incomes for fishers.

8-4-6 Approach for installation of fishery infrastructures in island villages

An approach to improving the maintenance capacity of fishing boats and gears and the living environment of fishing communities by improving the fishing production infrastructure, such as landing sites, fishing gear warehouses and engine maintenance facilities, in island fishing villages, which mother ports for most of Artisanal Fisheries. Many of the island residents depend on fisheries for their livelihood, and almost all of their daily necessities, such as water and food, are transported by fishing boats. Developing fisheries infrastructure in island area is an issue directly related to improving the living environment of fishing communities.

8-4-7 Approach for fishing productivity improvement for Subsistence Fisheries

An approach to improve catches and livelihoods of subsistence fishing communities through small-scale fishing gears and FADs that do not require large investments or advanced technology, targeting mainly small coastal pelagic fishes that are not being used effectively. It should be noted that the installing of FADs is expected to have two effects: fishing ground creation and fisheries resource enhancement.

8-4-8 Approach for income improvement for subsistence fishing communities

An approach that improves the income of the surviving fishing community by value addition to the catches through quality management and processing, as well as by promoting sales through market development and improved distribution.

Note that the two approaches are interdependent, as this approach is based on utilising the catches from the above approaches. The catches will help to improve income, and part of the income generated will support fisheries production by being used to repair and purchase fishing gears and FADs. This concept is illustrated in the diagram below.

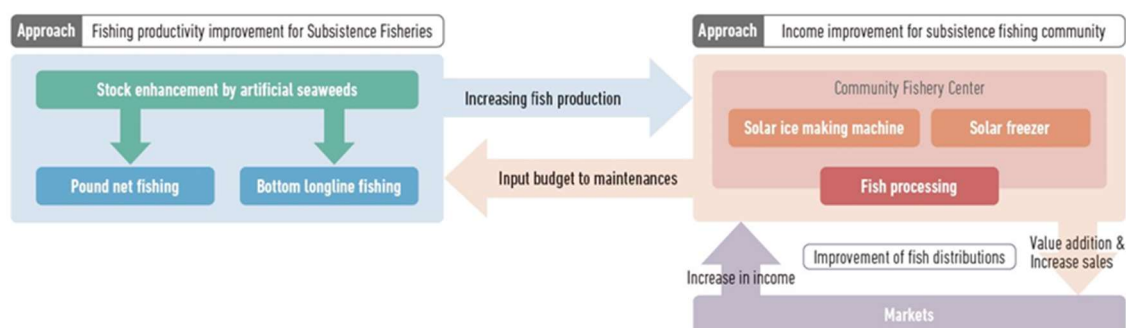


Fig 8-1 Relevance of the two approaches to Subsistence Fisheries

8-5 Adapting Coastal Fisheries Development Tools

Coastal fisheries development tools are specific means of solving challenges in the above approaches, such as technology, equipment and facilities, and are an important component of the approach. As mentioned above, these have been selected mainly from those that have been piloted and verified to be effective in the pilot projects of the project. Part 4 of the technical guidelines introduces the titles and overview of the development tools that are expected to be used in each approach, while Part 5 describes the specifics for each tool. For details on the development tools and the verification results and lessons learned from the pilot projects, please refer to the reports of pilot project (Annexes 3 to 5).

The development tools that were envisaged to be used for each approach are summarised in Table 8-3. However, it was difficult to pilot and verify the development tools categorised approaches of “Distribution, marketing and infrastructure” for Artisanal Fisheries as it was needed to trial infrastructure development and Institutional revision. The verification of these development tools is positioned as a future challenge and only their titles and outlines are introduced in the technical guidelines.

Table 8-3 Coastal Fisheries Development Tools envisaged for use in each approach

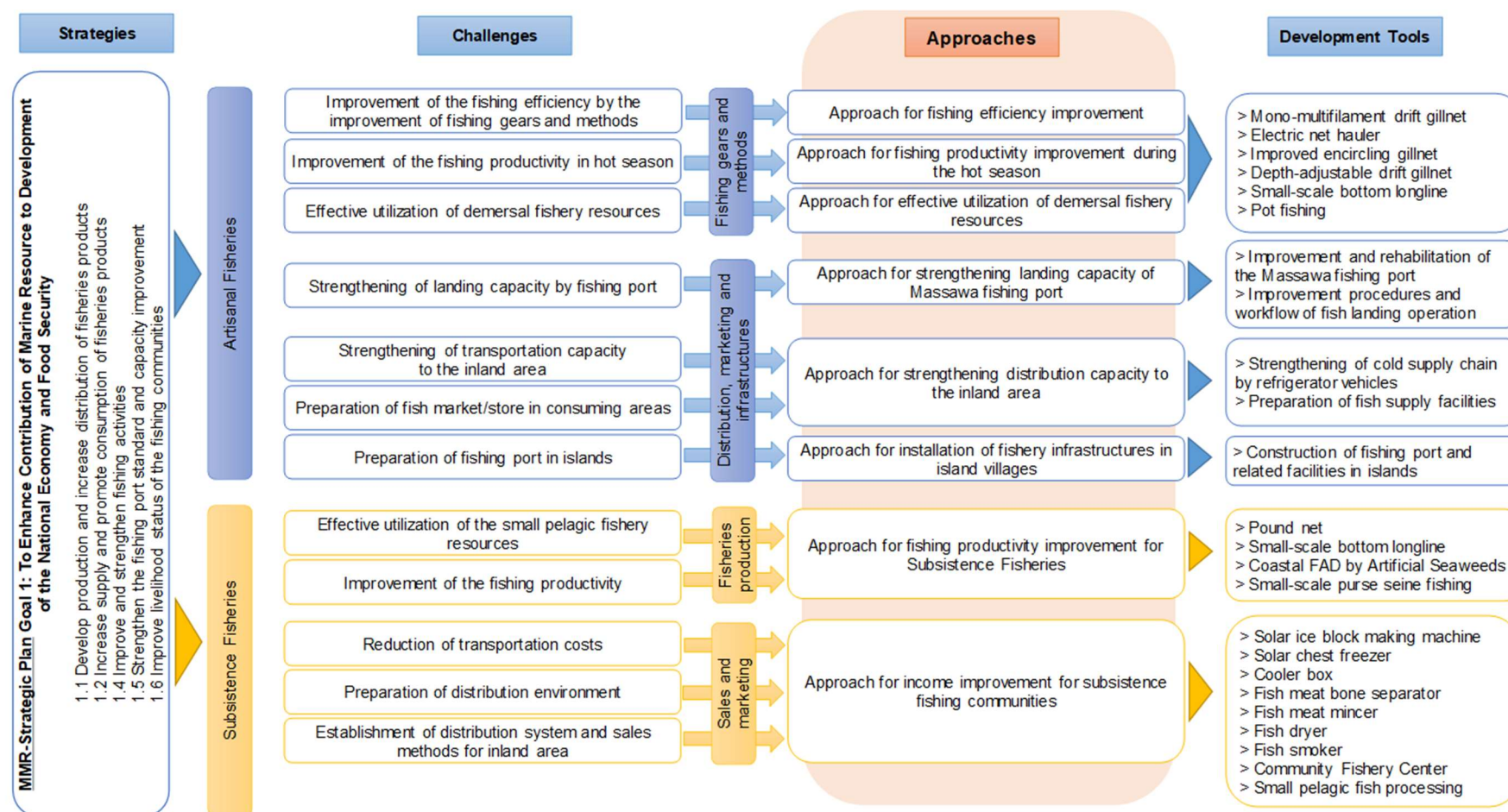
Classification of fisheries	Area of Approaches	Approaches	Expected Development Tools
Artisanal fisheries	Fishing gears and methods	Approach for fishing efficiency improvement	➤ Mono-multifilament drift gillnet ➤ Electric net hauler ➤ Improved encircling gillnet ➤ Depth-adjustable drift gillnet
		Approach for fishing productivity improvement during the hot season	➤ Improved encircling gillnet ➤ Depth-adjustable drift gillnet ➤ Electric net hauler ➤ Small-scale bottom longline ➤ Pot fishing
		Approach for effective utilization of demersal fishery resources	➤ Small-scale bottom longline ➤ Pot fishing
	Distribution , marketing and infrastructure	Approach for strengthening landing capacity of Massawa fishing port	➤ Improvement and rehabilitation of the Massawa fishing port ➤ Improvement of procedures and workflow of fish landing operation
		Approach for strengthening distribution capacity to the inland area	➤ Strengthening of cold supply chain by refrigerator vehicles ➤ Preparation of fish supply facilities
		Approach for installation of fishery infrastructures in island villages	➤ Construction of fishing port and related facilities in islands
Subsistence fisheries	Fisheries production	Approach for fishing productivity improvement for Subsistence Fisheries	➤ Pound net ➤ Small-scale bottom longline ➤ Coastal FAD by Artificial Seaweeds ➤ Small-scale purse seine fishing
	Sales and marketing	Approach for income improvement for	➤ Solar ice block making machine ➤ Solar chest freezer ➤ Cooler box

		subsistence fishing communities	➤ Fish meat bone separator ➤ Fish meat mincer ➤ Fish dryer ➤ Fish smoker ➤ Community Fishery Center ➤ Small pelagic fish processing
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8-6 Overall structure of the Technical Guidelines

The overall structure of the technical guidelines based on the above background is shown in Figure 8-2.

Fig 8-2 Overall structure of the Technical Guidelines



8-7 Stakeholder Consultation meeting

A stakeholder meeting was held on 27 June 2023 to discuss the draft technical guidelines with the MMR and other interested parties and to build consensus on their content. The participants and agenda are as follows.

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AGENDA

The Stakeholder Consultation Meeting for
The Technical Guidelines of The Practical Approaches for the Priority Challenges of Coastal
Fisheries Development of Eritrea
by
The Project for the Formulation of the Strategies and Practical Approaches for
Coastal Fisheries Development (FSPAC Project)

Date and Time: 27th June 2023, 9:00 – 13:00

Venue: Conference room of Ministry of Marine Resources, Massawa

Master of ceremonies: Project Director of FSPAC Project

Participants:

Chairperson: Hon. Mr. Tewelde Kelati, Minister of Marine Resources

Project Team: **[Eritrean side]**

Mr. Adonay Heruy, Project Director/Coordinator, Head of Projects and
Commissions Coordination Office of MMR

Mr. Idris Saleh, Project Manager, Head of Marine Resources Development
Department of MMR

Mr. Kidane Berhane, Member of Project Management Unit

Mr. Mulugeta Mahdere, Member of Project Management Unit

Mr. Selomon Brhane, Member of Project Management Unit

[Japanese side]

Dr. ECHIGO Manabu, Team Leader of JICA Study Team

Mr. IIJIMA Atsushi, Project Formulation Adviser of JICA Kenya Office

Mr. Ghebremichael Estifanos, Consultant, JICA Eritrea Liaison Office

<First Session>

Communities Stakeholders:

Representatives of Zula fishery cooperative

Representatives of Hirugigo fishery cooperative

Representatives of Dahlak Artisanal fishers

Participants of MMR and other related organizations:

Representative of MMR Northern Red Sea Zoba

Representative of MMR Foro extension office
 Representative of MMR Dahlak extension office

<Second Session>

Participants of MMR and other related organizations:

Representative of National Fisheries Corporation
 Representative of MMR Northern Red Sea Zoba
 Representative of MMR Foro extension office
 Representative of MMR Dahlak extension office
 Representative of Marine Resource Engineering and Technical Working
 Division
 Acting DG of Marine Resource Regulatory Services Department
 Director of Marine Resource and Environment Research Division
 Director of Fish Quality Control Laboratory

Time Schedule of the Stakeholder Consultation Meeting:

Time	Item	Speaker
9:00	Pre-opening address	Project Director
9:10	<u>1st Session</u> : Pre-consultation to the community stakeholders (1) Instruction of the Guideline - Development Tools (2) Discussion	PMU member (30 minutes)
10:00	Breakfast (30min)	
10:30	Opening address	Project manager
	Remarks from JICA Study Team	Team leader of JICA Study Team
	Introduction of participants	Project Director
10:45	<u>2nd Session</u> : Main consultation session (1) Instruction of the Guidelines - Outline of the Guidelines - Development Tools (2) Question and answer (3) Discussion	PMU member (30 minutes) (30 minutes)
12:15	Wrap-up the session	Project Director
12:30	Remarks from JICA official	Representative of JICA Kenya Office
12:40	Closing address	Minister of Marine Resources
12:50	Lunch	

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The stakeholder meeting was divided into two sessions: session 1 for consultations with fishermen and fishing community representatives, and session 2 for the relevant MMR departments and NFC. In Session 1, participants expressed high expectations for the new technology tested and introduced in the project, with comments such as “I have high hopes for the bottom longline fishery introduced in the project” and “It should be put to practical use and spread to fishers as soon as the verification trials are over”. The three main comments from Session 2 were that (i) there was insufficient explanation of the operating body and structure of the technical guidelines, (ii) an operational plan is required when villages introduce the equipment described in the development tools, and (iii) the relationship between the elements of the approach and the tools was not clear. These points were discussed within the project team and some amendments were made to the relevant sections of the guidelines.



Fig 8-3 Stakeholder Consultation meeting

Note that all explanations of draft technical guidelines, question and answer and the wrap-up sessions on the Stakeholder Consultation meeting were led by the MMR counterparts, including the project director. As with the drafting of the technical guidelines, consideration was given to fostering ownership of the technical guidelines and contributing to capacity-building of counterparts by having the MMR side take charge of stakeholder meetings.

The total number of participants was 45: 11 fishermen/communities, 31 MMR staff and others, and 3 on the JICA side. See Attachment 3 for minutes and list of participants.

Attachment 1: Assignment of JICA Consultants

The Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development in The State of Eritrea

	2019			2020												2021												2022												2023										Total days	Total M/M
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10														
ECHIGO Manabu Team leader / Fisheries Development 1	10/20-11/28 40																										11/20-12/12 23										10/29-11/30 40		2/22-3/18 25		6/4-6/30 27	8/5-8/27 23		217	7.23						
ISHIKAWA Satoshi Fisheries Development 2																																												16	0.53						
MORIMITSU Ritsuo Fishing gear & method	10/20-11/17 29				2/28-3/23 25																						11/20-12/26 37					3/5-4/26 53						10/23-11/27 36		2/22-3/18 25					205	6.83					
TSURUSAKI Tsuneo Fishing community development	10/20-11/28 40				2/21-3/23 32																						11/20-12/26 37					3/19-4/11 24	4/25-26 2		7/18-8/21 35		10/23-11/30 39		3/7-31 25					234	7.80						

Attachment 2: Minutes of Meeting of Joint Coordinating
Committee Meetings

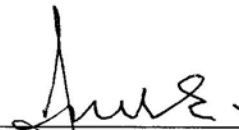
**MINUTES OF MEETING
OF
THE FIRST JOINT COORDINATING COMMITTEE
OF
THE PROJECT FOR FORMULATION OF THE STRATEGIES AND PRACTICAL
APPROACHES FOR COASTAL FISHERIES DEVELOPMENT
IN
THE STATE OF ERITREA**

The first meeting of the Joint Coordinating Committee (hereinafter referred to as “JCC”) of the “The Project for Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development” (hereinafter referred to as “the Project”) was held in 25th October, 2019 in Massawa with participation of representatives of Eritrean government authorities concerned, representatives of Japan International Cooperation Agency (hereinafter referred to as “JICA”) and the Project Team members. As a result of discussion, members of the committee agreed on the matters referred to in the documents attached hereto.

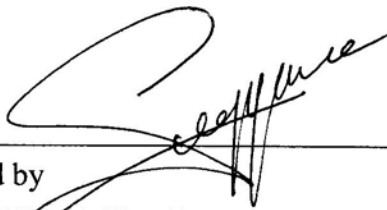
Massawa, 25th October, 2019



Dr. ECHIGO Manabu
Team Leader of the Project
Japan International Cooperation Agency



Amb. Tewolde Woldemikael
Director General
Ministry of Marine Resources



Witnessed by
Mr. SUGIYAMA Shunji
Senior Advisor
Japan International Cooperation Agency

ATTACHED DOCUMENT

1. Inception report

After thorough review of the contents of the draft inception report, it was accepted by the Eritrean side. It was also noted that the schedule of expert dispatch as well as timing of pilot activities shall be modified as necessity arises.

2. Inception workshop

Considering the fact that the project requires the involvement of wider stakeholders such as fishing communities, fishery cooperatives, fishery corporations and local authorities, it was suggested that an inception workshop be held in order to inform key stakeholders of the project. The MMR will organize the event with the technical assistance of the Japanese experts.

3. Requested items of equipment and materials for pilot activities

Serious concern over the local provision of the equipment and materials for conducting pilot activities was expressed by the Eritrean side as there are no local suppliers of fishing equipment and materials in the country. As such, it was urged that necessary equipment and materials for pilot activities be procured from Japan. It was further explained that MMR will make use of the specifications of the equipment and materials to be elaborated by the project for the government procurement of fishing equipment and materials in due course.

The MMR shall elaborate the list of requested items for production, fish handling/processing, and other tools and materials for economic activities of the fishing communities as required for undertaking the pilot activities. The list shall be submitted to JICA.

4. Additional members of JCC

It was recommended that the following members be invited as members of the JCC

- Representative of the Ministry of Foreign Affairs
- Representative of the Ministry of National Development
- Representative of the Ministry of Finance
- Representative of the National Fisheries Corporation
- Representative of the Northern Red Sea Regional Administration

End



**MINUTES OF MEETING
OF
THE SECOND JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR THE FORMULATION OF THE STRATEGIES AND
PRACTICAL APPROACHES FOR COASTAL FISHERIES DEVELOPMENT**

The second meeting of the Joint Coordinating Committee (hereinafter referred to as “JCC”) of the Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (hereinafter referred to as “the Project”) was held in 1st December, 2021 in Massawa with participation of representatives of Eritrean government authorities concerned, representatives of Japan International Cooperation Agency (hereinafter referred to as “JICA”) and the Project Team members. As a result of discussion, members of the committee agreed on the matters referred to in the documents attached hereto.

Massawa, 1st December, 2021



ECHIGO Manabu
Team Leader of the Study Team
Japan International Cooperation Agency



Adonay Heruy
Project Director/Coordinator
Head of Projects and Commissions Coordination
Office, Ministry of Marine Resources

ATTACHED DOCUMENTS

1. Progress of the Project

Based on the Progress Report 1 made by the JICA Study Team and MMR's counterpart teams of the Project, the meeting reviewed current status and progress of the project activities. It was confirmed that the project activities have been conducted with lengthy delays as effect of COVID-19 and amendment of the project plans are required to be addressed.

2. Future project plans

Based on the Progress Report 1, the meeting confirmed the necessity to implement the remaining activities of the project and hence proposed future project plans and its timelines to complete the activities so as to achieve the expected objective.

3. Extension of project duration

The JCC confirmed the duration of the project is extended from 31 months to 48 months as described in the Attachment 2 due to the suspension of the project activities during the prevalence of COVID-19 pandemic. The notification of the amendment of Record of Discussions will be confirmed by the Minutes of Meetings between the Ministry and JICA.

4. Appointment of the Project management posts

It was reported by the Eritrean side that amendment to the project implementation structure (i.e. responsibilities assigned to Project Director/Coordinator and Project Manager) is necessary as described in the Attachment 2 due to organizational change along with re-arrangement of responsibilities among senior management staff in the Ministry of Marine Resources. The notification of the amendment will be confirmed by the Minutes of Meetings between the Ministry and JICA.

5. Approval of the Progress Report 1

The meeting discussed the Progress Report 1 of the project and approved it with some minor corrections to be done. The Progress Report 1 is attached to the Minutes of Meeting.

Attachment 1: Progress Report 1 of the project

Attachment 2: Proposed amendments of the Record of Discussions

Attachment 3: Proposed overall time schedule of the Project

Attachment 1: Progress Report 1 of the Project

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Attachment 2: Proposed Amendments of the Record of Discussions

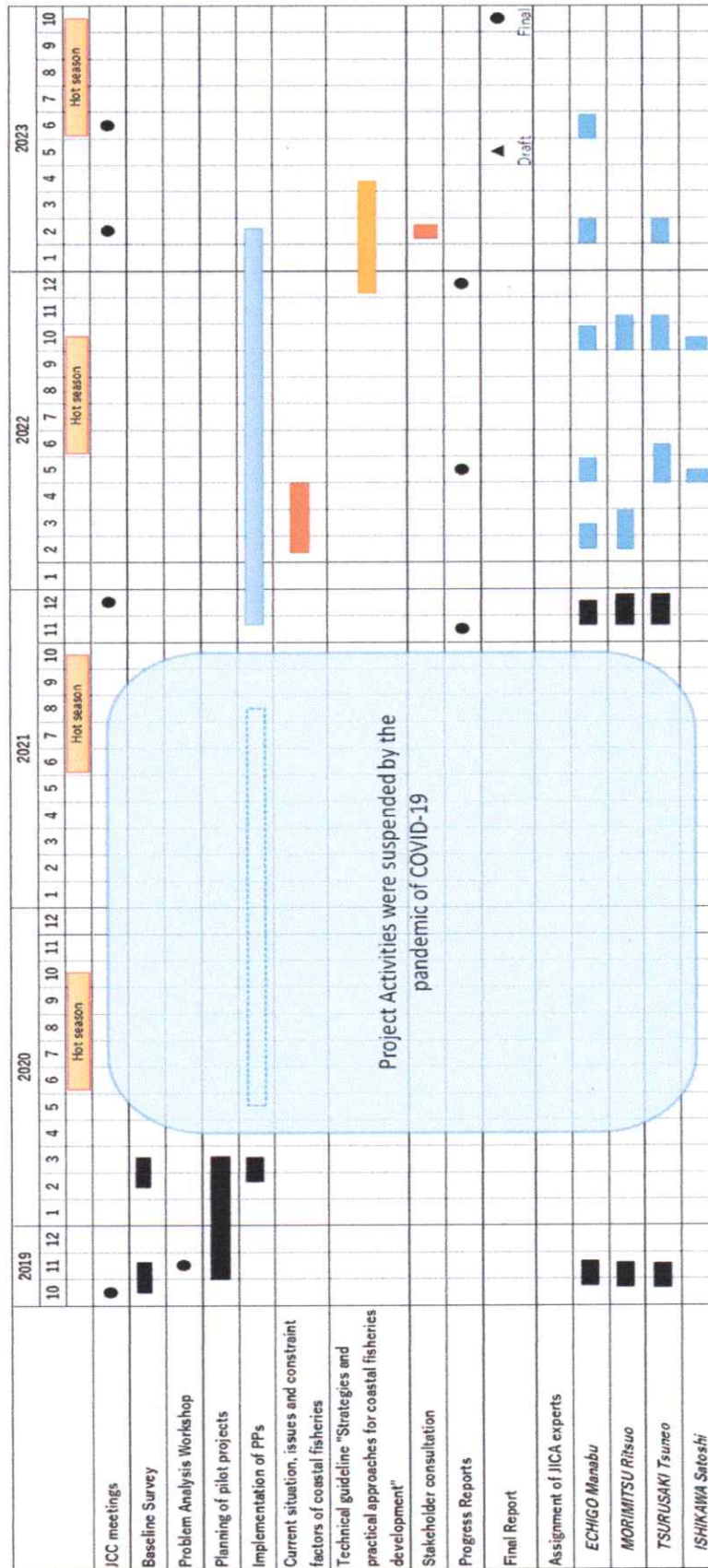
Before	Amended Version
<u>Annex 2</u> <u>PROJECT DESCRIPTION</u> <u>5. Duration</u> Duration of the Project is approximately 31 months	<u>Annex 2</u> <u>PROJECT DESCRIPTION</u> <u>5. Duration</u> Duration of the Project is approximately 48 months
Reason: The Project has been suspended due to the global spread of the coronavirus disease 2019 (COVID-19). In order to achieve the project purpose after the project team resumed the activities, it is necessary to extend the duration of the Project.	
<u>Annex 2</u> <u>PROJECT DESCRIPTION</u> <u>7. Implementation Structure</u> (1) Responsible Organization: MMR (a) Project Director / Coordinator Director General, Marine Resources Development of MMR (b) Project Manager Director, Research Department of MMR	<u>Annex 2</u> <u>PROJECT DESCRIPTION</u> <u>7. Implementation Structure</u> (1) Responsible Organization: MMR (a) Project Director / Coordinator Head of Projects and Commissions Coordination Office of MMR (b) Project Manager Director General of Marine Resources Development Department of MMR
Reason: Minister of Marine Resources assigned a new project management structure according to the organizational change in the Ministry.	

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Attachment 3: Proposed Overall Time Schedule of the Project

Expected Overall Time Schedule of the Project



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**MINUTES OF MEETING
OF
THE THIRD JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR THE FORMULATION OF THE STRATEGIES AND
PRACTICAL APPROACHES FOR COASTAL FISHERIES DEVELOPMENT**

The third meeting of the Joint Coordinating Committee (hereinafter referred to as “JCC”) on the Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (hereinafter referred to as “the Project”) was held on the 5th May 2022 in Massawa with participation of representatives of Eritrean government authorities concerned, representatives of Japan International Cooperation Agency (hereinafter referred to as “JICA”) and the Project Team members. As a result of discussion, members of the committee agreed on the matters referred to in the documents attached hereto.

Massawa, 5th May 2022



ECHIGO Manabu
Team Leader of the Study Team
Japan International Cooperation Agency



Adonay Heruy
Project Director/Coordinator
Head of Projects and Commissions Coordination
Office, Ministry of Marine Resources

ATTACHED DOCUMENTS

1. Progress of the Project

Based on the Progress Report 2 of the project and series of reports related to the pilot projects made by the JICA Study Team and the Project Implementation Units (PIU), the meeting reviewed current status and progress of the project activities implemented after the issuance of the Progress Report 1 until April 2022. It was confirmed that the project activities have been conducted according to the amended project plans adopted in the second JCC meeting held on the 1st December 2021.

2. Future project plans

The meeting confirmed the continuous implementation of the project activities which include the pilot projects in the areas of “fishing gear and methods” and “fishing community developments” and also the development of the technical papers that “Current status, issues and constraints of coastal fisheries in Eritrea” as well as “Technical guidelines of strategies and practical approaches for coastal fisheries development in Eritrea” as final outputs of the project. Hence, the proposed project plan till the end of the project scheduled for October 2023 that includes the final seminar of the technical guidelines in May 2023 and final report adoption in July 2023 were also confirmed.

3. Approval of the Progress Report 2

The meeting discussed on the Progress Report 2 and approved it with some minor corrections to be done. The final version of Progress Report 2 will be submitted to all JCC members and related organizations.

Attachment 1: List of the participants

Attachment 2: Overall time schedule of the project



Attachment 1: List of the participants

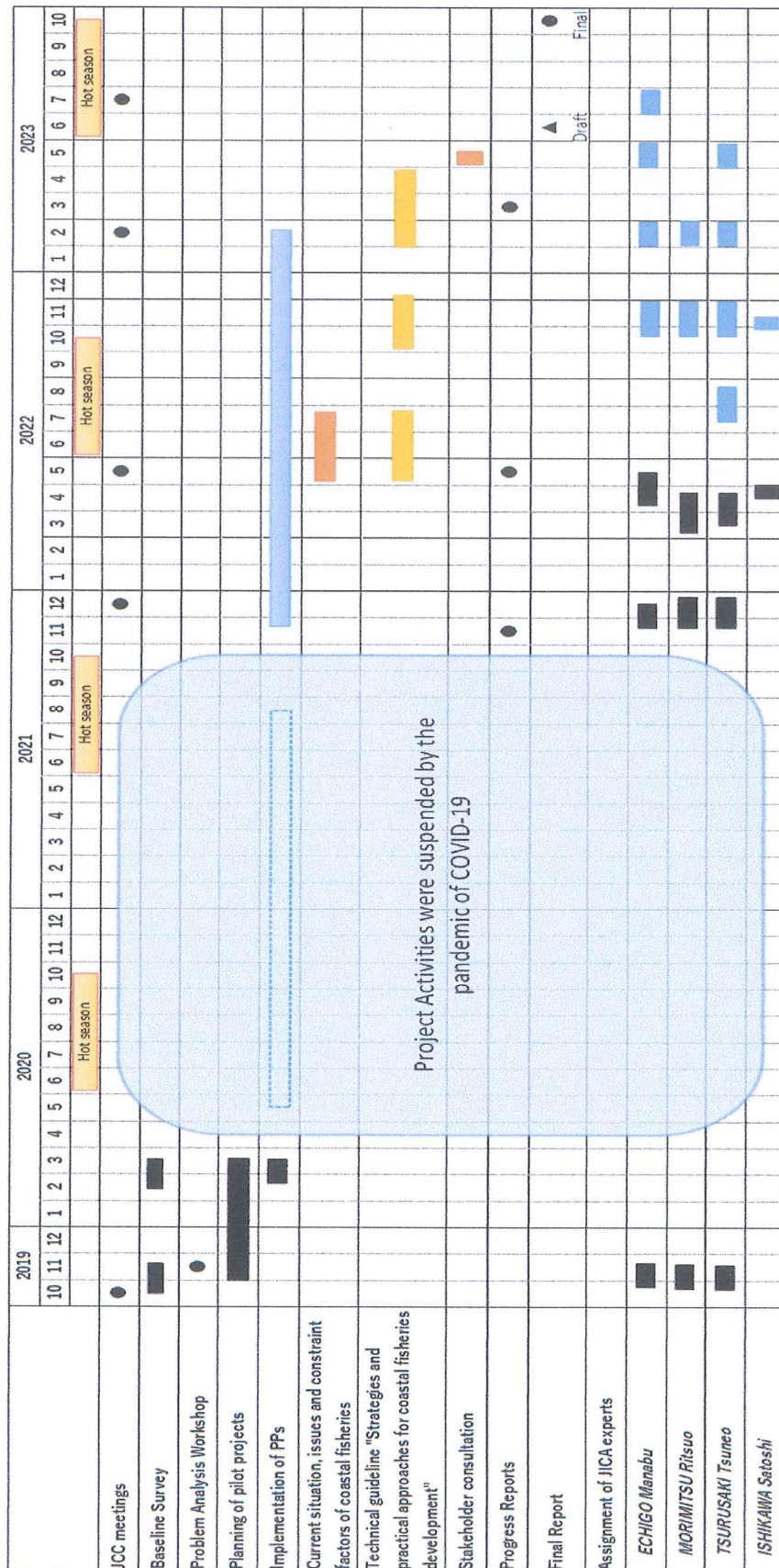
S.No.	Name	Department/Division
1.	Adonay Heruy	PCCO
2.	Idris Saleh	MRDD/ Project Manager
3.	Yohannes Teclemariam	MRRSD
4.	Filimon Bereket Berhe	MRDD
5.	Filimon Bereket Bairu	MRDD
6.	Merhawi Beyene Araya	Research
7.	Eyasu Haile Ahferom	National Fisheries Corporation
8.	Yohannes Kelit Habtom	Quality Control Laboratory
9.	Mulugeta Mahdere	MRDD/ Project Counter Part
10.	Yohanna Negassi	QCL/ / Project Counter Part
11.	Aklilu Tsehaye	MMR Zoba Branch
12.	Robel Solomon	ETWD
13.	Tekle Mengstu	Office of Minister
14.	Solomon Brhane	Research/ Project Counter Part
15.	Mewael Debesay	ETWD
16.	Mekonen Shishay	Research
17.	Adiam Abraham	PCCO
18.	Meseret Gebremichael	JICA Eritrea
19.	Echigo Manaba	JICA Study team

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Attachment 2: Overall Time Schedule of the Project

Expected Overall Time Schedule of the Project



**MINUTES OF MEETING
OF
THE FOURTH JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR THE FORMULATION OF THE STRATEGIES AND
PRACTICAL APPROACHES FOR COASTAL FISHERIES DEVELOPMENT
IN
THE STATE OF ERITREA**

The fourth meeting of the Joint Coordinating Committee (hereinafter referred to as “JCC”) on the Project for the Formulation of the Strategies and Practical Approaches for Coastal Fisheries Development (hereinafter referred to as “the Project”) was held on the 10th March 2023 in Massawa with participation of representatives of the concerned Eritrean government authorities, representatives of Japan International Cooperation Agency (hereinafter referred to as “JICA”) and the Project Team members. As a result of discussion, members of the committee agreed on the matters referred to in the documents attached hereto.

Massawa, 10th March 2023



ECHIGO Manabu
Team Leader of the Study Team
Japan International Cooperation Agency



Adonay Heruy
Project Director/Coordinator
Head of Projects and Commissions Coordination
Office, Ministry of Marine Resources

ATTACHED DOCUMENTS

1. Progress of the Project

Based on the Interim Report of the project with series of reports related to the pilot projects and other technical reports made by the JICA Study Team and the Project Implementation Units (PIU), the meeting reviewed current status and progress of the project activities implemented until January 2023 and some results of the pilot projects. It was confirmed that the project activities have been conducted according to the amended project plans adopted in the second JCC meeting held on the 1st December 2021.

2. Future project plans

The meeting confirmed the continuous implementation of the project activities which includes compilation of the final reports of the pilot projects, the technical report “Current status, issues and constraints of coastal fisheries in Eritrea” as well as “The Technical Guidelines of the Practical Approaches for the Priority Challenges of Coastal Fisheries Development of Eritrea” as final outputs of the project. Hence, the proposed project plan till the end of the project, scheduled for October 2023, that includes the final seminar of the technical guidelines in June 2023 and final report adoption in August 2023 were also confirmed.

3. Approval of the Interim Report

The meeting discussed on the Interim Report and approved it with some minor corrections to be done. The final version of Interim Report will be submitted to all JCC members and related organizations.

Attachment 1: List of the participants

Attachment 2: Overall time schedule of the project

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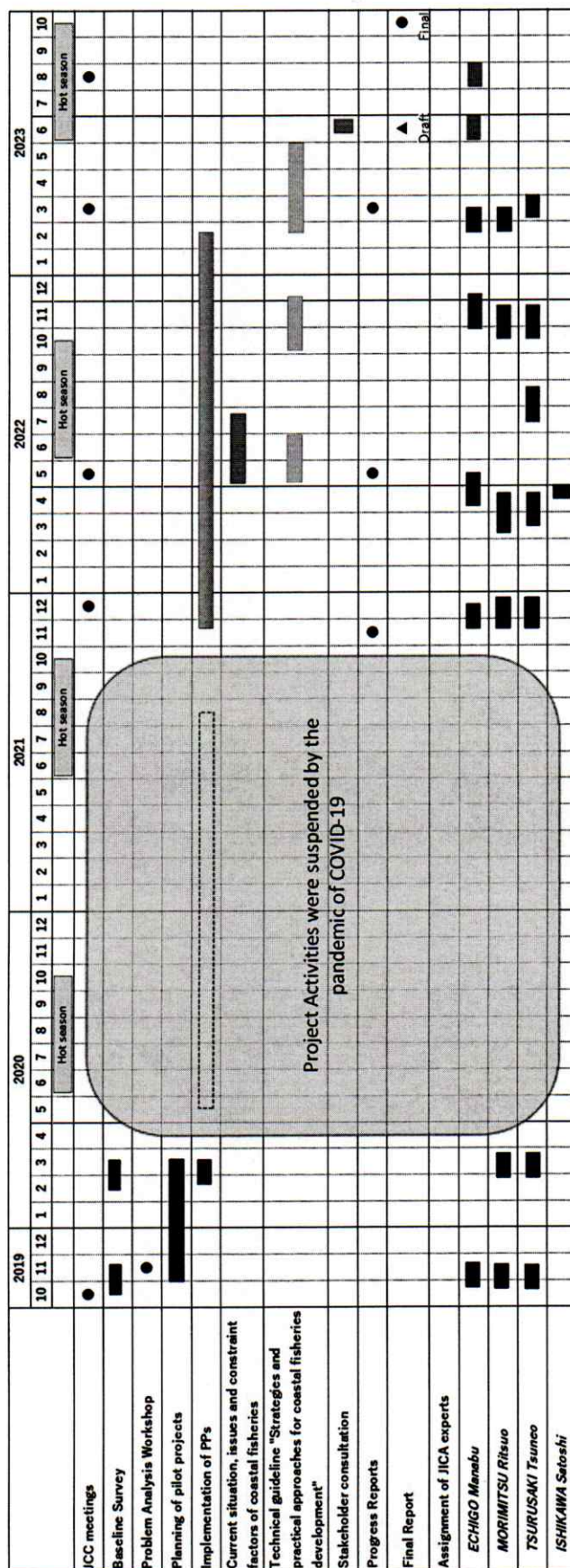
Attachment 1: List of the participants

	Full Name	Department/ Division/Organization
1.	Yosief Redae	MR Development Dept
2.	Dita Amanuel	MR Development Dept
3.	Filmon Bereket Bairu	MR Development Dept
4.	Osman Ibrahim Ahmed	MR Regulatory service Dept
5.	Tesfamariam Arefe	MR and Environment Research
6.	Yossief G/kidan	National Fisheries Cooperation
7.	Medhanie Mehari	Engineering & Technical Works Division
8.	Mewael Debesay	Engineering & Technical Works Division
9.	Misgina Tesfu	MR Development Dept
10.	Teklay Zeru	MMR Northern Red Sea branch
11.	Selim Mohammed	MMR Northern Red Sea branch
12.	Adiam Abraham	Projects & Commissions Coordination Office
13.	Aklilu Tsehaye	MMR/Northern Red Sea Branch
14.	Mahta Goitom	MMR/Fish Quality control Laboratory
15.	Natnael Hailemicheal	Information & Documentation Division
16.	Barkat Samuel	Public relation/MMR
17.	Tekle Mengstu	Minister office
18.	H.E Minister Tewelde	Minister office
19.	Kidane Berhane	MR Regulatory service Dept
20.	Mulugeta Mahdere	MR Development Dept
21.	Mohammedsiraj Abdelhafiz	MMR Documentation unit
22.	Filmon Bereket Berhe	MR Development Dept
23.	Morimistu Ritsuo	JICA team study
24.	Selomun Brhane	MR Research Division
25.	Tsuneo Tsurusaki	JICA team study
26.	Gebermicheal Estifanos	JICA-Eritrea office
27.	Simon Kariuki	JICA Kenya Office
28.	Idris Saleh	MR Development Dept
29.	Feruz Angosom	MR Information & documentation Division
30.	Adonay Heruy	Projects & Commissions Coordination Office
31.	Hermon Alazar	Projects & Commissions Coordination Office
32.	Echigo Manabu	JICA study team
33.	Teame Merese	MR Information & documentation Division

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Attachment 2: Overall Time Schedule of the Project

Expected Overall Time Schedule of the Project



Attachment 3: Minutes of the Stakeholder Consultation for the Technical Guidelines

Minutes of the Stakeholder consultation work shop for the Coastal Fisheries Development Guidelines

Date 27/06/2023

Venue MMR meeting hall

Session I: Meeting with fishers and fishing communities

Time 9:00 AM -10:00 AM

Comments from fishers

1. The small scale longline which is tested by the pilot project should be distributed to fishers because the result was promising.
2. The result of the pilot study should be distributed to the community soon. Especially, the activities which were done in fishing gear are very promising and should be transferred to the fishing communities.
3. The activities in Hirigiro are not yet started. The container as the facility of Community Fishery Center (CFC) was installed before seven months and it is not yet started working. The pound net which was installed at the beginning is not yet functioned and it should be solved soon.
4. The pound net in Zula was started successfully but now it needs some parts to maintain.
5. The ice making machine was started successfully in Zula at the beginning but now it is out of work so Zula community needs to repair it.
6. The cooperatives in Zula and Hirigiro required small fishing boat to use the opportunity of getting ice and CFC to improve their income.
7. The cooperative in Zula needs big cooler box to store the ice produced from the block ice making machine.

Session II: Meeting with official stakeholders mainly MMR participants

Time 11:00 AM -12:30 PM

Comments from official stakeholders

1. The activities planned according to the Guidelines produced from the pilot projects must be monitored and evaluated properly.
2. Cost benefit analysis of the Development Tools on the activities planned by Guidelines should be determined.

3. In the FAD technique there were many attached organisms which causes to take down artificial seaweed. There should be necessary a countermeasure to solve the problem.
4. Implementation structure included related MMR's sections should be mentioned in the Guidelines.
5. The CFCs in Zula and Hirgigo are not functional at this time. The CFC must be functional to use this Guidelines for the development of the coastal fishing communities.
6. The Guidelines shall help to make coastal fisheries development frame work.
7. The linkages between the approaches and Development Tools are unclear.

The Wrap-up Session

Time 12:30 PM – 12:45 PM

The project director noted that the following three points need to be considered for revise/amendment to the guidelines.

1. It should be clearly stated in the guidelines that business plans should be drawn up for those Development Tools that require income and expenditure calculations for their operation.
2. The implementing body and responsibilities of the Guidelines should be clearly stated in the appropriate sections of the Guidelines.
3. Check the description in the main text of the relationship between Approaches and Development Tools and correct it if it is unclear.

Participants list

No	Full Name	Department/Division/Organization
1.	Mahmud Mussa	Hirgigo Cooperative member
2.	Ahmed Saleh	Hirgigo Cooperative member
3.	Zahra Saleh	Hirgigo Cooperative member
4.	Fatna Ahmed	Hirgigo Cooperative member
5.	Tesfalem Tekleab	Massawa Cooperative member
6.	Mehari G/tinsae	Massawa Cooperative member
7.	Mohammed Omer	Massawa Cooperative member
8.	Saleh Mahmud Jabr	Zula Cooperative member
9.	Ibrahim Omer	Zula Cooperative member
10.	Meryem Ibrahim	Zula Cooperative member
11.	Fatna Hamed	Zula Cooperative member
12.	Frehiwet Kibrom	MMR Northern Red Sea Branch
13.	Msgna Tesfu	Marine Resources Development Department
14.	Mekonen Shishay	Marine Resources Development Department
15.	Luul Kahsay	MMR Northern Red Sea Branch

16.	Kidane Berhane	Marine Resources Regulatory Service Departement
17.	Robiel Solomun	Engineering and Technical Works Division
18.	Merhawi Beyene	MMR Northern Red Sea Branch
19.	Solomun Berhane	Marine Resources Research Division, C/P
20.	Trhas Bereket	Engineering and Technical Works Division
21.	Mulugeta Mahdere	Marine Resources Development Department
22.	Nguse Kflu	Marine Resources Development Department
23.	Samuel Tesfagabir	Engineering and Technical Works Division
24.	Filmon Bereket Bairu	Marine Resources Development Department
25.	Filmon Bereket Berhe	Marine Resources Development Department
26.	Bilen Alazar Abrha	Marine Resources Development Department
27.	Mewael Debesay	Engineering and Technical Works Division
28.	Medhane Mehari	Engineering and Technical Works Division
29.	Yohana Negassi	Marine Resources Development Department
30.	Werede Desta	MMR Northern Red Sea Branch
31.	Alexander Goneche	MMR Northern Red Sea Branch
32.	Awet Yemane	Minister office
33.	Dita Amnuel	Marine Resources Development Department
34.	Melke Welderufael	Marine Resources Development Department
35.	Beraki Haile	MMR Northern Red Sea Branch
36.	Tesfamichael Okbazghi	Marine Resources Development Department
37.	Barkat Samuel	Public Relations
38.	Feruz Angosom	Marine Resources Information and Documentation Division
39.	Adonay Heruy	Project Coordination and Commissions Office
40.	Aklilu Tshaye	MMR Northern Red Sea Branch
41.	Teklay Zeru	MMR Northern Red Sea Branch
42.	Telehaimanot Beraki	Marine Resources Development Department
43.	IJJIMA Atsushi	JICA Kenya office
44.	ECHIGO Manabu	JICA Study Team
45.	Ghebremichael Estifanos	JICA Eritrea Liaison Office