

Assessing The Environmental, Social And Economic Impacts Of The Sea Cucumber Fishery In The Red Sea Of Eritrea

Mohammad Afsar Alam, Dr. Ravinesh Rohit Prasad & Dr. Sakul Kundra

Department of Social Sciences, College of Humanities and Education, Fiji National University , E-mail: drmaalam92@gmail.com , Orcid: [0000-0001-5989-6399](https://orcid.org/0000-0001-5989-6399)

Abstract

This research is an attempt to assess the social, economic and environmental impacts of the sea cucumber fishery in the red sea of Eritrea. In this research both primary and secondary data have been used and expressed in quantitative and qualitative form. Sea Cucumber fishery has been practiced in Eritrea since 1960. It is one of the most important economic activities of the coastal people as it creates employment opportunities and generates their income. It plays a very crucial role in shaping and maintaining societal betterment and has significant contribution to national GDP. In Eritrea the effective management measures is limited like other developing countries. The government of Eritrea along the Ministry of fisheries adopted some management strategies for the preservation and sustainability of marine resources. But the adequate and effective management measures specifically for Sea Cucumber fishery is very limited. The fishery is being practiced through traditional methods and some of the methods like Net trawling is very destructive to marine life and their habitats. Most of the fishers in Eritrea are not well trained and have little information about the statues of the Sea cucumber species and they do not have adequate knowledge about marine bio-diversities and their habitats. Their main objective is only to maximize their profit. Hence, they do not care about marine resources and the marine ecosystem has been disturbed by such fishery. Therefore, these kinds of fishing practices have an adverse impact on marine ecosystem and the sustainability of Sea Cucumber fishery. These impacts could be economic, social and environmental that could hamper the development of the fishery. This research may be a milestone for the planners, policy makers and the government as well for the future planning of sea cucumber fishery in Eritrea.

Keywords: Environmental, Economic, Eritrea, Social, Sea Cucumber Fishery.

I. Introduction

For more than a millennium, the Indo-Pacific region has been home to a multi-species invertebrate fishery for traditional and subsistence uses. Sea cucumbers, particularly those of the families Holothuridae and Stichopodidae, play a significant role in this fishery (Bruckner et al., 2003). Sea cucumbers are a key source of revenue for coastal people and play a significant role in marine ecosystems. Therefore, it is crucial that they are managed and

conserved. Sea cucumbers are a significant component of the multispecies invertebrate fishery in Eritrea. Products made from sea cucumbers are exported because there is no domestic market for them. The sea cucumber fishery in Eritrea is not subject to any laws or restrictions, and no accurate predictions of the stock status are available. As a result, there are management and technical capacity restrictions in the sea cucumber fishing (Kaleab et al., 2008). The Ministry of Fisheries, State of Eritrea,

received funding from the UN Food and Agriculture Organization (FAO) through the United Nations Development Programme (UNDP) for a preliminary assessment of the status of sea cucumber stocks and a study of the socioeconomic and environmental effects of sea cucumber fishing. The ecological and biological features of Eritrea's sea cucumber fisheries are described in this research. The northern fishing grounds of Eritrea are comparatively rich in numerous commercial sea cucumber species. Comparatively speaking, the sea cucumber fishery in Eritrea is in better shape than the sea cucumber fishery in other Red Sea regions. As opposed to shallow and onshore habitats, offshore and deeper locations have a larger animal density. All of the significant fishing grounds were chosen to have monitoring locations. At the islands of Green and Dissie, which have been suggested as marine protected zones, permanent monitoring stations will be set up.

In many Southeast Asian countries, the current high demand for dried sea cucumber products is projected to persist and grow (FAO 2003). The dried body wall, also known as beche-de-mer or trepang, is a frequently exported product. Sea cucumber populations have decreased globally over time, primarily as a result of overharvesting in numerous nations. There have been cycles in sea cucumber fisheries where the overall catch dropped despite an increase in fishing effort. This has resulted in excessive resource exploitation and poor economic returns for coastal communities (Ibarra and Soberon 2002). Sea cucumbers are susceptible to overexploitation because of their high market value, ease of harvesting, unique biology, population dynamics, and habitat preferences (Bruckner et al. 2003). As a result, the fishery experiences boom and bust cycles, with biological overexploitation frequently happening before economic overexploitation (Preston 1993; Conand 1997).

Initially restricted to shallow seas, sea cucumber collecting has been carried out in Eritrea for the past 50 years. However, there has been extensive exploitation since 2000, which has led to significantly higher sea cucumber catches and export rates. In 1998, the southern region of Egypt saw the start of the beche-de-mer fishery. Initially, trawling boats were largely used to conduct this at a low level. By 2000, the fisheries had grown significantly, raising concerns about overfishing. Because of this, the Red Sea Governorate enacted a sea cucumber fishing ban in 2001 in order to carry out a baseline survey and stock assessment (Lawrence et al., 2005). Beche-de-mer goods made from dried sea cucumbers are presently supplied by Eritrea to foreign markets (Tewelde and Woldia 2007). A total of 11 tons of dried and gutted sea cucumbers were produced in 2000. The sum has gradually grown since then (Table 5.1). An administrative decision to stop illegal fishing and exports caused the fishery to be closed in 2007. (Tewelde and Woldia 2007). Due to the tiny sizes of the stocks and the power of market pressures, highly valued and commercial species in Latin America and the Caribbean have been overfished. In addition, at least 12 out of the 17 countries where sea cucumber fisheries have been studied show symptoms of overfishing, and in the Western Pacific, the majority of species are largely extinct (Conand, 1997). Traditional consumers of sea cucumbers (Echinodermata: Holothuroidea) are primarily Asian populations, and their fisheries have been documented in detail (Conand, 1998).

2. Objectives of the study

This study has manifold objectives;

- i) To examine the social, economic and environmental impacts of Sea Cucumber fishery in Dahlak Archipelago.

- ii) To enhance better understanding for protecting the quality of the environment in the Eritrean Red Sea.
- iii) To ensure sustainable development of Sea Cucumber fishery in that region.

3. Materials and Methods

In this research both primary and secondary data have been used and expressed in quantitative and qualitative form. Primary data were obtained through field observations in Dahlak islands by observing the methods of gathering, processing and drying. Sailors, local people and the officials were also interviewed whether they care about other untargeted marine resource or not? Secondary data were gathered from the reference books, internet and some raw data from Eritrea's marine resource office. Besides, graphs, tables, pictures and maps have been used for visual clarification.

3.1 Survey of the area

The coast of Eritrea was divided into three sea cucumber fishing grounds for this study: the northern, central, and southern (Fig. 3). A coral reef, sand substrate, muddy beaches, mangrove beds, seagrass beds, and macro algae were considered to be significant sea cucumber habitats and were taken into consideration while choosing survey locations. Additionally, grounds that were fished and unfished as well as regions that were onshore and offshore were taken into account. 120 locations were chosen in all, including 40 sites in the center fishing areas, 35 sites in the south, and 35 sites in the north.

3.2 Survey Methodology

A 100-meter transect was surveyed by two teams of divers, who recorded data one meter on either side of the transect (i.e. 2 m total width). The

whole width of the observation was decreased to 1 m when there was low visibility. Depending on the terrain of the area, the transect was sometimes set parallel to and sometimes perpendicular to the shore. A 30 m depth below the reef flat was reached for the investigation. All observed sea cucumber species' lengths were measured, and the kind of substrate was characterized in terms of its percentage coverage by coral, seagrass, microalgae beds, sand, mud, or mangrove stands.

4. The Area of Study

Between Sudan and Djibouti, Eritrea is located on the northeastern coast of Africa (between 12 and 18°N and 36 and 43°E). The length of Eritrea's mainland coastline, from Ras Quesar (the country's northern border with Sudan) to Ras Dumera, is roughly 1350 km (southern border with Djibouti). About 1900 kilometers of shoreline encircles the numerous offshore islands. The coastline of Eritrea is separated into three sections, namely the Northern fishing ground, Central fishing ground, and Southern fishing ground, from the perspective of the sea cucumber fishery.

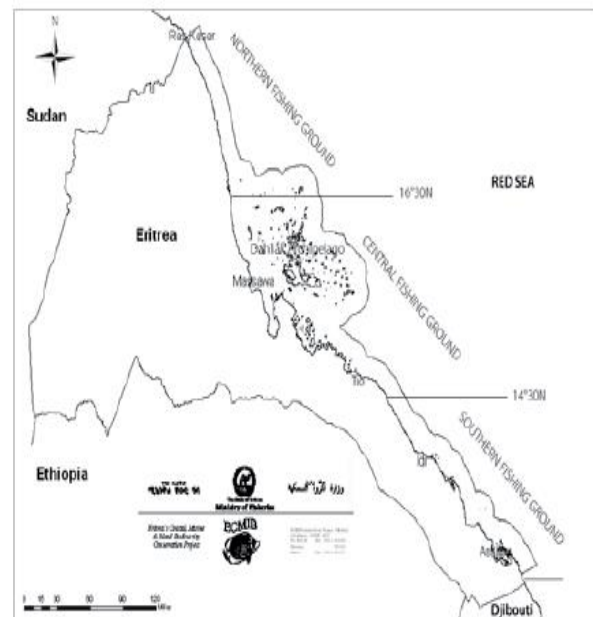


Fig. 4 Northern, Central and Southern Sea Cucumber fishing grounds

5. Effects of the Sea Cucumber Fishery on the Environment

On land close to sea cucumber processing camps, commercial sea cucumber harvesting has an adverse environmental impact. Particularly on the central and south-central islands, where sea cucumber fishermen have set up processing stations, terrestrial environmental impact studies were carried out. Mangrove degradation, halophyte removal, littering, and solid waste disposal were all noted throughout the assessment. There was evidence of bird nest disturbance and turtle consumption. The survey did not document any harm to the seabed brought on by sea cucumber trawling.

Due to the absence of proper fisheries management plans Sea Cucumbers are highly vulnerable to overexploitation. Information collected on fishermen's perceptions about environmental impacts of sea cucumber fishing provided a valuable addition to assessments. The following are the main findings from interviews with sea cucumber harvesters:

- More than 90% of fishermen believed trawling is the most destructive gear, while 91% felt that collection by foot is the least damaging.
- More than 70% of respondents consider the fishery will be sustainable with some sort of management, and
- 75% of fishermen will harvest sea cucumbers during the coming season in same fishing ground visited by them last season.

5.1 Impact of Sea Cucumber Fishery on Marine Organisms

Sea Cucumber gathering has big impact on the surrounding environment, i.e., deforestation of mangrove forest, destruction of sea flowers due to diving to collect sea cucumber found on coral reef, gathering by net collect all organism found in sea bed so killing of small organism, destruction of nursery area of marine organism, destruction of the place of reproduction, spoiling the beauty of island shore by throwing rubbish of sea cucumber and throwing the remaining garbage in the coast, and also turtles are hunted for food and birds nesting place destruct.

A. Declining of Sea Cucumber Species

Sailors in many islands today are running to exploit White Sea cucumber species as a result these species are nearly endangered in many islands around Dahlak up to the depth of 30m. In addition to this, sailors collect under size species of sea cucumber for maximizing their profit without considering the ecological and species impact. On the other side Sea Cucumbers are very vulnerable to exploitation because; 1. Sea Cucumbers have a limited movement, in a day move less than one meter. Due to these, sailors can easily exploit them. 2. Sea Cucumber takes more time to reach reproduction period. 3. Sea Cucumbers have density dependent reproduction nature. 4. Out of total Sea Cucumbers that reach reproductive stage is very few. Due to above mentioned characters Sea Cucumber are reducing in type and potentiality. Besides, the fishers are exploiting the under sized Sea Cucumbers by violating the rules and regulations set by the Government as seen in the table 5.1 below.

Table 5.1 Collected Sea Cucumbers in Kgs in 2017

Exploited sea cucumbers	Black fish (Shalakh)	Holitheriaedulis	Holitheriaatra	Sand fish	Total
Number of (under 8cm in size) sea cucumber by counting in one day	7	22	2	123	154
Number of (over 8cm sized) sea cucumber by counting in one day	53	38	58	117	266
Total	60	60	60	240	420
% of under sized (8cm) sea cucumber	11.7%	36.7%	3.3%	51.3%	100%
Total unloaded sea cucumber by kg in these three months	5552	1830	30708	882	38972
Under 8cm sized sea cucumber harvested in this year by kg	375	322	417	129	1242
% of Under 8cm sized sea cucumber expelled from weight in these three months	2.2%	1.9%	2.5%	0.8%	7.3%

Source: Ministry of Fishery, 2017

When we see the weight of collected sea cucumbers of each type and the ratio of under sized dried sea cucumber of each type collected in 2017, out of the total 5552 kg of black fish (Shalakh) 375 kg were under size (8cm), out of 1820 kg of holothurians edulis 322 kg were under size, out of 30708 kg of holothurians atra 417 kg

were under size and out of 882 kg sand fish 129 kg were under size. When we see the percentile of under sized sea cucumber expelled from weighting in this year 2017, 2.2% of black fish were expelled, 1.9 of holothurians edulis, 2.5% of holothurians atra and 0.8% of sand fish were expelled from weighting at the weighting center.

Table 5.1.2 Listing of sites, Species and Lengths (cm) of juveniles commercially important sea cucumbers in 2017.

Sites	Species	Length (cm)
Museri	H. edulis	10
Yermelikin	H. edulis	9
Arabisied	H. atra	6.5
Marbasan	H. atra	9
AmmuNamus	A. miliaris	10
Bari asoli (mainland)	H. atra	10
Bari asoli (island)	A. mauritiana	6

Source: Ministry of Marine Resources 2017

The above table shows that the sites of juvenile commercially important sea cucumber under 10cm recorded in 2017, *H.edulis* of 9-10cm are seen in Museri and Yermelikin, *H.atra* of 6.5-10cm were recorded in SeidArabi, Marbasa and Bari asoli (main land), *Actinopygamiliaris* of 10cm in size were recorded in Ummunamus and *Actinopygamouritania* of 6cm in size were recorded in Bari asoli (island).

Vriegatus, is a medium sized species with the mean length 35cm, but larger Specimens have been observed. The firm body wall disintegrates easily when collected. Its color yellow to greenish gives it its name of Curry fish. It occurs in the reefs and lagoons, in seagrass beds, rubbles and muddy-sandy bottoms. The sexual reproduction takes place during the warm season in the Pacific. The average body length at first maturity is 36cm and the diameter of mature Oocyte is 200 micrometers. This species does not borrow and is able to move rapidly when disturbed (FAO, 2008).

B. Killing Sea Turtles for Food

Turtles are one of the endangered species, which needs more protection and preservation. They are slow swimmers and could not escape from their enemies. As they move slowly, the fishers simply take the turtles by their hands and slaughter them to eat them as food (Fig. 5). The fishers do not

care about this endangered species. Some of the Turtles have Shabannar (poisonous) hence they cannot be eaten by the people but many of them are eaten by the people. While hunting the turtles the fishers simply hunt the turtles and slaughter them without considering its purity. Simply turtles are hunted and slaughtered by the fishers. It is only after the slaughtering that they start to examine whether it has Shabannar or not. This is done (examined) by putting small amount of its blood on their skin or Tongue. If the blood burns (irritates) their skin or tongue it means that the turtle has Shabannar hence it cannot be eaten by the people, and it is simply dumped without any use. Therefore, many turtles have been simply hunted, slaughtered, and thrown without consumption and many others are eaten by the fishers. In addition to this Sea Turtles naturally lay eggs in the coast and the hatched young's stay there up to several weeks until they become strong enough to move (Sea Turtles news on Haddas Eritra, 23 April 2015). While the fishers are cutting mangrove forests for fuel wood, they break the turtles' eggs and kill their young without any care. Thus, the fishers are not caring the endangered species of the marine environment as a result the already endangered Turtle species are gradually declining in number because of excessive hunting. Therefore, serious measures should be taken to ensure the species availability and abundance in the area.



Fig. 5 Turtles slaughter to eat as food

C. Destroying the Snail Species

Sometimes Sea Cucumber fishers face more challenges in the process of Sea Cucumber harvesting. The problems that encounter the fishers could be disorder of oxygen compressor, strong winds and scarcity of fuels, during this they are forced to shift to snail nail gathering. This is because the snail nail gathering does not require the use of oxygen compressors as it is practiced in shallow sea water which is not more than two meters depth. Hence, the fishers collect many snails in the barrels and take them outside the Sea water and separate the nails from its mother snails. Then once the fishers separated the nails from its mother snails, they do not return them back to the Sea and they simply throw them in the coasts outside the Sea as a result they are destroyed in huge numbers and if they return them to the Sea, they simply pour them in one place without care, as a result they die due to suffocation.

D. Throwing Dead Fish on the Sea makes alive Fishes to Migrate from that Area

Throwing dead fish in the sea is common practice in the red sea, so that the endemic fishes are continuously forcing to migrate to other area

where there are no such occurrences. This results in reduction of endemic fishes in the originally rich fishing grounds in the bays and gulfs of Nora and around Dahlak Kabir areas. Also, net trawling for collecting fishes also collects all economically useful and non-useful fishes and those economically use less fishes are throwing to the sea or to the coast making the sea and the coast polluted.

5.2 Impacts of Sea Cucumber Fishery on Marine Habitat

Wastage of sea cucumber has local impact, specially gathering sea cucumber by net has a severe impact on marine organism especially on corals, sea grass, sea flowers and habitat. Say for instance, in one pulling 2.5 kg sponge, 6.6 kg varieties of small organism, 0.30 kg gastropods, 0.50 kg star fish, 0.10 kg scarabs, 0.30 kg sea urchin, 0.60 kg unvalued sea cucumber, 1 kg sand and stones, fish eggs, bivalve organisms etc. can be pulled. Generally, out of 14 kg pulled by net only 2.5 kg are valued, and targeted organism and others are wastage. The net trawling method has severe impact on environment by distracting habitat, displacing nursery area, wasting varieties of untargeted organisms and cause ecological

imbalance. This is because this work done near the shore not far from 1-4 miles from the shore.

A. Destruction of Sea Flowers and Coral Reefs

Sea Flowers are important plants which grow in shallow waters of tropical, subtropical, and temperate zones. They cover a large coastal and offshore island. It is used as a source of food for many marine organisms like fish, Dugong, Turtles etc. They are also habitats for variety of Marine organisms, and they are used to protect Seabeds from wave erosion. Therefore, they are useful natural resources of the country that helps in existence of rich Marine biodiversity.

There are five new types of coral reefs in Eritrean Red Sea which are not found anywhere in the world. Corals are habitats of different kinds of plants and animals, so as it is a home of marine biodiversity, and it is also used to protect coastal

wave erosion and for making beads and other ornaments. Therefore, corals are useful natural resources that enable the Red Sea to be endowed with rich marine biodiversity. But according to this research I directly observed that these marine habitats have been destroyed and displaced by the fishing activities of the fishery. For example, while they are harvesting Sea Cucumbers through net trawling all the targeted (Sea cucumber) and untargeted organisms (Corals, Sea grasses, Sea weeds, Sea flowers, Fishes, etc.) uprooted, damaged and displaced from their original places and pulled and collected in the net. In addition to net trawling through scuba diving and Banshar the fisheries also destroy the coral reefs and Sea Flowers. As a result, many marine habitats are destroyed and this could create disturbance of marine ecosystem and make the fishery unsustainable.



Fig. 5.2 Different types of marine organism pulled by net

B. Disturbance and Displacement of Marine Ecosystem

As observed on the way to field research the marine ecosystem around Dahlak is being continuously disturbed by sailors. Due to this, fishes, snails, sea cucumbers and other sea

organisms forced to migrate to deep sea region that have many enemies to them. And those animals that are unable to migrate start to die and extinct in mass. Say for instance, it is common to see many bivalve mollusks and giant calm and other shelled organisms that die inside the sea

water. As a result of this ecosystem disturbance now a day we can't see or find any fishes, turtles around the shore of the islands around Dahlak except on the bays and gulfs even though there are corals that needed to them for shelter and nesting.



Fig. 5.3 Moving on Corals and Sea Flowers

C. Increasing Sea Temperature

Red Sea is one of the warmest and the most saline seas of the world. Apart from this, the sailors have been throwing piles of plastic garbage's that can absorb more heat. As a result, it is common to see many old plastic materials that are thrown into the sea and dispersed plastic materials along the coast. This plastic material by nature has a power to absorb heat from the sun and to increase the temperature of the sea. Due to increasing temperature of the sea coral bleaching is happening in many islands of Eritrea today.

5.3 Impact of Sea Cucumber Fishery on Terrestrial Environment

A. Destruction of Mangrove Forest

Mangroves are salt tolerant trees which grow in coastal areas and islands areas of Eritrea. They provide variety of functions to the coastal communities. Mangrove forests protect the coastal areas from wave erosion; they act as

habitats and food for a variety of Marine animals and birds. They are also used for the construction of boats and used as a source of wood for the coastal communities and the fishers. Despite all these functions mangrove forests have been deforested or cut down by the sea Cucumber fishers and snail nail gatherers in the central fishing grounds of Eritrea. This is because mangroves are the only source of energy for the fishers in the islands of Eritrea for fuel wood. The fishers do not have any other alternative energy as fuel wood for the processing of sea cucumber fishery. Besides, most of the fishers do not care about the environment and mangrove forests. Many any mangrove forests have been destroyed for the processing of Sea Cucumber harvesting. According to the information provided by the Ministry of Fisheries in Massawa, in one trip (20-30 days), each boat consumes about 4.7 quintals of wood. When we compare this with the product, it means to cook one kilogram of Sea Cucumber, they consume about 3.1 kilograms of wood. Therefore, the fishers have been engaged in the mass destruction of mangrove forests and this

destruction of Mangroves have been resulted in a serious problem like rapidity of the coastal erosion, displacement of settlements, loss of habitats and migration of many animal species. Therefore, all the stake holders should work hard jointly to conserve these important trees from being not to be deforested completely.



Fig. 5.4 Destruction of mangrove forest

B. Accelerating Coastal Erosion

The coastal and Inland areas of Eritrea are continuously being eroded by different natural and man-made agents. The main factors accelerating the coastal erosion are the clearance of Mangrove forests, the uprooting, displacing, and damaging of Sea flowers, Coral reefs and Sea weeds, and the destruction of marine habitats, during Sea Cucumber fishery causes the acceleration of coastal wave erosion. As a result, there are continuous formation of caves, and these caves are continuously collapsed due to the overuse of the coasts by the fishers. Hence, they are causing displacement of settlement and other organisms. So, the coastal wave erosion is creating problems like displacement of settlements, migration of animal species, collapsing of caves etc. To understand the

B. Destruction of Sea flowers and Coral reefs

Sea flowers are important trees which grow in shallow water of tropical, subtropical, and temperate zones. They cover a large coastal area and islands.

consequences of coastal erosion in Dahlak islands (Fig. 5.5). These problems are going to continue unless the net trawled method in sea cucumber fishery is banned, and other alternative fuels are replaced the destruction of mangrove forests during sea cucumber fishery.

C. Hunting of Wild Animals and Birds

The Red Sea and the coastal islands of Eritrea are very rich in marine biodiversity and variety of birds. In addition to this there are also terrestrial animals like antelopes, turtles and others which play a crucial role in making the islands very attractive to the people, especially for tourists. But these endangered or the already scares wild animals in these islands like antelopes have been excessively hunted by the fishers, as a result the number of antelopes are dramatically decreasing in these islands. Therefore, the responsible stake

holders should strive hard at least to minimize the adverse effects of hunting of endangered wild

animals in these islands before the extinction of these species occur.



Fig. 5.5 Consequences of Coastal erosion in Dahlak Island

Moreover, the sea birds are continuously hunted, and their eggs are hatched by the fishers at nesting places, such as in mangrove trees and the caves. This makes the birds to migrate to the places where the ideal conditions are available.

D. Pollution of the coast

- ✓ Throwing garbages and waste products on the coasts

The Red Sea is one of the world's unpolluted Seas and hence it is known as the world's unspoiled paradise. It is one of the country's best natural resources, which attract a large number of tourists annually. Many tourists visit Red sea and its coastal area to appreciate its rich potentialities and entertain in its attractive and unpolluted marine environment. And these tourists flow has a lot of contribution in country's economy. However, the Fisheries in general and the sea Cucumber fishers are not protecting and preserving the environmental qualities of the coastal islands. They are continuously polluting the coastal environment in the islands of Aysammuha, Debanet, Duhlia, Muhun, Dataman, Darguman, Karakis, and Agrab by throwing different wastes or garages like ashes, piles of old and dirty clothes and shoes etc. Moreover,

during net trawling all untargeted marine organisms which are pulled by the net are thrown on the coasts of the islands and thus pollute the coastal environment. Not only these but also during the processes of sea cucumber harvesting, once the sea Cucumber are fished, they are cut or slaughtered with a knife from its side bilaterally and they remove all its internal body parts and throw these wastes into the coastal islands. They do not have any specific dumping site for these wastes, so they dump anywhere which adversely affect the environmental qualities and health of the individuals in the Dahlak islands.

- ✓ Spilling Oils and Chemicals into the Sea

Eritrea is one of the countries of the world which possess unpolluted and well protected sea and coast area. But nowadays large number of fishers with their boats are engaged in the sea cucumber fisheries, Snail nails gathering. Thus, the well protected marine environment is being polluted by different chemicals and oils. During harvesting of Sea Cucumber fishery and snail gathering the sailors can spill oils, other plastic materials, and chemicals, such as Meffalehi, gear detergent, useless batteries, old zinc into the sea. These also are also continuously polluting the marine environment. Most of the Seabeds are not

in their ideal condition to support aquatic life and this could have a negative impact on the stability of marine ecosystem and sustainable development of the fishery unless the quality of the marine environment is protected or preserved.

6. Social Impacts of Sea Cucumber Fishery

A. Loss of life and Health Implication

Accidents and safety issues are a common and serious concern facing sea cucumber harvesters using air compressors, scuba, and skin diving. Most divers are young (average 36 years) and receive no diving training, other than very basic guidance by their colleagues. This includes little more than how to operate the machinery, how to take the hose in the mouth, ‘clear’ the ears and dive. Most interviewees use air compressors and dive to the depth up to 30 meters. Divers’ only concern seems to be filling their sacks with sea cucumbers. Evidently, they do not log dives or the number of repetitive dives. Basic safety rules are not followed, and equipment is generally poorly maintained.

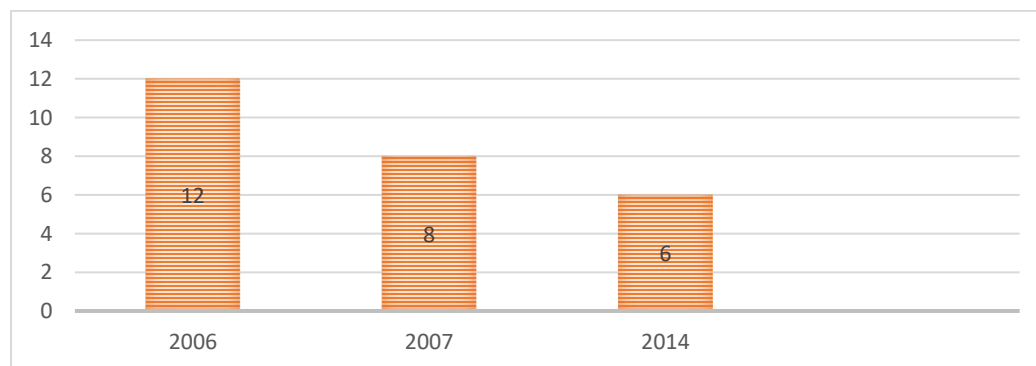
Fishermen work for more than 8 hours per day and may do 20 repetitive dives a day. When accidents occur, their colleagues do not know what to do. The injured diver must await his fate until he receives medical treatment at the hospital, or through traditional practices.

Some divers attributed paralysis or deaths (Fig. 6) to cold temperatures in the deep sea, while the others believed it is caused by the corrosive air compressor tank. A few believed accidents were caused by an evil spirit in the deep sea.

B. Deviating Tension of School Children

As the income of the sailors are very high when we compare with other economic activity of the coastal area. The school children are attracted by the income of the sailors and continuously rushing to work in the sea, but this work is too hard to tolerate. As a result, most children could not continue their education and hence they are deviating away from the right track at their young age and are facing different health problems.

Figure 6. Official Numbers of Diving Accidents Occurred in Sea Cucumber Fishery



Source: Navy Force Office, Oct-2014

C. Slug Diseases

In Dahlak area there are scarcity of fresh water so that the sailors let alone to get enough water to wash their bodies, it is difficult to get it for drinking. Hence sailors do not wash their body by

soft, clean water and the sea water also become hot at the afternoon sailors get sick by the slug dieses that makes wounds under the limbs which do not make the sailors to move well and make severe pain at night time and do not have any solution or medical (treatment) except washing and cleaning your body by clean, soft water and stay some days out of the sea.

7. Economic Impact of Sea Cucumber Fishery

A. Creates Employment Opportunities

Table 7. Number of boats engaged in sea cucumber fishing in terms of sub zone in 2017

Month	Massawa	Foro	Gelalo	Dahlak	Total
July	9	-	-	3	12
August	21	28	134	17	200
September	25	26	111	30	192
Total	55	54	245	50	404

Source: Surveyed by the researcher

In the above stated months 404 boats were engaged in the collection of Sea Cucumber, departing from four sub zones of Massawa, Foro, Galalo and Dahlak. In these 404 boats by average if we take six persons in the boat 2424 people were engaged in this work in three months and for about 120,000 people benefits from this work in northern Red Sea region.

The biggest re-exporters in the trade are China, Hong Kong, and Singapore. Of the 650 species of sea cucumbers, just 10 species have commercial

value. In 2013, the Chinese government cracked down on the purchasing of sea cucumbers by officials as their expensive price tag could be seen as a sign of opulence. In Japan, sea cucumber is also eaten raw, as sashimi or sunomono, and its intestine is also eaten as konowata, which is salted and fermented food (one of a variety of shiokara). The dried ovary of sea cucumber is also eaten, which is called konoko (FAO fisheries technical paper, 2004)

D. Economic Benefit

Table 7.1 Collected product of Sea Cucumber in 2017

Month	Benzin (litre)	Nafta (litre)	Product in (ton)
July	4600	4820	Total production of three months 38.972
August	58530	7450	
September	39650	6910	
Total	102,780	19,180	

Source: Surveyed by the researcher

The above table shows that in three months of work more than 40 tons of sea cucumber are gathered but only 38,97 tons are bought by the Ministry of Marine Resources and documented, the rest sold on merchants and its weight cannot be able to get because it is illegal. when we see

the percentile of the collected sea cucumber in terms of their type, 92.5% were lagae (Holitheriaatra) and shalakh Holotheriaedulis) and the rest 7.5% are the other type of sea cucumbers.

Table 7.1.2 Revenue of Ministry from the Boats

Month	Tax from Fish (Nakfa)	Tax from sea cucumber (Nakfa)	Punishment	Total
July	16'507.6	-	250'000	266'507.6
August	16'514.6	257'611.8	-	274'126.4
September	7'063.24	984'304.4	-	991'367.64
Total	40084.44	124,1916.2	250'000	1,532,001.64

Source: National Corporation of Fishery, 2014

*Nakfa: Eritrean currency

The main sources of revenues reaching the Ministry of Fisheries are registration fees, boat licensing fees, crews fees, royalty/export fees and resources utilization fees from artisanal and industrial fishermen. The annual income is substantial. In the months of July, August and September, the government get over one and a half million Nakfa from the boat owners by tax and punishment. Peoples of this region benefits more than the ministry by earning minimum 7000 Nakfa per head who engage in this work and up to 40,000 each ownership of the boat in one month. The fisheries have expanded overall, and interest in this benthic resource has increased. Conflicts between fishermen, processors, and the

authorities in charge of regulating the resources are common in many sea cucumber fisheries (Conand et al., 2004).

8. Result and Discussion

The survey of 91 of the 120 total sites includes 35 sites in the northern fishing ground, 40 sites in the center fishing ground, and 35 sites in the southern fishing ground. Future surveys of the remaining 10 sites will be conducted. Two sea cucumber species have been documented as unidentified, while 16 species have been identified thus far (Table 8).

Table 8 Sea cucumber species along the Eritrean coast

S. No.	Name of the Species	Grade	Trade Value
1	H. nobilis	1st grade	Yes
2	Holothuria atra	3 rd grade	Yes
3	A. miliaris	3 rd grade	Yes
4	H. scabra	1st grade	Yes
5	H. spinifera	No grade	No
6	Thelenata ananas	1st grade	Yes
7	Synaptula media	No grade	No
8	S. horrens	No grade	No
9	S. herrmanni	2 nd grade	Yes
10	Pearsonothuria graeffei	No grade	No
11	H. fuscogilva	1st grade	Yes
12	H. hilla	No grade	No
13	H. edulis	2 nd grade	Yes
14	H. impatiens	No grade	No
15	Stichopus chloronotus	No grade	No

16	<i>Actinopyga mauritiana</i>	2 nd grade	Yes
17	unidentified (1)	Unknown	Unknown
18	unidentified (2)	Unknown	Unknown

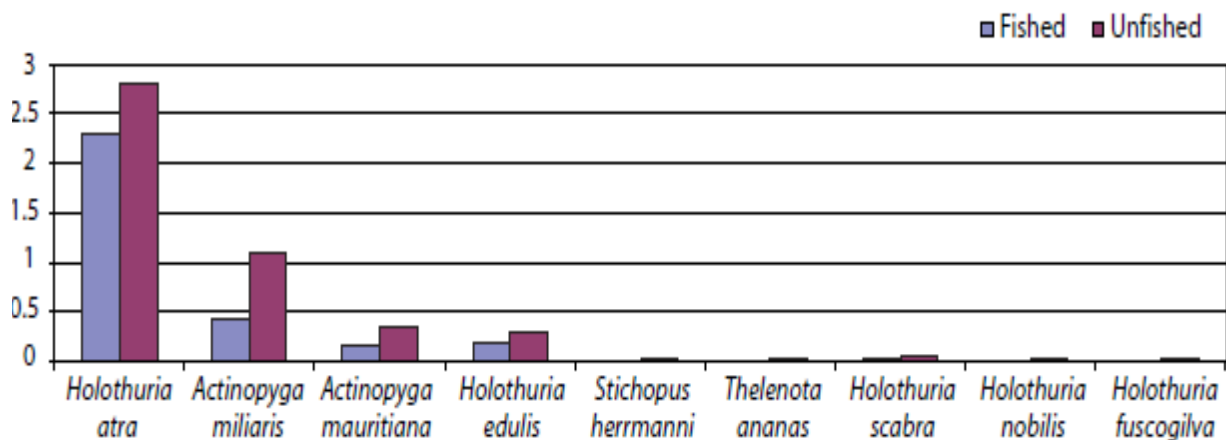
Source: Field Survey, 2017

9. Fished and Unfished Sections

The number of sea cucumbers in heavily and lightly fished areas was examined in order to assess the effects of sea cucumber fishing on stocks. In areas that were not heavily fished, the

average abundance values were 21.6 individuals per transect and 11.8 individuals per transect. Figure 9 clearly demonstrates a pattern of rising fishing pressure on sea cucumber populations as a whole.

Fig. 9 The Red Sea of Eritrea has both fished and unfished sections. Values are shown as the average number of people per transect.



Source: Kalaeb, T. et al. (2008) Status and preliminary assessment of the sea cucumber fishery in Eritrea.

10. Conclusion

Before the finished product is prepared for shipment, the sea cucumbers must undergo comprehensive processing. This processing has negative effects on the local flora and fauna as well as the terrestrial environment. Mangroves are chopped down to make fuel for boiling sea cucumbers, plastic and other trash are dumped nearby or in the water, bird nests are damaged, and fisherman catch and devour turtles.

While there are apparent trends of growing fishing intensity, not all commercial species have yet reached overfishing, according to a

comparison of sea cucumber abundance across fished and unfished locations. As a result, the level of fishing has a significant effect on the diversity of sea cucumber species as a whole. It is challenging to demonstrate overexploitation in the sea cucumber fisheries in the lack of data on catch per unit of effort. The drop in sea cucumber production is tied to the central fishing ground, where the majority of fishing effort has been focused recently.

The status, governance, and management of the sea cucumber fishery in Eritrea currently face numerous challenges. In actuality, the sea cucumber fishing is not covered by any special

laws. All types of fisheries are subject to a seasonal closure from October to February. The National Fisheries Corporation and fishermen who participate in the sea cucumber fishery have an agreement that specifies a maximum annual capture of 500 tons and a minimum permissible size of 5 cm wet length. On the population dynamics of exploited species, nothing is known. Illegal exporting and fishing are taking place. Despite this resource's ecological relevance and economic significance to small coastal communities, there is not much concern over it.

The implementation of sufficient management and regulation measures, including season and fishing ground restrictions and closures, size and catch limitations, is required. The establishment of mariculture for sea cucumbers as well as routine monitoring and surveying programs are required. By taking these steps, Eritrea could be able to establish a sustainable sea cucumber fishery.

II. Recommendations

This study on the sea cucumber fishery has forwarded the following recommendations to the Ministry of Fisheries, Eritrea.

- Carry out in-depth analysis on the biology of sea cucumbers i.e., growth, reproduction, etc.
- Develop management plans for adopting a preventative strategy that involves the establishment of a national fishing advisory council.
- Implement effective methods for post-harvest handling and mariculture to replace stock; and
- Bring legislation to safeguard wild sea cucumber populations.

References

1. Bruckner, A. W., Johnson, K. A., & Field, J. D. (2003). Conservation

- strategies for sea cucumbers: Can a CITES Appendix II listing promote sustainable international trade. SPC *Bêche-de-mer information Bulletin*, 18(1), 24-33.
2. Conand, C. (1997). Are holothurian fisheries for export sustainable. In *International Congress on Coral Reefs*, Panama (Vol. 2, pp. 2021-2026).
3. Conand, C. L. (1998). Overexploitation in the present world sea cucumbers fisheries and perspectives in mariculture. In *Proceedings of the Ninth International Echinoderm Conference*, San Francisco, 1998. Balkema.
4. Conand, C., Mercier, A., Purcell, S., Lovatelli, A., Uthicke, S., & Hamel, J. (2004). *Advances in sea cucumber aquaculture and management*. Food and Agriculture Organization of the United Nations.
5. FAO fisheries technical paper, United Nations Food & Agriculture Org. (2004)., Volume 463, ISBN 978-92-5-105163-4. 425 p- 58.
6. FAO. 2003. *Commodities, trade and production, 1976–2001*. Available in: *Fish stat*, FAO Fishery Information Data and Statistics Unit. Rome.
7. Ibarra, A. A., & Soberón, G. R. (2002). Economic reasons, ecological actions and social consequences in the Mexican sea cucumber fishery. *SPC Beche-de-Mer Information Bulletin*, 17, 33-36.
8. Kalaeb, T., Ghirmay, D., Semere, Y., & Yohannes, F. (2008). Status and preliminary assessment of the sea cucumber fishery in Eritrea. *BECHE-DE-MER*, 8.

9. Lawrence, A. J., Ahmed, M., Hanafy, M., Gabr, H., Ibrahim, A., & Gab-Alla, A. A. F. A. (2005). Status of the sea cucumber fishery in the Red Sea-the Egyptian experience. FAO Fisheries Technical Paper, 79-90.
10. Preston G.L, 1993. Beche-de-mer. In: Nearshore marine resources of the South Pacific: Information for fisheries development and management. Forum Fisheries Agency, Honiara, Solomon Islands. p. 371-401.
11. Sea Turtles news on Haddas Eritra 23 April 2015 page 3.
12. Tewelde, M., & Jeudy de Grissac, A. (2007). Socio-economic survey of Eritrean fisheries for sea cucumber. Unpub. Report ECMIB GEF/UNDP and FAO.
13. Tewelde, M., & Woldia, M. (2007). Socio economic aspects of sea cucumber fishery in Eritrea (Red Sea). Unpublished data, GEF/UNDP, ECMIB project, State of Eritrea.
14. Toral-Granda, V., Lovatelli, A., & Vasconcellos, M. (2008). Sea cucumbers. A global review of fisheries and trade. FAO