Thesis for the Degree of Master of Fisheries Science

Ecosystem-based resource assessment and management system for Red Sea fisheries off Egypt

by

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KOICA-PKNU International Graduate Program of Fisheries Science

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이집트 홍해어업의 생태계기반 자원 평가 및 관리시스템

Advisor: Prof. Zhang Chang-Ik

by

Mohammed Abdelaty Mahdy

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A dissertation

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for Red Sea fisheries off Egypt

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Abstract

Fish landings in the Egyption waters of the Red Sea have declined substantially from 82,400 metric ton in the 1999s to 44,000 metric ton in 2010 due to overfishing. Fish habitat quality in the Red Sea has been degraded by anthropogenic activities including tourism activities and coastal pollution. In this study an ecosystem-based fisheries assessment (EBFA) approach Tier 2 developed by Zhang et al. (2011) have been used to assess the Red Sea fisheries. Nested risk indices, such as objectives risk index (ORI), species risk index (SRI), fishery risk index (FRI), and ecosystem risk index (ERI), were estimated status of the two years. The results of the status of the two years were compared. Management status indices for 2012 have shown significant negative change compared to condition 2002 with respect to sustainability, biodiversity, ecosystem habitat quality and socio-economy. From the assessment of seven fish species risk index by the Tier 2 approach, the Egypt Red Sea had 80% of indicators in the green zone, 18.1% in the yellow zone and 1.9% in the red zone

in 2002. But in 2012 had 27.6% of indicators in the desirable green zone, 48.6% in yellow zone and 23.8% in red zone. Three fisheries namely; Purse seine, trawl and longline in 2002 had risk index 0.44, 0.79 and 0.46 respectively and fall in desirable green zone. But in 2012 they had risk index 1.78, 1.85 and 1.24 respectively and fall in yellow zone. The Egypt Red Sea ecosystem has risk index 0.70 in 2002 and fall in desirable green zone but in 2012 had 1.69 and fall in yellow zone. Recent 2012 management status indices have shown significant negative change compared to condition 2002 with respect to sustainability of the stock and fishery and with regards to biodiversity and ecosystem habitat quality and socio-economy. Therefore, the Red Sea fisheries management system need to be established considering four management objectives suggested in the study in order to improve the Red Sea marine ecosystem by reducing risk indices for each management objective.

I. Introduction

The Red Sea is a semi-enclosed tropical body of water. The Red Sea is located between the Mediterranean Sea from the north and the Indian Ocean from the south and is bordered by Egypt, Sudan, Eritrea and Djibouti on the west, and Yemen and Saudi Arabia on the east (Fig. 1.1). It has a surface area of 480,385 km^2, of which 2.33% is protected and includes 7.8 % of the world's coral reefs and Shelf area 141,005 km^2 and inshore fishing area (IFA) 190,695 km^2 (Sea Around Us, 2011). It is also an important shipping route for the oil tankers and other ships like shipping and military travelling through the Suez Canal. Bab-el-Mandeb Strait is separating the continents of Asia Yemen on the Arabian Peninsula and Africa Djibouti, north of Somalia on the Horn of Africa, connecting the Red Sea to the Indian Ocean Gulf of Aden. The Red Sea is connected to the Gulf of Aden, and hence to the Arabian Sea, via the Strait of Bab-El-Mandab, which is only about 20 km wide and 300 m deep. The shallowest part of the passage, however, lies about 140 km further basin-inward, near greater Hanish Island. Passage is only 137 m deep, while the channel deeper than 120 m is only 11 km wide (Rohling and Zachariassef, 1996).

Fig. 1.1. Map of Egypt and the Red Sea including Suez and Aqaba Gulfs.

The northern end of the Red Sea is bifurcated by the Sinai Peninsula, creating the Gulf of Suez In the west and to the east the Gulf of Aqaba. The Gulf of Aqaba stretches some 120 miles north from the Straits of Tiran, ending where the southern border of Israel meets the borders of Egypt and Jordan. The Red Sea is considered a Class I, highly productive ecosystem (Baars et al., 1998). Describe the seasonal fluctuations in plankton biomass and productivity in the southern Red Sea, based on research cruise data the phytoplankton, zooplankton and fish fauna bear more similarity to the Indian Ocean biota than Mediterranean Sea. Its complex reefs, together with extensive mangroves, seagrass and macro-algal beds form highly productive habitats for unique species assemblages. Endemism is very high, especially among reef fishes and invertebrates, the latter including a number of dinoflagellates and euphausiids (Roberts et al., 1992; Getahun, 1998). About 1,200 species of fish are known to occur in the Red Sea large marine ecosystem (Ormond and Edwards, 1987). Marked differences occur in fish species richness, assemblage compositions and species abundance in different parts of the Red Sea, reflecting the heterogeneous nature of its environment (Sheppard et al., 1992). Fishing occurs mainly at the subsistence or artisanal levels, although commercial trawling and purse

seining are also carried out in Egypt, Saudi Arabia and Yemen (FAO 2005). The fisheries of the Red Sea are of considerable socio-economic importance to the coastal nations of the region in terms of national food security and income generation for rural communities, with the exception of Jordan, which has minimal fisheries in the Red Sea.

The purpose of this study the management system for the Red Sea fisheries in Egyptian waters, application of the ecosystem based fishery assessment approach developed by Zhang et al. (2009, 2010) and evaluation of both the strengths and weaknesses of this approach. To compare the status of these fisheries in two time periods: in the year 2002 and in 2012. To achieve stock assessment for the ecosystem and facilitate develop the current management of these fisheries. This study was undertaken to address the declining trend of Red Sea fisheries, lost biodiversity, habitat degradation and solve socio-economic considerations for the Egyption Red Sea ecosystem.

1.1. Overview of Red Sea fisheries

The fish production developed dramatically in Egypt through the last ten years until 2012 to reach to 1,371,975 tons from capture fisheries and aquaculture. There are more than 354,237 metric ton of fish taken from Egyptian marine waters every year, and they are harvested by about 26,354 fishing vessels using 39 gear types (GAFRD, 2013). The total fish capture from the Mediterranean Sea in that year was 69,332 tons, representing 5.05% from the total fish production in Egypt; also the total fish capture from the Red Sea was 44,866 tons at same year, representing 3.27% from the total fish production in Egypt (GAFRD, 2013). With the extreme attention to the fisheries stock assessment of marine fisheries where working to find a proper management plan and sustainable fisheries management to maintain the depletion of fish stocks and reduce the catch effort from overfishing. So the Red Sea had chosen as study site where is playing an important role in contributing to the fish production in Egypt dramatically. Since 1997 the Red Sea total fish production recorded a significant increase (Fig. 1.2). These increases have come from significant increases in fishing fleet capacity, including increase in vessel numbers as well as the upgrading of fishing efficiency of existing vessels.

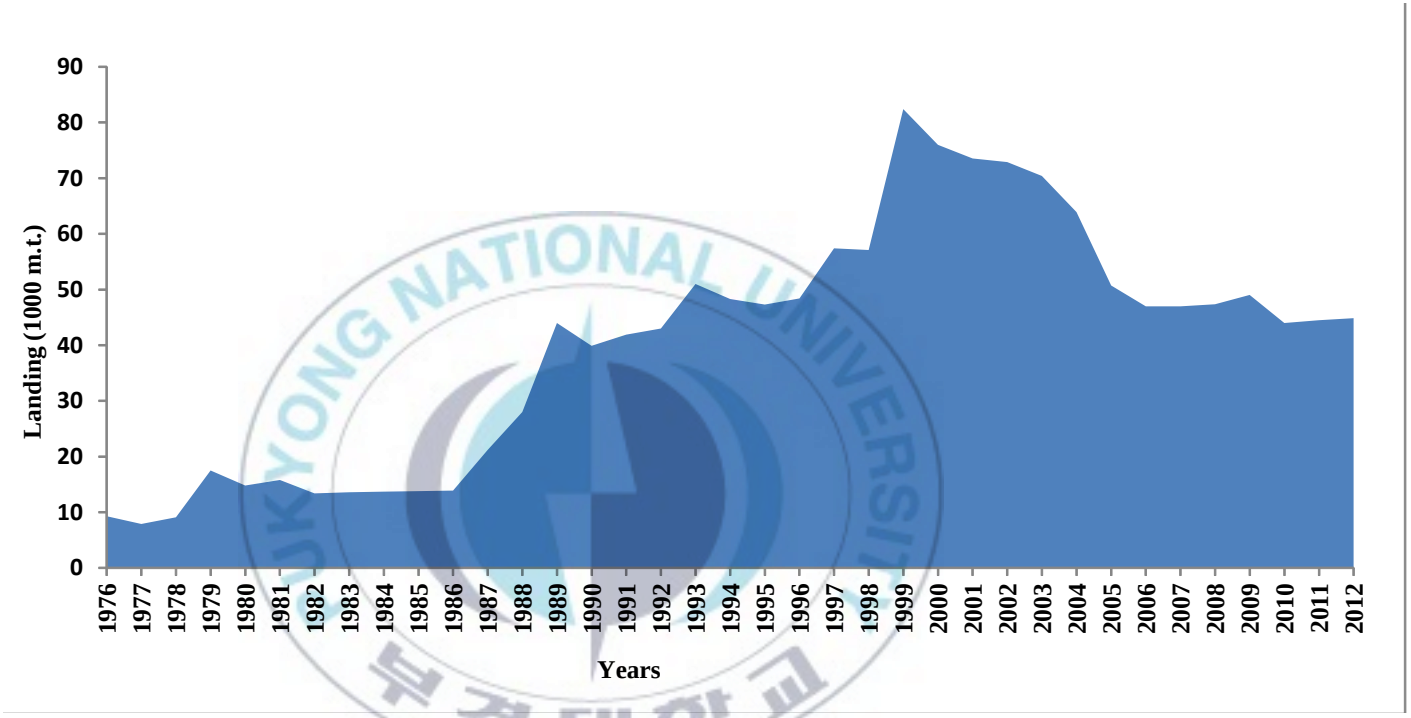

Fig. 1.2. Total marine landings for the Red Sea in Egypt.

1.2. Characteristics of Red Sea fisheries

1.2.1. Purse seine fishery in the Red Sea

Purse seine is one of the most important fishing gears in the Red Sea fishery of Egypt. A purse seine is made of a long wall of netting frame with float line and lead line usually, of equal or longer length than the former and having purse rings hanging from the lower edge of the gear, through which runs a purse line made from steel wire or rope which allow the pursing of the net. For most of the situation, it is the most efficient gear for catching large and small pelagic species that is shallow (FAO, 2013). Purse seine is a preferred technique for capturing fish species which aggregate, close to the surface: such as sardines, mackerel, anchovies, herring, certain species of tuna and others. There is no impact on the bottom habitat except when the water depth is less than the height of purse seine during the fishing operations and that the lower edge of the gear wipes the sea bottom (FAO, 2013). However purse seine fishing can have negative impacts on fish stocks because it can involve the bycatch of non-target species and it can put too much pressure on fish stocks. More than 46% of the total Egyption Red Sea catch is taken from the Purse seine fishery, and more than 87% of the

total purse seine fishery catch are round scad, sardinella and anchovy (GAFRD, 2011).

1.2.2. Trawl fishery in the Red Sea

Trawl systems are playing very important role in commercial fishery and in resources survey. The trawl consists of the warp, otter boards, ropes and trawl net. The mid-water trawl system on a commercial fishing vessel can be managed efficiently by the crew (Park, 2007). Trawl nets that are towed behind a boat to collect organisms have been used by fishers for centuries. Trawls can be divided into three categories based on where they sample the water column: surface, midwater, and bottom. More than 24% of total Egyption Red Sea catch is taken from the trawl fishery, and more than 62% of total trawl fishery catch are brushtooth lizardfish and trieadin breams (GAFRD, 2011).

1.2.3. Longline fishery in the Red Sea

Longline fisheries are a commercial fishing technique. It uses a long line, called the main line, with baited hooks attached at intervals by means of branch lines called Snoods or Gangions (Method and Apparatus, 2008). A snood is a short length of line, attached to the main line using a clip or swivel, with the hook at the other end. Longlines are classified mainly by

where they are placed in the water column. This can be at the surface or at the bottom. Lines can also be set by means of an anchor, or left to drift. Hundreds or even thousands of baited hooks can hang from a single line. In some unstable fisheries, such as the Patagonian Toothfish, fishermen may be limited to as few as 25 hooks per line. In contrast, commercial longliners in certain robust fisheries of the Bering Sea and North Pacific generally run over 2,500 hand-baited hooks on a single series of connected lines many miles in length (Rice et al., 2006). More than 16% of total Egyption Red Sea catch is taken from the longline fishery, and more than 79% of total longline fishery catch are groupers and emperors or scavengers (GAFRD, 2011).

1.3. Ecosystem-based fisheries management (EBFM)

The past decade has seen a gradual evolution in fisheries management from a primary focus on sustainability of target species and resources to a much wider focus on ecosystems, and the impacts of fisheries on them. This new approach has come to be called ecosystem-based fisheries management (EBFM), or alternatively the ecosystem approach to fisheries (Garcia et al., 2003; Pikkitch et al., 2004). However ecosystem approach to fisheries (EAF) is defined as "an extension of conventional fisheries management recognizing more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystems productivity for present and future generations, e.g. conserving critical habitats, reducing pollution and degradation, minimizing waste, protecting endangered species" (Ward et al., 2002). But the concern is growing over how ecosystems are being affected by fishing. Fisheries are managed within a setting that lacks full information on, for instance, fish population dynamics, interactions among species, effects of environmental factors, and the effects of human activity on fish and their ecosystem (Zhang and Marasco, 2003). Recently, fisheries have begun to be managed through comprehensive, interrelated ecosystem-based regulations designed to sustain fisheries in an

ecosystem context (Anonymous, 2006; FAO, 2003, 2007; Garcia et al., 2003; Zhang et al., 2009). Ecosystem based fisheries assessment methodologies and management have been common themes in discussions of fishery policy world-wide in recent years (e.g. Jamieson et al., 2010). (Zhang et al., 2009) developed a tool for assessing fishing impacts in an ecosystem, using relevant indicators and reference points (Fig. 1.3). The method involved a comprehensive ecosystem-based assessment of a fishery, including ecological interactions among target species, prey, predators and competitors; interactions with their habitats; and the effect of fishing on these processes (Zhang et al., 2009, 2010).

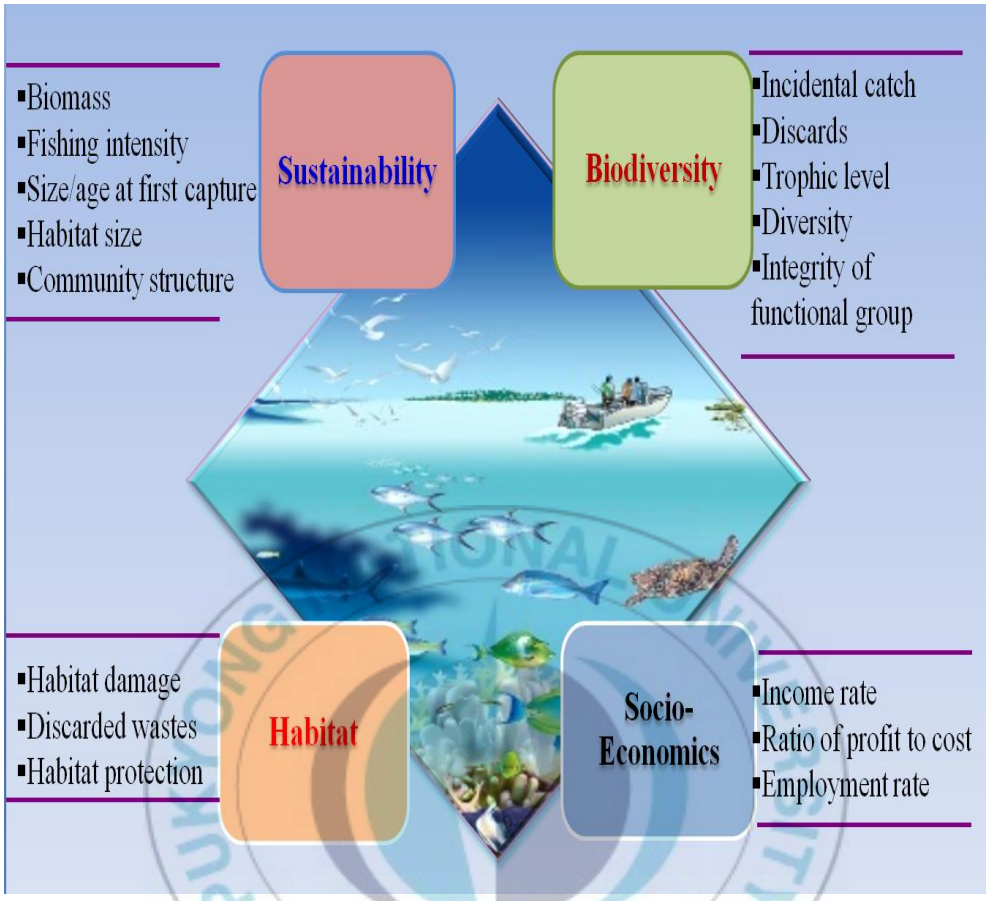

Fig. 1.3. Identification of objectives and attributes for the ecosystem-based fisheries assessment approach (Zhang et al., 2010).

II. Materials and Methods

2.1. Data sources

The study site was the Red Sea of Egypt is located between (Lat. 29.85, Lon. 32.54) from the north and (Lat. 22.06, Lon. 37.83) from the south including Suez Gulf and Aqaba Gulf (Fig. 1.1). The fishery data include time-series of annual catch and fishing effort from the most seven target species for purse seine, trawl and longline fisheries in the Red Sea round scad (*Decapterus macrosoma)*, sardinella (*Amblygaster sirm)*, anchovy *(Stolephorus indicus)*, brushtooth lizardfish (*Saurida tumbil)*, trieadin breams (*Nemipterus japonicus)*, groupers (*Epinephelus malabaricus)*, emperors (*Lethrinus harak)*. These fishery data were collected from fishing ports located along the Egyption west coast of the Red Sea (GAFRD, 2003, 2013) and data from interviews and questionnaires with Egyptian fishermen in the Red Sea. Size composition data were extracted from unpublished GAFRD data, which collected from the Hurgada fish market, the main port for purse seine, trawl and longline fisheries landings and one of the largest fishery landing ports in Egypt Red Sea.

2.2. Methods

Qualitative data by questionnaire survey from the Red Sea fishermen for the management of coastal fishery resources Table 2.1 (Yoon, 2014). Number of fishermen, was 30 fishermen (10 purse seine fisheries, 10 trawl fisheries and 10 longline fisheries) in the Egypt Red Sea.

Table 2.1. Survey for fishermen for the management of coastal fishery resources

Area :	Name :	Phone # :	Gear type :
Species			
Vessel name :	Vessel tonnage :	Vessel horse power :	

1. Production

1-1. What is the trend of catch during recent five years?

① Extremely small ② Small ③Moderately small ④Average
⑤ Moderately large ⑥ Large ⑦ Extremely large

2. Fishing intensity

2-1. What is the trend of fishing effort during recent five years?

① Extremely small ② Small ③Moderately small ④Average
⑤ Moderately large ⑥ Large ⑦ Extremely large

2--2. Did your organization conduct any activity of fisheries management (such as the closed fishing season or closed fishing ground) or self-regulations around your

fishing ground?

①Yes ②No

If yes, what is the activity?

① Extremely small ② Small ③Moderately small ④Considerable
⑤ Moderately large ⑥ Large ⑦ Extremely large

3. Size of fish

3-1. What are body lengths of the fish caught?

(1) Target Species : Body length : cm
(2) Bycatch Species : Body length : cm
(3) Bycatch Species : Body length : cm

3-2. Do you have a regulation for the limited body length of fish from fishing?

①Yes ②No

If yes, what is the condition?

① Extremely strong ② Strong ③Moderately strong ④Considerable
⑤ Moderately week ⑥ Week ⑦ Extremely week

4. Reproductive potential

4-1. When is the main fishing period for major fish species and what is the proportion of them?

(1) Target species: Period(month) : - (% of annual catch)
(2) Bycatch species: Period(month) : - (% of annual catch)
(3) Bycatch species: Period(month) : - (% of annual catch)

4-2. Are there matured fishes in your catch?

①Yes ②No

If yes, what is the amount?

① Extremely small ② Small ③Moderately small ④Considerable
⑤ Moderately large ⑥ Large ⑦ Extremely large

4-3. Do you have a closed season during the spawning period?

①Yes ②No

If yes, what is the condition?

① Extremely Strong ② Strong ③Moderately strong ④Considerable

⑤ Moderately week ⑥ Week ⑦ Extremely week

5. Genetic structure

5-1. Has the release of fry or juvenile fish been made before in your fishing ground?

① Extremely small ② Small ③Moderately small ④Considerable

⑤ Moderately large ⑥ Large ⑦ Extremely large

5-2. If yes, what kind of fish species was released and how many years?

(1) Species : Period(year) :

(2) Species : Period(year) :

(3) Species : Period(year) :

6. By-catch

6-1. What is the percentage of by-catch in your harvest?

① More than 95% ② 80 ~ 95% ③ 60 ~ 80% ④ 40 ~ 60% ⑤ 20 ~ 40%

⑥ 5 ~ 20% ⑦ Less than 5%

7. Discards

7-1. What is the percentage of discards in your harvest?

① More than 95% ② 80 ~ 95% ③ 60 ~ 80% ④ 40 ~ 60% ⑤ 20 ~ 40%

⑥ 5 ~ 20% ⑦ Less than 5%

8. Diversity

8-1. What is the trend of the number of fish species caught during recent five years?

① Extremely small ② Small ③Moderately small ④Average
⑤ Moderately large ⑥ Large ⑦ Extremely large

9. Fishing gear usage

9-1. How many fishing gears do you have? and what are the amounts?

(1) Fishing gear : Quantity : width / number
(2) Fishing gear : Quantity : width / number
(3) Fishing gear : Quantity : width / number

9-2. How many fishing gears do you use per unit fishing operation?

(width / number)

9-3. How long (hours) does it take to install the gear?

(hours)

9-4. What is the loss rate of your fishing gear per unit fishing operation?

① More than 95% ② 80 ~ 95% ③ 60 ~ 80% ④ 40 ~ 60% ⑤ 20 ~ 40%
⑥ 5 ~ 20% ⑦ Less than 5%

9-5. How many days do you conduct your fishing operation in a month?

(day / month)

10. Pollution

10-1. How do you handle wastes (cigarette butts, waste fishing gear , etc.) during the fishing operation?

① Dumping in the sea ② Bring to the land ③ Both

10-2. Are there any spawning or nursery grounds around your fishing ground?

① Yes ② No ③ Do not know

If yes, how do you conduct fishing operations?

① No difference
② Careful fishing operation to avoid destruction and/or pollution

10-3. Recently, is there any oil spill accident in your fishing ground?

① Yes ② No ③ Do not know

If yes, when did it occur? And what was the magnitude?

(Year:)

① Extremely small ② Small ③Moderately small ④Considerable
⑤ Moderately large ⑥ Large ⑦ Extremely large

11. Income

11-1. What is your annual income?

(USD)

11-2. What is the trend of your income during recent five years?

① 95% increase ② 80 ~ 95% ③ 60 ~ 80% ④ 40 ~ 60% ⑤ 20 ~ 40%
⑥ 5 ~ 20% ⑦ 5% increase
⑧ 95% decrease ⑨ 80 ~ 95% ⑩ 60 ~ 80% ⑪ 40 ~ 60% ⑫ 20 ~ 40%
⑬ 5 ~ 20% ⑭ 5% decrease

11-3. What is the percentage of your monthly income compared to the lowest cost of living (about 200 USD) during recent five years?

(%)

12. Cost of fishing operation

12-1. What is the trend of your annual fishing cost during recent five years?

① 95% increase ② 80 ~ 95% ③ 60 ~ 80% ④ 40 ~ 60% ⑤ 20 ~ 40%
⑥ 5 ~ 20% ⑦ 5% increase
⑧ 95% decrease ⑨ 80 ~ 95% ⑩ 60 ~ 80% ⑪ 40 ~ 60% ⑫ 20 ~ 40%
⑬ 5 ~ 20% ⑭ 5% decrease

13. Employment

13-1. How many people are working on your fishing vessel?

(Number :)

13-2. What is the trend of the number of fishermen on your fishing vessel?

① Increase (%) ② No changes ③ Decrease (%)

14. IUU

14-1. Has IUU been occurred in your fishing ground recently?

①Yes ②No

If yes, what is the condition?

① Extremely small ② Small ③Moderately small ④Considerable
⑤ Moderately large ⑥ Large ⑦ Extremely large

If yes, please describe specifically on the IUU fishing.

( )
( )

A pragmatic ecosystem-based fisheries assessment approach (EBFA) developed by Zhang et al. (2009, 2010) and MOMAF (2007) was applied to assess the Egyption fisheries stock and seven target species for purse seine, trawl and longline fisheries in the Red Sea. The assessment by a qualitative data analysis on Tier 2 ecosystem-based fisheries assessment approach (Zhang et al., 2009). Tier 2 is used when available information permits only a semi-quantitative or qualitative assessment. A total of 15 Tier 2 indicators (Appendices 1 and 2) were developed by Park (2013) for the assessment of ecosystem status in this study. Both target desirable and limit undesirable reference points were assigned for each indicator to assess the status of objectives, species, and fisheries, and the indicators were then weighted by an assigned priority for each objective. Relative weights for each indicator were the same as used by Zhang et al. (2009). Nested risk indices, an objective risk index (ORI), species risk index (SRI), and fishery risk index (FRI), Ecosystem Risk Index (ERI), were also estimated to assess the fishery and ecosystem status (Fig. 2.1) (MOMAF, 2007; Zhang et al., 2009, 2010).

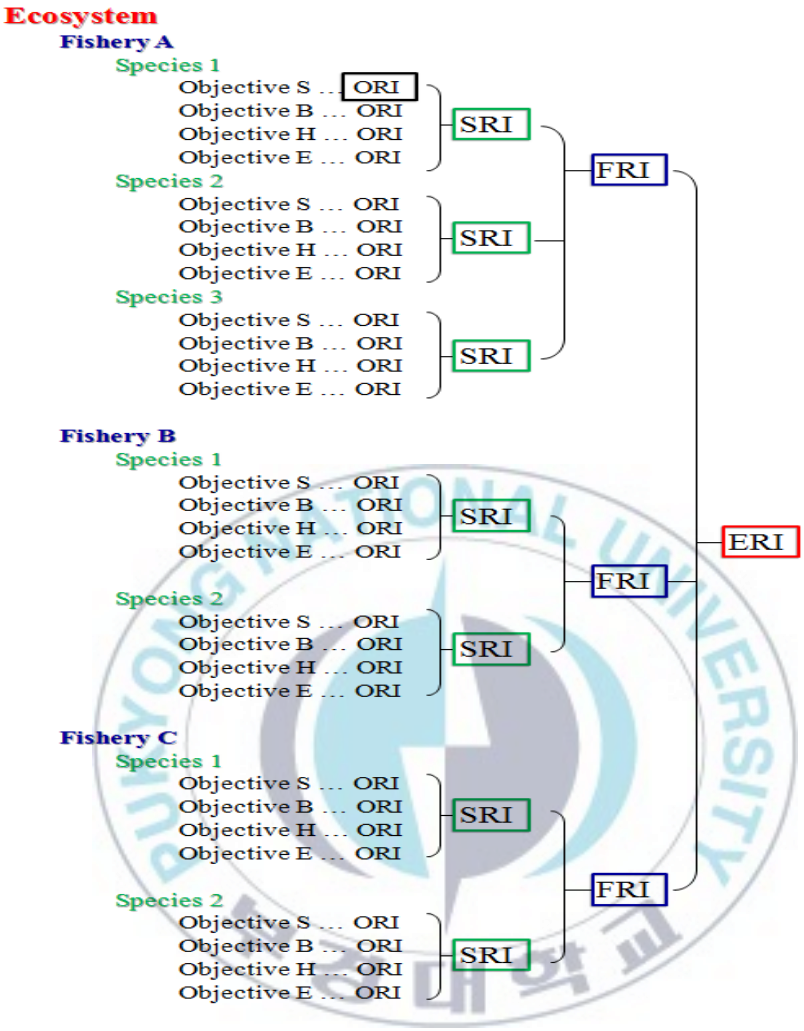

Fig. 2.1. Nested structure of risk indices used in the ecosystem-based fisheries assessment approach. ORI denotes objectives risk index, SRI, species risk index, FRI, fishery risk index, ERI, ecosystem risk index (Zhang et al., 2009, 2010).

2.2.1. Target and limit reference points for indicators of sustainability

Appendix 2.1 shows the target and limit reference points of sustainability for the Tier 2 assessment. Tier 2 approach requires quantitative data for indicators assessment. The ecosystem-based fisheries assessment (EBFA) identifies several critical indicators catch per unit effort (CPUE) or fishing mortality. Assessment is divided into seven categories as following; for 'Better than target', two reference points ('0' and '0.5'), for 'Between target and limit', three reference points ('1.0', '1.5' and '2'), for 'Beyond limit', two reference points ('2.5' and '3.0').

Catch per unit effort (CPUE) is assessed based on factors of data availability, standardization and catch trends of CPUE 'Fishing mortality or Fishing effort' is assessed based on factors of effort (number of F/V, horsepower etc.) trends. 'Age or length at first capture' is assessed based on factors Average length of various fish species in catch. 'Rate of mature fish' is assessed based on factors of the fishery occurs during the spawning season. 'Ratio of (release stock abundance) / (wild stock abundance) in catch' is assessed based on factors of release fish species in the area.

2.2.2. Target and limit reference points for indicators of biodiversity

Appendix 2.2 shows the target and limit reference points of biodiversity for the Tier 2 assessment. Biodiversity is one of most important objectives in Tier 2 assessment is divided into seven categories as follows; for 'Better than target', two reference points ('0' and '0.5'), for 'Between target and limit', three reference points ('1.0', '1.5' and '2'), for 'Beyond limit', two reference points ('2.5' and '3.0'). Indicators that are used in the ecosystem-based fisheries assessment (EBFA) for biodiversity in the Tier 2 include; 'Bycatch rate (BC/C)' is assessed based on factors of weight ratio of non target (except top X species in catch) species in catch. 'Discards rate' is assessed based on factors of ratio of discarded fish in catch. 'Diversity index' is assessed based on factors of existence of species composition data by scientific survey or catch data and change of species number in catch of the Red Sea fishery.

2.2.3. Target and limit reference points for indicators of habitat quality

Appendix 2.3 shows the target and limit reference points of habitat quality for the Tier 2 assessment. Habitat quality also is very important objectives in Tier 2 assessment same as sustainability and biodiversity and divided into

seven categories as follows; for ‘Better than target’, two reference points (‘0’ and ‘0.5’), for ‘Between target and limit’, three reference points (‘1.0’, ‘1.5’ and ‘2’), for ‘Beyond limit’, two reference points (‘2.5’ and ‘3.0’). Indicators that are used in the ecosystem-based fisheries assessment (EBFA) for habitat quality in the Tier 2 include; 'Critical habitat damage rate' is assessed based on characteristics of fishing gear and operating period of fishing gear in the habitat. ‘Pollution rate of spawning and nursery ground’ is assessed based on factors of information on the pollution (oil spillage) by the target fishery and pollution level on the spawning and nursery grounds. ‘Lost fishing gears’ is assessed based on factors of extent of potential loss of fishing gear that is operated by target fishery and setting period of fishing gear. ‘Discarded wastes’ is assessed based on factors of discard amount of wastes by target fishery and discard existence of fatal fishing wastes (Dry cell, fishing weight, fishing lead etc.).

2.2.4. Target and limit reference points for indicators of socio-economy

Appendix 2.4 shows the target and limit reference points of socio-economy for the Tier 2 assessment. Socio-economy management objective in Tier 2 assessment like sustainability, biodiversity and habitat quality and has

always been very sensitive to costal fishing communities. Socio-economy is divided into seven categories in the same manner with sustainability, biodiversity and habitat quality objectives. Indicators that are used in the ecosystem-based fisheries assessment (EBFA) for socio-economy in the Tier 2 include; 'Income per fisherman (IPF)' is assessed based on factors of change tendency of income for recent x years or difference with minimum living cost. 'Ratio of profit to cost (RPC)' is assessed based on factors of cost of target fishery or production value (Catch of target fishery, fishery value). 'Employment rate (ER)' are assessed based on factors of change tendency of number of fishermen for recent x years or actual fishing days.

2.2.5. Target and limit reference points for IUU indicator in the Tier 2 approach

Appendix 2.5 shows the target and limit reference points of IUU for the Tier 2 assessment. IUU also is very important in Tier 2 assessment and divided into seven categories as follows; for 'Better than target', two reference points ('0' and '0.5'), for 'Between target and limit', three reference points ('1.0', '1.5' and '2'), for 'Beyond limit', two reference points ('2.5' and '3.0').

The ORI was defined as,

$$\mathrm{ORI} = \frac{\sum_{i=0}^{n} \mathrm{RS}_i W_i}{\sum_{i=1}^{n} W_i}$$

Where "RS_i" is the risk score for indicator "*i*", "W_i" is the weighting factor (1, 2 or 3) for indicator "*i*" and "n" is the number of indicators.

The SRI calculated and defined as the weighted sum of the objective risk indices,

$$SRI_i = \lambda_S ORI_S + \lambda_B ORI_B + \lambda_H ORI_H + \lambda_E ORI_E$$

Where: SRI_i is species risk index for each species without IUU

λ_S, λ_B, λ_H and λ_E : Weighting value for objectives

$$\sum \lambda = 1.0$$

ORI_S: Sustainability risk index

ORI_B: Biodiversity risk index

ORI_H: Habitat risk index

ORI_E: Socio-economic risk index

$$SRI = SRI_i (1 + RS_{IUU} / 10)$$

Where: RS_{IUU} is risk score for IUU

The FRI was the weighted average risk index for exploited species in a fishery,

$$FRI = \frac{\sum C_i \, SRI_i}{\sum C_i}$$

Where C_i is the catch or catch index for species i.

The ecosystem risk index is defined as the weighted average of the fishery risk indices in an ecosystem,

$$ERI = \frac{\sum C_i FRI}{\sum C_i}$$

Where C_i is the catch of the fishery.

Table 2.2. Objectives and indicators for Tier 2 survey questionnaire by Red Sea fishermen

Objectives	Indicators	Weight	Questionnaires
Sustainability	Biomass or CPUE	3	1-1. Catch 2-1. Effort CPUE = Catch / Effort
	Fishing mortality or fishing effort	2	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
	Age (or length) at first capture	3	3-1. Body length 3-2. Regulate of body length
	Rate of mature fish	2	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
	Ratio of (release stock abundance) /(wild stock abundance) in catch (Rr/w)	1	5-1. Release fish 5-2. Fish species
Biodiversity	Bycatch rate	2	6-1. By-catch
	Discards rate	2	7-1. Discards
	Diversity index	2	8-1. Number of fish species
Habitat quality	Critical habitat	2	9-1. Amount of fishing gear 9-2. Number of fishing gear

	damage rate		9-3. Conduct fishing operations 9-5. Number of fishing days
	Pollution rate of spawning and nursery ground	2	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
	Lost fishing gear	2	9-4. Lost fishing gear
	Discarded wastes	1	10-1. Wastes
Socio-economic	Income per fisherman	2	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
	Ratio of profit to cost	1	12-1. Fishing cost
	Employment rate	1	13-1. Number of workers 13-2. Rate of fishermen
IUU	IUU		14-1. IUU occurred 14-2. Description of IUU fishing

III. Results

At the Red Sea marine fishery the target species are round scad *Decapterus macrosoma*, sardinella *Amblygaster sirm*, anchovy *Stolephorus indicus*, brushtooth lizardfish *Saurida tumbil*, trieadin breams *Nemipterus japonicus*, groupers *Epinephelus malabaricus*, emperors *Lethrinus harak* which are taken in purse seine, trawl and longline fisheries. A Tier 2 analysis was conducted for the seven species taken as bycatch as no quantitative data or information are available for these species. Indicator scores for these species are presented in Appendix 2. A Tier 2 assessment for score of two years was assigned for 2002 and 2012 to make comparison between the two years to evaluate and monitoring the changes of fishery. Risk scores (Appendices 1 and 2) were determined using Zhang et al. (2009) and MOMAF (2007) method (Appendix 2) modified by Park (2013). By 2012, most of the determined risk scores of indicators for sustainability, biodiversity, habitat and socio-economy objectives had little worse when compared to those for 2002 (Appendices 3 and 4).

3.1. Assessment of risk scores to each indicator of the Red Sea fisheries

The Red Sea purse seine fishery in 2002 had round scad 54.7% catch of the fishery, anchovy 7.09% catch of the fishery, sardinella 16.32% catch of the fisher and other fish species 21.89% catch of the fishery. Red Sea trawl fishery had brushtooth lizardfish 24.3% catch of the fishery, trieadin breams 12.93% catch of the fishery and other fish species 62.77% catch of the fishery. Red Sea longline fishery had groupers 44.74% catch of the fishery, emperors 42.63% catch of the fishery and other fish species 12.63% catch of the fishery. The above total catch constitutes 57.59 % of the total Egypt Red Sea catch, while other fish and fisheries constitute 42.41% as shown in Table 3.1.

Table 3.1. Major fisheries and fish species by fishing gear in marine water the Red Sea in Egypt 2002

Type of fishery	Target species	Scientific name	Catch by M.T.	(%)
Purse seine fishery	Round scad	*Decapterus macrosoma*	18,204	54.7
	Sardinellas nei	*Amblygaster sirm*	5,431	16.32
	Anchovy	*Stolephorus indicus*	2,359	7.09
	Other species		7,283	21.89
Subtotal			33,277	100
Trawl fishery	Brushtooth lizardfish	*Saurida undosquamis*	5,736	24.3
	Trieadin breams	*Nemipterus japonicus*	3,050	12.93
	Other species		14,816	62.77
Subtotal			23,602	100
Longline fishery	Groupers	*Epinephelus spp*	3,687	44.74
	Emperors	*Lethrinus harak*	3,513	42.63
	Other species		1,041	12.63
Subtotal			8,241	100
Catch of target species			41,980	57.59
Total catch			65,120	89.34
Other fisheries			7,769	10.66
Annual total catch			72,889	100

The Red Sea purse seine fishery in 2012 had round scad 46.33% catch of the fishery, anchovy 30.64% catch of the fishery, sardinella 1.94% catch of the fisher and other fish species 21.09% catch of the fishery. Red Sea trawl fishery had brushtooth lizardfish 31.95% catch of the fishery, trieadin breams 27.43% catch of the fishery and other fish species 40.58% catch of the fishery. Red Sea longline fishery had groupers 45.37% catch of the fishery, emperors 34.24% catch of the fishery and other fish species 20.39% catch of the fishery. The above total catch constitutes 58.15 % of the total Egypt Red Sea catch, while other fish and fisheries constitute 42.28% as shown in Table 3.2.

Table 3.2. Major fisheries and fish species by fishing gear in marine water the Red Sea in Egypt 2012

Type of fishery	Target species	Scientific name	Catch by M.T.	(%)
Purse seine fishery	Round scad	*Decapterus macrosoma*	8,057	46.33
	Anchovy	*Stolephorus indicus*	5,328	30.64
	Sardinellas nei	*Amblygaster sirm*	338	1.94
	Other species		3,668	21.09
Subtotal			17,391	100
Trawl fishery	Brushtooth lizardfish	*Saurida undosquamis*	3,877	31.95
	Trieadin breams	*Nemipterus japonicus*	3,333	27.47
	Other species		4,925	40.58
Subtotal			12,135	100
Longline fishery	Groupers	*Epinephelus spp*	2,828	45.37
	Emperors	*Lethrinus harak*	2,134	34.24
	Other species		1,271	20.39
Subtotal			6,233	100
Catch of target species			25,895	58.15
Total catch			35,759	80.3
Other fisheries			8,769	19.7
Annual total catch			44,528	100

3.2. Assessment for the seven species of the Egypt Red Sea ecosystem by Tier 2 approach.

The Red Sea ecosystem has seven species that were assessed by the Tier 2 approach for the fisheries as follows; purse seine fishery has three species namely; round scad *Decapterus macrosoma*, sardinella *Amblygaster sirm*, anchovy *Stolephorus indicus*, brushtooth lizardfish *Saurida tumbil*, trieadin breams *Nemipterus japonicus*, groupers *Epinephelus malabaricus*, emperors *Lethrinus harak*. Objective risk indices for all the fisheries were calculated using the formula

$$\mathrm{ORI} = \frac{\sum_{i=0}^{n} \mathrm{RS}_i W_i}{\sum_{i=1}^{n} W_i}$$

With given associated reference points. "W" is the weight factor for indicator "i" which is represented by the number of asterisks. The "n" in the equation is the number of indicators. Separate objective Risk indices (ORI) are calculated for each species respectively. These are $\mathrm{ORI_S}$ for sustainability, $\mathrm{ORI_B}$ for biodiversity, $\mathrm{ORI_H}$ for habitat quality, $\mathrm{ORI_E}$ for socio-economy. Indicators risk zone for the Red Sea fisheries were classified into four objectives for the seven species as assessed by the Tier 2 approach (Appendices 3 and 4).

For Egypt Red Sea target fisheries 2002 sustainability has 80 % of the indicators in the desirable green zone, the yellow zone has 20 % of the indicators and no indicators in the red zone. Biodiversity has 66.7 % of the indicators in the desirable green zone, the yellow zone has 33.3 % of the indicators and no indicators in the red zone. Habitat quality has 85.8 % of the indicators in the desirable green zone, the yellow zone has 7.1 % of the indicators and the red zone has 7.1 % of the indicators. Socio-economy has 85.7 % of the indicators in the desirable green zone; the yellow zone has 14.3 % of the indicators and no indicators in the red zone. Overall the Red Sea fisheries ecosystem has 80 % of the indicators in the desirable green zone, 18.1 % in the yellow zone and 1.9 % in the red zone (Table 3.3).

Table 3.3. Risk zone by number of indicators for four objectives in Egypt Red Sea target fisheries 2002

Objective	Number of indicators in the green zone	Number of indicators in the yellow zone	Number of indicators in the red zone
Sustainability	28 (80 %)	7 (20 %)	0 (0 %)
Biodiversity	14 (66.7 %)	7 (33.3 %)	0 (0 %)
Habitat quality	24 (85.8 %)	2 (7.1 %)	2 (7.1 %)
Socio-economy	18 (85.7 %)	3 (14.3 %)	0 (0 %)
Total	84 (80 %)	19 (18.1 %)	2 (1.9 %)

Purse seine fishery has species; Round scad *Decapterus macrosoma* with risk indices '0.89', '0.78', '0.73' and '0.53' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.4).

Sardinella *Amblygaster sirm* with risk indices '0.85', '0.85', '0.66' and '0.53' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.4).

Anchovy *Stolephorus indicus* with risk indices '0.79', '0.78', '0.73' and '0.53' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all the objectives (Table 3.4).

Table 3.4. Objective risk index (ORI) for purse seine fishery of Egypt Red Sea in 2002 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2002
Purse seine	Round scad *(Decapterus macrosoma)*	Sustainability	0.89
		Biodiversity	0.78
		Habitat	0.73
		Socio-economy	0.53
	Sardinella (*Amblygaster sirm*)	Sustainability	0.85
		Biodiversity	0.85
		Habitat	0.66
		Socio-economy	0.53
	Anchovy (*Stolephorus indicus*)	Sustainability	0.79
		Biodiversity	0.78
		Habitat	0.73
		Socio-economy	0.53

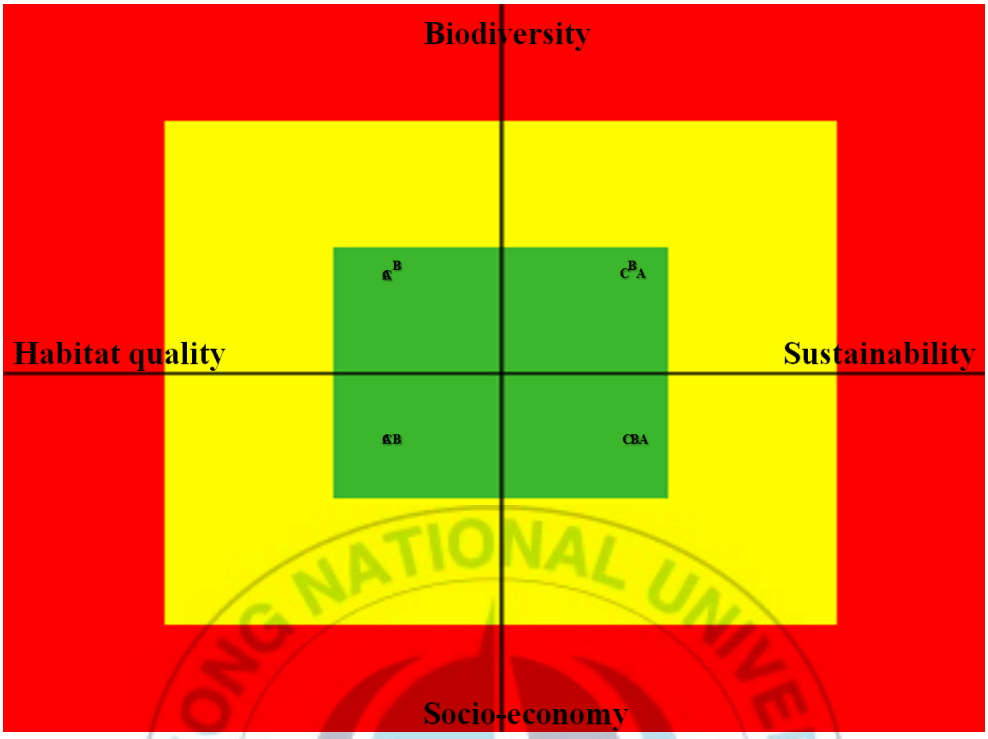

Fig. 3.1. Objective risk diagram for three target species (A) Round scad, (B) Sardinella and (C) Anchovy by the purse seine fishery in Egypt Red Sea in 2002.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	3	0	0
Biodiversity	3	0	0
Habitat quality	3	0	0
Socio-economy	3	0	0

0 1 2 3

Fig. 3.2. Number of species by risk zone diagram for four objectives by purse seine fishery of Egypt Red Sea in 2002.

Trawl fishery has two species namely; Brushtooth lizardfish *Saurida undosquamis* with risk indices '0.81', '0.75', '1.13' and '0.40' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.5).

Trieadin breams *Nemipterus japonicus* with risk indices '0.77', '0.70', '1.13' and '0.40' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all objectives (Table 3.5).

Table 3.5. Objective risk index (ORI) for trawl fishery of Egypt Red Sea in 2002 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2002
Trawl	Brushtooth lizardfish (*Saurida undosquamis*)	Sustainability	0.81
		Biodiversity	0.75
		Habitat	1.13
		Socio-economy	0.40
	Trieadin breams (*Nemipterus japonicus*)	Sustainability	0.77
		Biodiversity	0.70
		Habitat	1.13
		Socio-economy	0.40

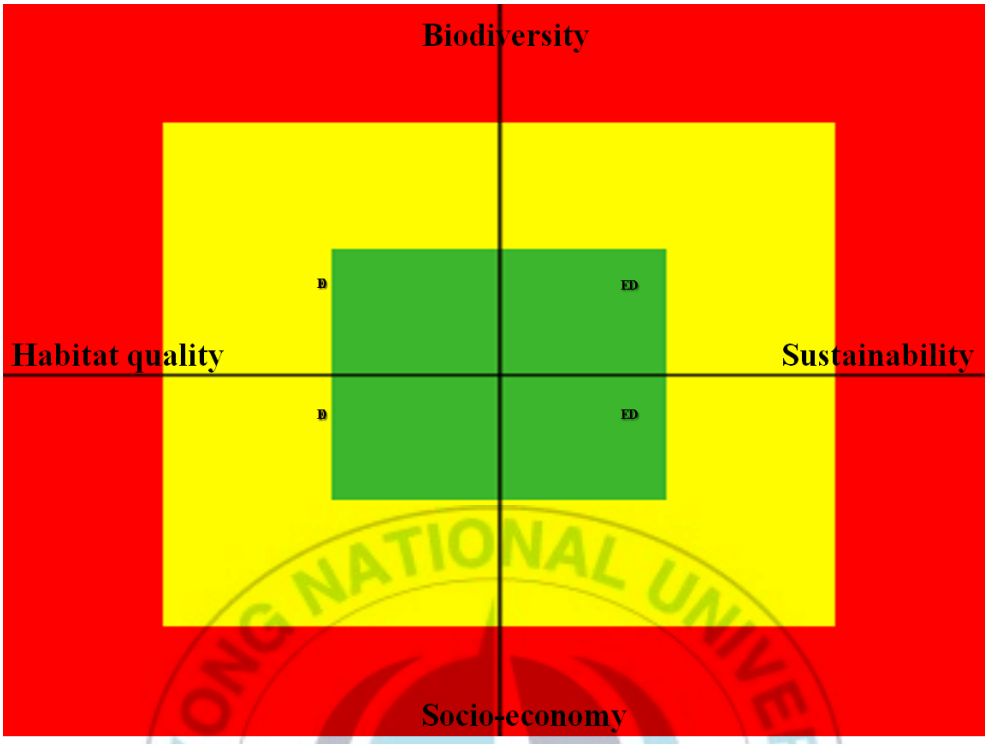

Fig. 3.3. Objective risk diagram for two target species (D) Brushtooth lizardfish and (E) Trieadin breams by the trawl fishery in Egypt Red Sea in 2002.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	2	0	0
Biodiversity	2	0	0
Habitat quality	0	2	0
Socio-economy	2	0	0

0 1 2 3

Fig. 3.4. Number of species by risk zone diagram for four objectives by trawl fishery of Egypt Red Sea in 2002.

Long line fishery has two species namely; Groupers *Epinephelus spp* with risk indices '0.55', '0.73', '0.39' and '0.21' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.6).

Emperors or scavengers *Lethrinus harak* with risk indices '0.58', '0.53', '0.39' and '0.21' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all fishery (Table 3.6).

Table 3.6. Objective risk index (ORI) for long line fishery of Egypt Red Sea in 2002 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2002
Long line	Groupers (*Epinephelus spp*)	Sustainability	0.55
		Biodiversity	0.73
		Habitat	0.39
		Socio-economy	0.21
	Emperors (*Lethrinus harak*)	Sustainability	0.58
		Biodiversity	0.53
		Habitat	0.39
		Socio-economy	0.21

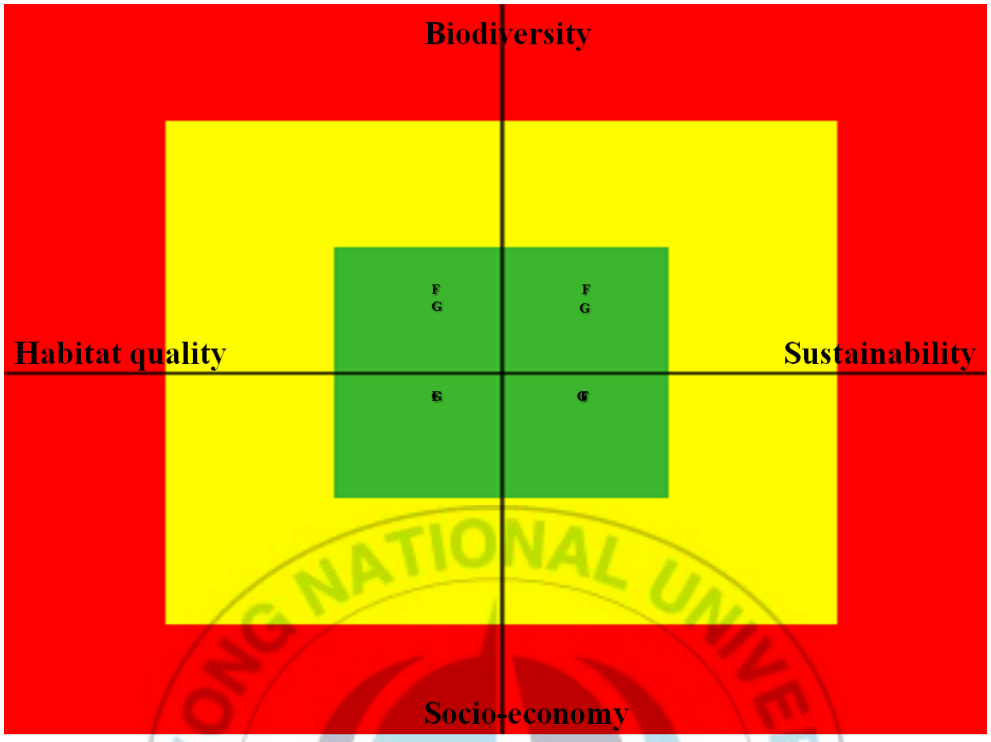

Fig. 3.5. Objective risk diagram for two target species (F) Groupers and (G) Emperors by the long line fishery in Egypt Red Sea in 2002.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	2	0	0
Biodiversity	2	0	0
Habitat quality	2	0	0
Socio-economy	2	0	0

0 1 2 3

Fig. 3.6. Number of species by risk zone diagram for four objectives by the long line fishery of Egypt Red Sea in 2002.

Sustainability has all the seven species with risk indices in the green zone for all the fisheries (Fig. 3.7). Biodiversity has all the seven species with risk indices in the green zone. Habitat quality has five species with risk indices in the desirable green zone and two species with risk indices in the yellow zone. Socio-economy has all species with risk indices in the desirable green zone.

Most of the fisheries have risk indices in the green zone for the seven species as classified by objectives and only two species have risk indices in the yellow zone. No objectives have species with risk indices in the red zone. Corrective management measures are required for objectives with risk indices in the yellow zone to improve on their status for all the fisheries.

Objective risk indices for seven species assessed by the Tier 2 approach for Egypt Red Sea fisheries were summarized as shown in Table 3.7.

Table 3.7. Number of species by risk zones for four objectives for Egypt Red Sea fisheries in 2002

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	7 (100%)	0 (0%)	0 (0%)
Biodiversity	7 (100%)	0 (0%)	0 (0%)
Habitat quality	5 (71.4%)	2 (28.6%)	0 (0%)
Socio-economy	7 (100%)	0 (0%)	0 (0%)
Total	26 (92.86%)	2 (7.14%)	0 (0%)

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	7	0	0
Biodiversity	7	0	0
Habitat quality	5	2	0
Socio-economy	7	0	0

0 1 2 3

Fig. 3.7. Number of species by risk zone diagram for four objectives in Egypt Red Sea fisheries in 2002.

Sustainability has 100% of species risk index in the desirable green zone, no species risk index in the yellow zone and no species risk index in the red zone. Biodiversity has 100% of species risk index in the desirable green zone, no species risk index in the yellow zone and no species risk index in the red zone. Habitat quality has 71.4% of the species risk index in the desirable green zone, 28.6% of the species risk index in the yellow zone and no species risk index in the red zone. Socio-economy has 100% of species risk index in the desirable green zone, no species risk index in the yellow zone and no species risk index in the red zone.

For Egypt Red Sea target fisheries 2012 sustainability has 22.9 % of the indicators in the desirable green zone, the yellow zone has 40 % of the indicators and the red zone has 37.1 % of the indicators.

Biodiversity has 47.6 % of the indicators in the desirable green zone, the yellow zone has 42.9 % of the indicators and the red zone has 9.5 % of the indicators.

Habitat quality has 32.1 % of the indicators in the desirable green zone, the yellow zone has 42.9 % of the indicators and the red zone has 25 % of the indicators.

Socio-economy has 9.5 % of the indicators in the desirable green zone, the yellow zone has 76.2 % of the indicators and the red zone has 14.3 % of the indicators. Overall the Red Sea fisheries ecosystem has 27.6 % of the indicators in the desirable green zone, 48.6 % in the yellow zone and 23.8 % in the red zone (Table 3.8).

Table 3.8. Risk zone by number of indicators for four objectives in Egypt Red Sea target fisheries 2012

Objective	Number of indicators in the green zone	Number of indicators in the yellow zone	Number of indicators in the red zone
Sustainability	8 (22.9%)	14 (40%)	13 (37.1%)
Biodiversity	10 (47.6%)	9 (42.9%)	2 (9.5%)
Habitat quality	9 (32.1%)	12 (42.9%)	7 (25%)
Socio-economy	2 (9.5%)	16 (76.2%)	3 (14.3%)
Total	29 (27.6%)	51 (48.6%)	25 (23.8%)

Purse seine fishery has species; Round scad *Decapterus macrosoma* with risk indices '2.03', '0.95', '1.29' and '1.89' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.9).

Sardinella *Amblygaster sirm* with risk indices '1.64', '1.02', '1.29' and '1.89' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.9).

Anchovy *Stolephorus indicus* with risk indices '1.92', '1.05', '1.29' and '1.89' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all the objectives (Table 3.9).

Table 3.9. Objective risk index (ORI) for purse seine fishery of Egypt Red Sea in 2012 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2012
Purse seine	Round scad *(Decapterus macrosoma)*	Sustainability	2.03
		Biodiversity	0.95
		Habitat	1.29
		Socio-economy	1.89
	Sardinella (*Amblygaster sirm*)	Sustainability	1.64
		Biodiversity	1.02
		Habitat	1.29
		Socio-economy	1.89
	Anchovy (*Stolephorus indicus*)	Sustainability	1.92
		Biodiversity	1.05
		Habitat	1.29
		Socio-economy	1.89

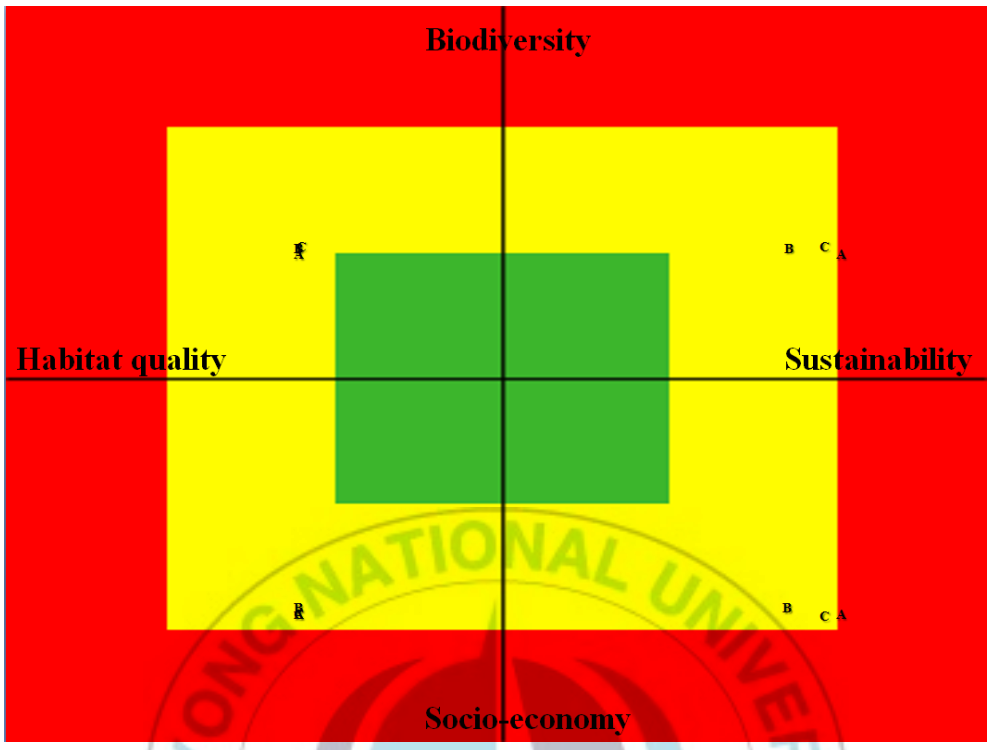

Fig.3.8. Objective risk diagram for three target species (A) Round scad, (B) Sardinella and (C) Anchovy by the purse seine fishery in Egypt Red Sea in 2012.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	0	2	1
Biodiversity	1	2	0
Habitat quality	0	3	0
Socio-economy	0	3	0
	0	1	2 3

Fig. 3.9. Number of species by risk zone diagram for four objectives by the purse seine fishery of Egypt Red Sea in 2012.

Trawl fishery has two species namely; Brushtooth lizardfish *Saurida undosquamis* with risk indices '1.74', '1.32', '1.91' and '1.01' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.10).

Trieadin breams *Nemipterus japonicus* with risk indices '1.67', '1.27', '1.91' and '1.01' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all objectives (Table 3.10).

Table 3.10. Objective risk index (ORI) for trawl fishery of Egypt Red Sea in 2012 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2012
Trawl	Brushtooth lizardfish (*Saurida undosquamis*)	Sustainability	1.74
		Biodiversity	1.32
		Habitat	1.91
		Socio-economy	1.01
	Trieadin breams (*Nemipterus japonicus*)	Sustainability	1.67
		Biodiversity	1.27
		Habitat	1.91
		Socio-economy	1.01

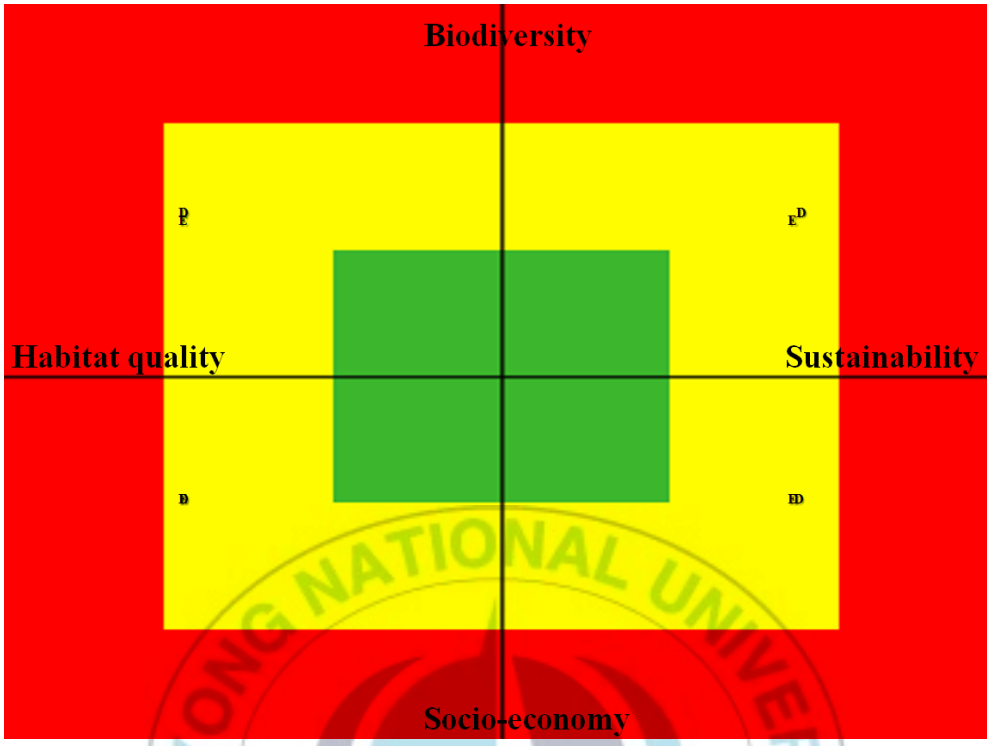

Fig. 3.10. Objective risk diagram for two target species (D) Brushtooth lizardfish and (E) Trieadin breams by the trawl fishery in Egypt Red Sea in 2012.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	0	2	0
Biodiversity	0	2	0
Habitat quality	0	2	0
Socio-economy	0	2	0

0 1 2 3

Fig. 3.11. Number of species by risk zone diagram for four objectives by the trawl fishery of Egypt Red Sea in 2012.

Long line fishery has two species namely; Groupers *Epinephelus spp* with risk indices '1.47', '0.97', '0.7' and '1.29' for sustainability, biodiversity, habitat quality and socio-economy, respectively (Table 3.11).

Emperors *Lethrinus harak* with risk indices '1.54', '1.1', '0.7' and '1.29' for sustainability, biodiversity, habitat quality and socio-economy, respectively for all fishery (Table 3.11).

Table 3.11. Objective risk index (ORI) for long line fishery of Egypt Red Sea in 2012 by using the ecosystem based Tier 2 fisheries assessment approach

Fishery	Species	Objective	ORI
			2012
Long line	Groupers (*Epinephelus spp*)	Sustainability	1.47
		Biodiversity	0.97
		Habitat	0.7
		Socio-economy	1.29
	Emperors (*Lethrinus harak*)	Sustainability	1.54
		Biodiversity	1.1
		Habitat	0.7
		Socio-economy	1.29

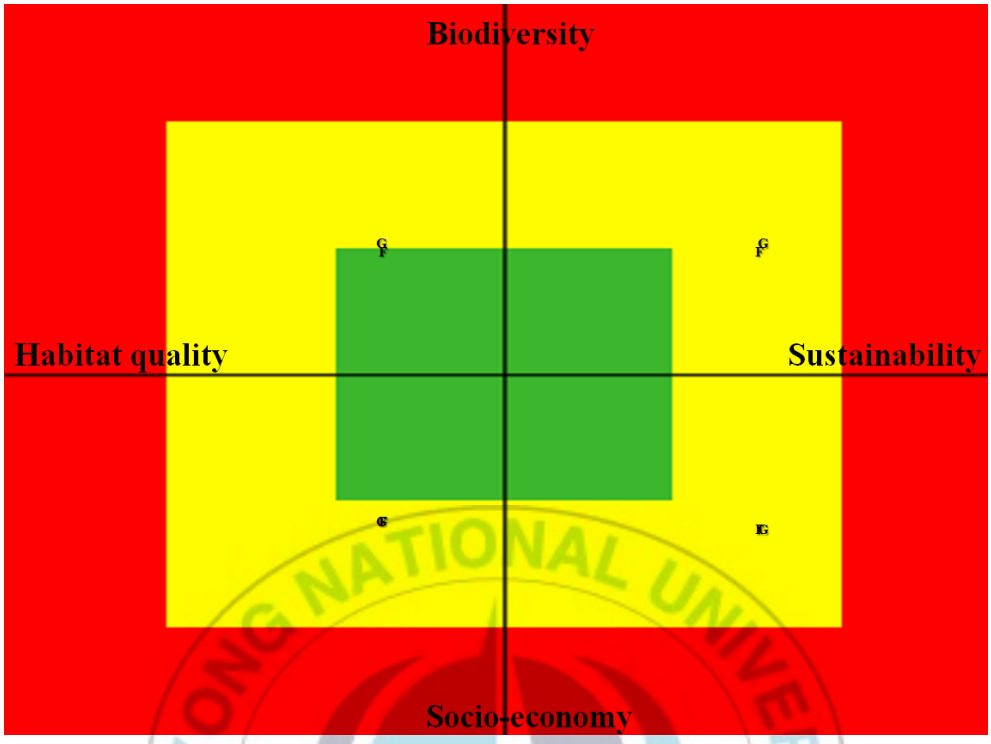

Fig. 3.12. Objective risk diagram for two target species (F) Groupers and (G) Emperors by the long line fishery in Egypt Red Sea in 2012.

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	0	2	0
Biodiversity	1	1	0
Habitat quality	2	0	0
Socio-economy	0	2	0
	0	1	2 3

Fig. 3.13. Number of species by risk zone diagram for four objectives by the long line fishery of Egypt Red Sea in 2012.

Sustainability has all the six species with risk indices in the yellow zone and one species with risk indices in the red zone. Biodiversity has two species with risk indices in the green zone and five species with risk indices in the yellow zone. Habitat quality has two species with risk indices in the desirable green zone and five species with risk indices in the yellow zone. Socio-economy has all the seven species with risk indices in the yellow zone (Fig. 3.14).

Most of the fisheries have risk indices in the yellow zone and some in red zone for the seven species as classified by objectives. Corrective management measures are required for objectives with risk indices in the red zone and yellow zone to improve on their status for all the fisheries.

Table 3.12. Number of species by risk zones for four objectives for Egypt Red Sea fisheries in 2012

Objectives	Number of species in the green zone	Number of species in the yellow zone	Number of species in the red zone
Sustainability	0 (0%)	6 (85.7%)	1 (14.3%)
Biodiversity	2 (28.6%)	5 (71.4%)	0 (0%)
Habitat quality	2 (28.6%)	5 (71.4%)	0 (0%)
Socio-economy	0 (0%)	7 (100%)	0 (0%)
Total	4 (14.3%)	23 (82.1%)	1 (3.6%)

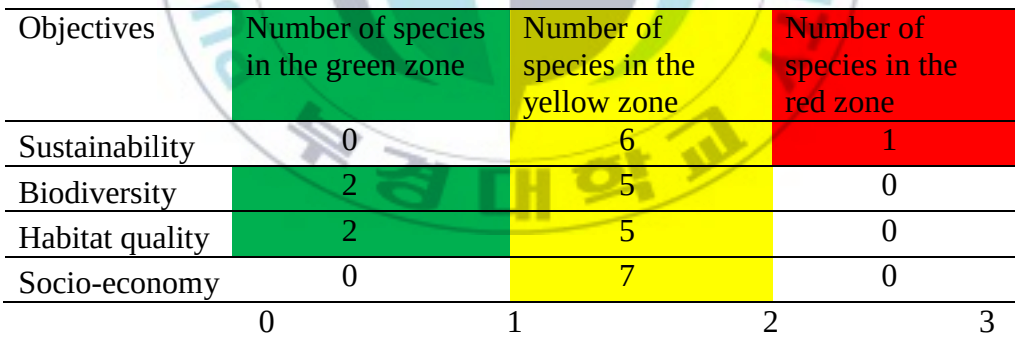

Fig. 3.14. Number of species by risk zone diagram for four objectives in Egypt Red Sea fisheries in 2012.

Objective risk indices for seven species assessed by the Tier 2 approach for Egypt Red Sea fisheries were summarized as shown in Table 3.12. Sustainability has no species risk index in the desirable green zone, 85.7% of the species risk index in the yellow zone and 14.3% of the species risk index in the red zone. Biodiversity has 28.6% of the species risk index in the desirable green zone, 71.4% of the species risk index in the yellow zone and no species risk index in the red zone. Habitat quality has 28.6% of the species risk index in the desirable green zone, 71.4% of the species risk index in the yellow zone and no species risk index in the red zone. Socio-economy has no species risk index in the desirable green zone, 100% of the species risk index in the yellow zone and no species risk index in the red zone.

3.3. Species Risk Indices of each fishery in Egypt Red Sea fisheries assessed by Tier 2 approaches.

Species risk indices for Egypt Red Sea fisheries in 2002 and 2012 were calculated from objective risk indices for the seven species. In this study we assumed $\lambda_S = \lambda_B = \lambda_H = \lambda_E = 0.25$ for calculating SRI_S from ORI_S for all the species as follows;

$$SRI_i = \lambda_S ORI_S + \lambda_B ORI_B + \lambda_H ORI_H + \lambda_E ORI_E$$

$$SRI = SRI_i (1 + RS_{IUU} / 10)$$

Where: RS_{IUU} is risk score for IUU

Species Risk Indices for the purse seine fishery in 2002

The purse seine fishery had three species namely; round scad *Decapterus macrosoma*, sardinella *Amblygaster sirm*, anchovy *Stolephorus indicus*. The three species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.13. All the three species have risk indices that fall in the green zone as shown in Fig. 3.15.

Species Risk Indices for the trawl fishery in 2002

The trawl fishery had two species namely; Brushtooth lizardfish *Saurida tumbil*, trieadin breams *Nemipterus japonicus*. The two species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.13. All the two species have risk indices that fall in the green zone as shown in Fig. 3.15.

Table 3.13. Species Risk Indices by fishery assessed by the Tier 2 approach in the Egypt Red Sea in 2002

Fishery	Species	Species Risk Indices
Purse seine	Round scad	0.74
	Sardinella	0.73
	Anchovy	0.71
	FRI	0.57
Trawl	Brushtooth lizardfish	0.80
	Trieadin breams	0.78
	FRI	0.30
Long line	Groupers	0.48
	Emperors	0.43
	FRI	0.40

Purse seine fishery

Species	Green zone	Yellow zone	Red zone
Round scad	0.74		
Sardinella	0.73		
Anchovy	0.71		

Trawl fishery

Species			
Brushtooth lizardfish	0.80		
Trieadin breams	0.78		

Long line fishery

Species			
Groupers	0.48		
Emperors	0.43		

0 **1** **2** **3**

Target RP.

Fig. 3.15. Species Risk diagrams by fishery assessed by the Tier 2 approach in the Egypt Red Sea in 2002.

Species Risk Indices for the long line fishery in 2002

The long line fishery had two species namely; Groupers *Epinephelus malabaricus*, emperors *Lethrinus harak*. The two species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.13. All the two species have risk indices that fall in the desirable green zone as shown in Fig. 3.15.

All the species are fall in the desirable green zone and no species that were assessed fall in the yellow zone.

Species Risk Indices for the purse seine fishery in 2012

The purse seine fishery had three species namely; round scad *Decapterus macrosoma*, sardinella *Amblygaster sirm*, anchovy *Stolephorus indicus*. The three species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.14. All the three species have risk indices that fall in the yellow zone as shown in Fig. 3.16.

Species Risk Indices for the trawl fishery in 2012

The trawl fishery had two species namely; Brushtooth lizardfish *Saurida tumbil*, trieadin breams *Nemipterus japonicus*. The two species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.14. All the two species have risk indices that fall in the yellow zone as shown in Fig. 3.16.

Table 3.14. Species Risk Indices by fishery assessed by the Tier 2 approach in the Egypt Red Sea in 2012

Fishery	Species	Species Risk Indices
Purse seine	Round scad	1.78
	Sardinella	1.68
	Anchovy	1.78
	FRI	1.43
Trawl	Brushtooth lizardfish	1.86
	Trieadin breams	1.83
	FRI	1.10
Long line	Groupers	1.22
	Emperors	1.27
	FRI	0.99

Purse seine fishery

Species	Green zone	Yellow zone	Red zone
Round scad		1.78	
Sardinella		1.68	
Anchovy		1.78	

Trawl fishery

Species			
Brushtooth lizardfish		1.86	
Trieadin breams		1.83	

Long line fishery

Species			
Groupers		1.22	
Emperors		1.27	

0 **1** **2** **3**

Target RP Limit RP.

Fig. 3.16. Species Risk diagrams by fishery assessed by the Tier 2 approach in the Egypt Red Sea in 2012.

Species Risk Indices for the long line fishery in 2012

The long line fishery had two species namely; Groupers *Epinephelus malabaricus*, emperors *Lethrinus harak*. The two species of this fishery were assessed by Tier 2 approach in the Egypt Red Sea as shown in Table 3.14. All the two species have risk indices that fall in the yellow zone as shown in Fig. 3.16.

All species that were assessed fall in the yellow zone. Corrective management system should be out in place for the seven species to reduce species risk indices.

3.4. Fisheries Risk Indices and Ecosystem Risk Index for the Egypt Red Sea.

Fisheries risk indices were calculated from the following formula.

$$FRI = \frac{\sum C_i \ SRI_i}{\sum C_i}$$

Where C_i is catch.

Fisheries risk indices and ecosystem risk index for the Egypt Red Sea 2002.

Seven species risk indices were used to calculate fishery risk indices for the three fisheries in Egypt Red Sea in 2002 as shown in Table 3.15.

The three fisheries assessed by the Tier 2 approach are; purse seine fishery, trawl fishery and longline fishery. All the three fisheries have risk indices that fall in the desirable green zone (Fig. 3.17).

Ecosystem risk index of the Egypt Red Sea ecosystem was assessed based on the fishery risk indices from the formula.

$$ERI = \frac{\sum C_i \ FRI_i}{\sum C_i}$$

Where C_i is catch

Three fisheries were assessed in the Egypt Red Sea ecosystem. The Egypt Red Sea ecosystem has risk index '0.70'. This risk index falls in green zone (Fig. 3.17). The Egypt Red Sea ecosystem management system needs to be organized into four management objectives in line with ecosystem approach of fisheries management to save the fisheries and ecosystem risk indices respectively.

Type of Risk Index	Green zone	Yellow zone	Red zone
Purse seine fishery	0.74		
Trawl fishery	0.79		
Long line fishery	0.46		
Ecosystem Risk Index	0.70		

0 **1** **2** **3**

Target RP. Limit RP

Fig. 3.17. Fishery and Ecosystem Risk diagram assessed by the Tier 2 approach for the Egypt Red Sea in 2002.

Fisheries risk indices and ecosystem risk index for the Egypt Red Sea 2012

Seven species risk indices were used to calculate fishery risk indices for the three fisheries in Egypt Red Sea 2012 as shown in Table 3.16.

The three fisheries assessed by the Tier 2 approach are; purse seine fishery, trawl fishery and longline fishery. The three fisheries purse seine fishery, trawl fishery and long line fishery have risk indices that fall in the yellow zone (Fig. 3.18). This fishery has a draft management plan but not working well. This explains why they have high risk indices.

Ecosystem risk index of the Egypt Red Sea ecosystem was assessed based on the fishery risk indices from the formula.

$$ERI = \frac{\sum C_i \, FRI_i}{\sum C_i}$$

Where C_i is catch

Three fisheries were assessed in the Egypt Red Sea ecosystem. The Egypt Red Sea ecosystem has risk index '1.69'. This risk index falls in yellow zone (Fig. 3.18). The Egypt Red Sea ecosystem management system needs to be organized into four management objectives in line with ecosystem approach of fisheries management to reduce fisheries and ecosystem risk indices respectively.

Type of Risk Index	Green zone	Yellow zone	Red zone
Purse seine fishery		1.78	
Trawl fishery		1.85	
Long line fishery		1.24	
Ecosystem Risk Index		1.69	

0 **1** **2** **3**

Target RP. Limit RP.

Fig. 3.18. Fishery and Ecosystem Risk diagram assessed by the Tier 2 approach for the Egypt Red Sea in 2012.

IV. Discussion

An ecosystem-based management strategy for marine fisheries is one that reduces potential fishing impacts while at the same time allowing the extraction of fish resources at levels sustainable for the ecosystem (Zhang et al., 2009). Ecosystem-based assessment approach has several advantages. First, it is an integrated, holistic approach using a number of management indicators to get single collective indices for objectives, species, fishery, or ecosystem, unlike other approaches which mostly use individual indicators (Zhang et al., 2009). Second, the approach is easy to apply. This approach can be applied to any situation even when scientific data are limited (Zhang et al., 2009). Third, it is possible to evaluate the impact of management practices such as stock rebuilding programs, habitat recovery programs, or alternative management policies (Zhang et al., 2009). Fourth, it is possible to compare the status of species, fisheries or ecosystems relative to several management objectives, both spatially and temporally, using the management status index (Zhang et al., 2009). Finally, results lend themselves to graphical analysis, which aids in interpretation by scientists, managers, and stakeholders alike (Zhang et al., 2009).

The Tier 2 approach was used to assess risk indices for all the indicators due to the quality of the data available and was compared between two different times in the sustainability, catch biodiversity, habitat and socio-economy of the Egypt Red Sea purse seine, trawl and longline fisheries in 2002 and 2012 (Fig 4.1) and (Fig 4.2). Results of the calculations indicated that in both cases most risk indices were increased significantly between the two reference years. The species risk index (SRI) for the seven target species caught by purse seine, trawl and longline fisheries in the Red Sea off Egypt in 2002 were 0.74, 0.73, 0.71, 0.80, 0.78, 0.48 and 0.43 respectively. But species risk index (SRI) for the same seven target species in 2012 were 1.78, 1.68, 1.78, 1.86, 1.83, 1.22 and 1.27 respectively. So the increases of the species risk index (SRI) that shown in 2012 indicates to weakness in the current management for those species. By 2012, most of the determined risk scores of indicators for sustainability, biodiversity, habitat and socio-economic objectives have deteriorated when compared to those for 2002 (Appendices 3 and 4).

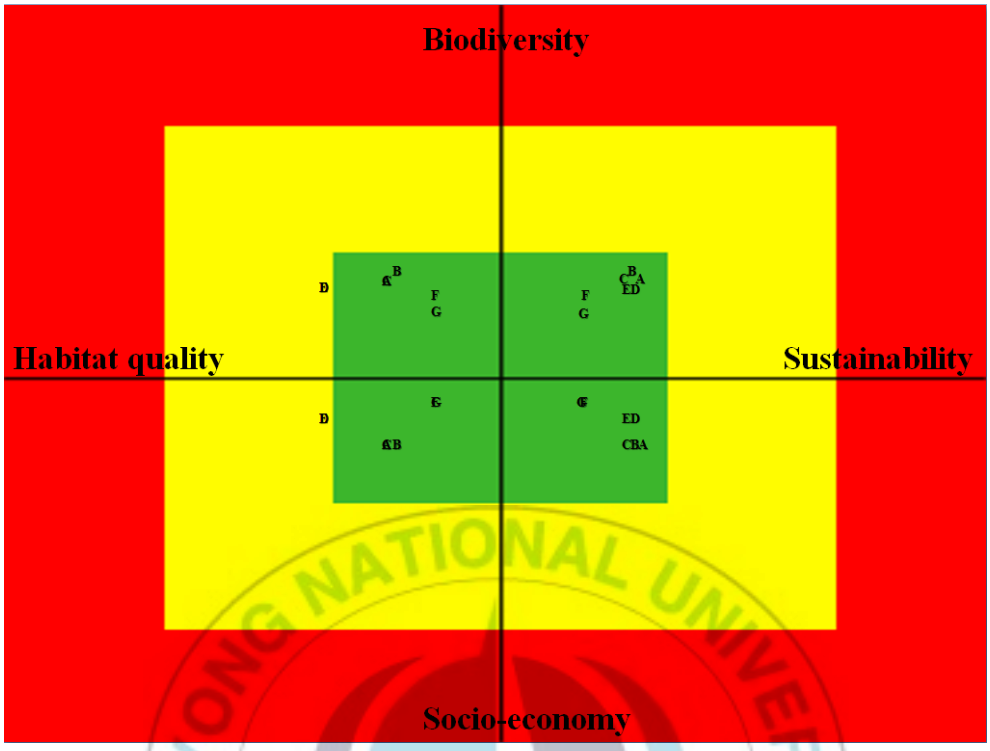

Fig. 4.1. Relative positions of objective risk indices (ORI) for seven target species (A) Round scad, (B) Sardinella, (C) Anchovy, (D) Brushtooth lizardfish, (E) Trieadin breams, (F) Groupers and (G) Emperors by purse seine, trawl and longline fisheries in the Red Sea off Egypt using the ecosystem-based Tier 2 fisheries assessment approach in 2002.

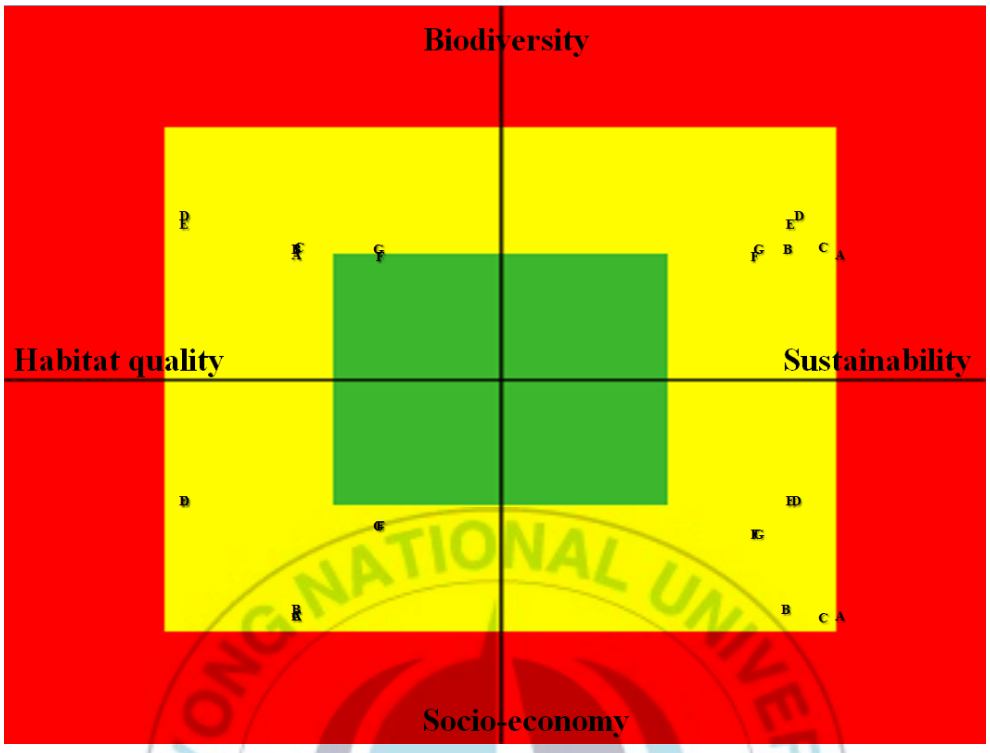

Fig. 4.2. Relative positions of objective risk indices (ORI) for seven target species (A) Round scad, (B) Sardinella, (C) Anchovy, (D) Brushtooth lizardfish, (E) Trieadin breams, (F) Groupers and (G) Emperors by purse seine, trawl and longline fisheries in the Red Sea off Egypt using the ecosystem-based Tier 2 fisheries assessment approach in 2012.

Fig. 4.2 shows a shift for the values of these seven species from the green or yellow zones in 2002 to the yellow or red zones in 2012. Zhang et al. (2009) reported that an ecosystem-based management strategy can reduce potential fishing impacts as well as allowing harvest of fishery resources at sustainable levels within the ecosystem. Using their evaluation criteria (Zhang et al., 2009, 2010), these results can be used as benchmarks for evaluating Red Sea fisheries management policy effectiveness in the improvement of stock and habitat conditions. Deteriorated in the various sub-indices of the Red Sea stock status are evidenced by decreased of target fish stock size, deteriorate habitat quality, as well as deteriorate in harvest sustainability, community biodiversity and socio-economic.

Fig. 4.3 shows a shift for the values of the three target fisheries risk index from the green zones in 2002 to the yellow in 2012 and that is indicated to the status of fisheries risk index became worse need to improve fishery management.

Fig. 4.4 shows a shift for the values of the ecosystem risk index from the green zones in 2002 to the yellow in 2012 and that is indicated to the status of ecosystem risk index became worse need to protection by develop the ecosystem management.

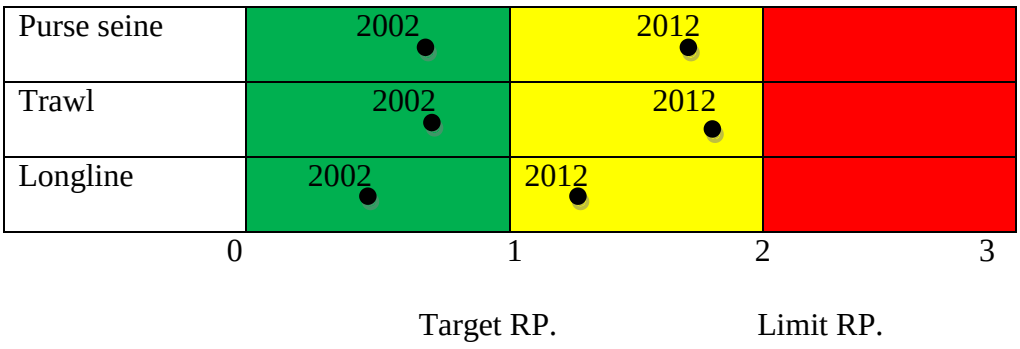

Fig. 4.3. Fishery risk index (FRI) diagram to the three target fisheries assessed by Tier 2 approach for the Egypt Red Sea in 2002 and 2012.

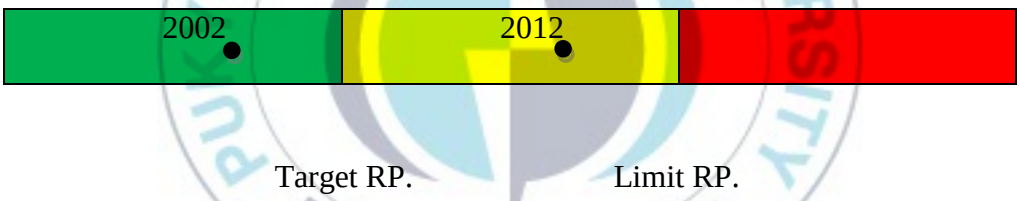

Fig. 4.4. Ecosystem risk index (ERI) diagram assessed by Tier 2 approach for the Egypt Red Sea in 2002 and 2012.

Suggestions for proper management to reduce risk indices.

The Red Sea ecosystem has 1 species by four objectives in the red zone and 23 species in the yellow zone (Table 3.12). Indicators risk zone are as shown in Table 3.8. Sustainability for the Red Sea ecosystem has 40% of the indicators in the yellow zone, e.g. (CPUE) catch per unit effort, Age (or length) at first capture and Rate of mature fish. Biomass or (CPUE) catch per unit effort, fishing mortality or fishing effort, Age (or length) at first capture are indicators in the red zone with 37.1%. These are very important indicators for this objective; therefore a proper system of data collection for these indicators is required. Assessment of risk index should be done again. A proper management plan in line with ecosystem approach to fisheries management is suggested to reduce high risk indices.

Biodiversity has 12.9% of indicators in the yellow zone. Indicators in the yellow zone are bycatch rate (BC/C) and diversity index. Diversity index recorded 9.5% of indicators in the red zone. These are very important indicators for this objective; therefore a proper system of data collection for these indicators is required. Assessment of risk index should be done again. A proper management plan in line with ecosystem approach to fisheries management is suggested to reduce high risk indices.

Habitat quality has 71% of the indicators in the yellow zone. Indicators in the yellow zone are critical habitat damage rate, pollution rate of spawning and nursery ground, lost fishing gear and discarded wastes. These are very important indicators for this objective; therefore a proper system of data collection for these indicators is required. Assessment of risk index should be done again. Fisheries management plan in line with ecosystem approach of fisheries management for fisheries with these indicators are suggested to reduce high risk indices.

Socio-economy has 100% of indicators in the yellow zone. Indicators in the yellow zone are income per fisherman (IPF), ratio of profit to cost (RPC) and employment rate (ER). These are very important indicators for this objective; therefore a proper system of data collection for these indicators is required. Assessment of risk index should be done again. A proper management plan in line with ecosystem approach to fisheries management is suggested to reduce high risk indices.

In conclusion, the Tier 2 approach was used to assess risk indices for all the indicators due to quality of the data available. An improvement on the data used for Tier 2 assessment is suggested. This will enable another assessment by the same approach, which will then be compared with Tier 1

approach after better qualitative data collection. The results shown high variation between the two reference years (2002 and 2012) led to the deterioration in the current status of the Red Sea ecosystem. A proper management plan in line with ecosystem approach to fisheries management is suggested to reduce high risk indices. Ecosystem approach to fisheries management is currently the core reference point for all fisheries management strategies. The Integrated Fisheries Risk Analysis Method for Ecosystems (IFRAME) approach that tracks climate change impacts is suggested for the Egyption Red Sea Ecosystem for future study since the IFRAME framework is made up of three components; assessment, forecast and management (Zhang et al., 2011).

References

Anonymous, 2006. Ecosystem-based Fisheries Management (online). The Australian Fisheries Management Authority, Civic, ACT, Australia, accessed 22 May 2008: updated 18 September 2008. Available from http://www.afma.gov.au/information/puplications/education/dpfs/fs22-ebfmpdf

Baars, M.A., Schalk, P.H. and Veldhuis, M.J.W. 1998. Seasonal fluctuations in plankton biomass and productivity in the ecosystems of the Somali Current, Gulf of Aden and Southern Red Sea, p 143-174 in: Sherman, K., Okemwa, E.N. and Ntiba, M.J. (eds), Large Marine Ecosystems of the Indian Ocean – Assessment, Sustainability and Management. Blackwell Science, Cambridge, U.S.

FAO (Food Agriculture Organization), 2003. Fisheries management. 2. The ecosystem approach to fisheries. In: FAO Tech. Guidelines for Responsible Fisheries, 4, Suppl. 2, 112 pp.

FAO (Food Agriculture Organization), 2005. Fishery Country Profiles. www.fao.org/fi/fcp/fcp.asp Gerges, M.A. 2002. The Red Sea and Gulf

of Aden Action Plan – Facing the challenges of an ocean gateway. Ocean and Coastal Management 45:885-903.

FAO (Food Agriculture Organization), 2007. Models for an ecosystem approach to fisheries. In: FAO Fisheries Technical Paper 477, 108 pp.

FAO (Food Agriculture Organization), 2013. Fishing Gear types. Purse seines. Technology Fact Sheets. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 13 September 2001. [Cited 24 December 2013]. http://www.fao.org/fishery/geartype/249/en

Garcia, S. M., Zerbi, A., Aliaume, C., Do Chi, T., and Lasserre, G. 2003. The Ecosystem Approach to Fisheries. Issues, Terminology, Principles, Institutional Foundations, Implementation and Outlook. FAO Fisheries Technical Paper, 443. 71 pp.

GAFRD, 2003. The 2002 Statistical Yearbook. General Authority for Fish Resources Development. Ministry of Agriculture Publications. Egypt.

GAFRD, 2011. The 2010 Statistical Yearbook. General Authority for Fish Resources Development. Ministry of Agriculture Publications. Egypt.

GAFRD, 2013. The 2012 Statistical Yearbook. General Authority for Fish Resources Development. Ministry of Agriculture Publications. Egypt.

Getahun, A. 1998. The Red Sea as an Extension of the Indian Ocean, p 277-283 in: Sherman, K., Okemwa, E.N. and Ntiba, M.J. (Eds), Large Marine Ecosystems of the Indian Ocean – Assessment, Sustainability and Management. Blackwell Science, Cambridge, U.S.

Jamieson, G., Livingston, P., Zhang, C.I., 2010. Report of Working Group 19 on Ecosystem-based Management Science and its Application to the North Pacific. PICES Sci. Rep. 37. , 166 pp.

Method and Apparatus for Long Line and Recreational Bait Fishing Patent application 20080202013. 28 August 2008. http://www.faqs.org/patents/app/20080202013

MOMAF (Ministry of Maritime Affairs and Fisheries), 2007b. Studies on the ecosystem-based resource management system. MOMAF, Seoul, Korea, 341 pp. (in Korean with English abstract).

Ormond, R.F.G. and Edwards, A. 1987. Red Sea Fishes, p 252-287 in: Edwards, A.J. and Head S.M. (Eds), Red Sea. Pergamon Press, Oxford, U.K.

Park, H. H. 2007. East Sea Fisheries Research Institute, National Fisheries R & D Institute, 30-6 Dongduk-ri, Yeongok-myon, Gangneung city, Gangwon-do 210-861, South Korea.

Park, H. 2013. A study on the risk scoring and risk index for the ecosystem-based fisheries assessment, Doctoral dissertation. Pukyong National University. 123- 130p.

Pikitch, EllenK, E. A. Santora, A. Babcock, A. Bakun, R. Bonfil, D. O. Conover, P, "Ecosystem-based fishery management." Science 305, no. Weekly 2004: 346-347.

Rice J, Cooper J, Medley P and Hough A 2006. South Georgia Patagonian Toothfish Longline Fishery. Moody Marine, May 2006.

Roberts, C.M., Shepherd, A.R.D. and Ormond, R.F.G. 1992. Large-scale variation in assemblage structure of Red Sea butterfly fishes and angel fishes. Journal of Biogeography 19:239-250.

Rohling E. J., W.J. Zachariassef 1996. Red Sea Outflow During The Last Glacial Maximum. Quaternary International, Vol. 31, pp. 77-83, 1996.

Sea Around Us 2011. A Global Database on Marine Fisheries and Ecosystems. Fisheries Centre, University British Columbia, Vancouver, Canada. http://www.seaaroundus.org/lme/33.aspx

Sheppard, C., Price, A., Roberts, C. 1992. Marine Ecology of the Arabian Region: Patterns and Processes in the Extreme Tropical Environments. Academic Press, the Netherlands.

Ward, T., Tarte, D., Hegerl, E. and Short, K. 2002. Ecosystem-based management of marine capture fisheries. World Wide Fund for Nature Australia, 80 pp.

Yoon, S.C. 2014. Characteristics of Korean costal fisheries and ecosystem-based resource assessment. Doctoral dissertation. Pukyong National University. 226pp.

Zhang, C.I., Marasco, R.J., 2003. New approaches in fisheries assessment and management under the exclusive economic zone regime in Korea. Am. Fish. Soc. Symp. 38, 685–693.

Zhang, C.I., Kim, S., Gunderson, D., Richard, M., Lee, J.B., Park, H.W., Lee, J.H., 2009. An ecosystem-based fisheries assessment approach for Korean fisheries. Fish. Res. 100, 26–41.

Zhang, C.I., Park, H.W., Lim, J.H., Kwon, H.C., Kim, D.H., 2010. A study on indicators and reference points for the ecosystem-based resources assessment. J. Korean Soc. Fish. Technol. 46 (1), 32–49.

Zhang, C. I., Hollowed, A. B., Lee, J-B., and Kim, D-H. 2011. An IFRAME approach for assessing impacts of climate change on fisheries. ICES Journal of Marine Science, 68: 1318–1328.

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Appendix 1: Criterion of risk states for semi-quantitative assessment Tier 2

Magnitude	Abundance	Condition	Likelihood	Risk score	%
Extremely small	Never or None	Optimal or Best	High degree of uncertainty	0	<5%
Small	Part or a few	Negligible	Highly unlikely	0.5	5-20%
Moderately small	Some	Minor	Unlikely	1	20-40%
Average	Considerable or Average	Moderate	Ambiguous	1.5	40-60%
Moderately large	Many or Major	Major	Likely	2	60-80%
Large	Most	Severe	Highly likely	2.5	80-95%
Extremely large	All	Catastrophic or Worst	High degree of certainty or Evident	3	>95%

Appendix 2.1 Target and limit reference points for indicators of sustainability in the Tier 2 approach of Egypt Red Sea

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
Biomass	Biomass or CPUE	More than x years of CPUE data are available Current CPUE are extremely large compared with average of CPUE during X years	More than x years of CPUE data are available Current CPUE are large compared with average of CPUE during X years	More than X years of CPUE data are available Current CPUE are moderately large compare with average of CPUE during X years or Less than X years of CPUE data are available Current CPUE are moderately large compared with average of CPUE during X years	Less than X years of CPUE data are available CPUE is unchanged or Less than X years of CPUE data are available Current CPUE is similar to average of CPUE during X years	Less than X years of CPUE data are available Current CPUE is moderately small compared with average of CPUE during X years	CPUE data are not available, catch trend is unchanged or CPUE data are available, Current CPUE are small compared with average of CPUE during X years	CPUE data are not available, catch trend is declining or, CPUE data are available, Current CPUE are extremely small compared with average of CPUE during X years
Fishing intensity	Fishing mortality or fishing effort	Effort is extremely small compared with average of effort during X years fisheries management and active self-regulation exist	Effort is small compared with average of effort during X years fisheries management or self-regulation exist	Effort is moderately small compared with average of effort during X years fisheries management or self-regulation exist partly	Effort is similar to average of effort during X years	Effort is moderately large compared with average of effort during X years	Number of license or fishing gear is unchanged or Effort is in an increasing state	Number of license or fishing gear is excessive or Effort is rapidly increasing

Appendix 2.1 Continued.

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
Size at first capture	Age (or length) at first capture	Length at first capture is extremely large compared with mature length	Length at first capture is large compared with mature length or Average length of catch is extremely large compared with mature length	Length at first capture is moderately large compared with mature length or Average length of catch is large compared with mature length or Institutional prohibition length is established and managed	Length at first capture is similar to mature length or Average length of catch is moderately large compared with mature length or Self-regulated prohibition length is established and managed	Length at first capture is moderately small compared with mature length or Average length of catch is similar to mature length	Length at first capture is small compared with mature length or Average length of catch is moderately small compared with mature length or Prohibition length is establish but length at first capture is smaller than prohibition length	Length at first capture is extremely small compare with mature length or Average length of catch is small compared with mature length or Length at first capture is not available, prohibition length is not establish
Reproductive potential	Rate of mature fish (MR)	Fishing never occurs during the spawning season or Prohibition season(prohibition fishing ground) is set up and conduct to conserve mature fish	No more than a minor amount of the catch is taken during the spawning season	No more than a moderate amount of the catch is allowed to be to be harvested during the spawning season	No more than a moderate to a considerable amount of fish is allowed to be taken during the spawning season	A significant amount of catch is allowed to be taken during the spawning season	A significant to most of the fisheries place during the spawning season	Fishing activities are free to operated wherever during the spawning season

Genetic structure	Ratio of (release stock abundance) /(wild stock abundance) in catch (Rr/w)	Never release fish in the area (There is no entrance from external area)	A few release fish in the area	Release conducted once and small amount in recent X year (X = generation period – age at release) on the area	Release conducted twice in recent X year (X = generation period – age at release) on the area	Release conducted three times and considerable amount in recent X year (X = generation period – age at release) on the area	Release conducted more than four times and considerable amount in recent X year (X = generation period – age at release) on the area	Release conducted continuously and considerable amount in the most recent past

Appendix 2.2: Target and limit reference points for indicators of biodiversity in the Tier 2 approach of Egypt Red Sea

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
Total bycatch	Bycatch rate (BC/C)	Bycatch never occurs compared with average of bycatch rate during X years	Current bycatch rate is extremely small compared with average of bycatch rate during X years	Current bycatch rate is small compared with average of bycatch rate during X years	Current bycatch rate is moderately small compared with average of bycatch rate during X years	Current bycatch rate is similar compared with average of bycatch rate during X years	Current bycatch rate is moderately large compared with average of bycatch rate during X years	Current bycatch rate is large compared with average of bycatch rate during X years
Total discards	Discards rate (D/C)	Amount of discarded fish is extremely small	Amount of discarded fish is small	Amount of discarded fish is moderately small	Amount of discarded fish is average	Amount of discarded fish is moderately large	Amount of discarded fish is large	Amount of discarded fish is extremely large
Diversity	Diversity index (DI)	There are sufficient time series data (more than recent 5 years) on species composition by scientific survey, Number of species is unchanged Dominant species is unchanged	There are sufficient time series data (more than recent 5 years) on species composition by catch data, Number of species is unchanged Dominant species is unchanged	There are time series data (recent 3-5 years) on species composition by catch data, Number of species is unchanged Dominant species is unchanged	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is part decreased There are part of data (less than recent 3 years) on species composition by catch data, Dominant species is part changed	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is some decreased or There are part of data (less than recent 3 years) on species composition by catch data, Dominant species is some changed	Number of species is considerable decreased or Dominant species is considerable changed	Number of species is most decreased or Dominant species is most changed

Appendix 2.3 Target and limit reference points for indicators of habitat quality in the Tier 2 approach of Egypt Red Sea

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
Habitat damage	Critical habitat damage rate (DH/H)	Fishing gear that has extremely small impact on the habitat (Purse seine, Midwater trawl etc.) or Fishing gear that has small impact on the habitat (Surface gillnet, anchovy tow net, boat seine, jigging, pole and line, lift net etc.) Operating period of fishing gear is short	Fishing gear that has small impact on the habitat (Surface gillnet, anchovy tow net, boat seine, jigging, pole and line, lift net etc.) Operating period of fishing gear is very long or Fishing gear that has moderately small impact on the habitat (Stow net, swing net on stakes, long bag set net etc.) Operating period of fishing gear is long	Fishing gear that has moderately small impact on the habitat (Stow net, swing net on stakes, long bag set net etc.) Operating period of fishing gear is very long or Fishing gear that has average impact on the habitat (bottom longline, bottom drift gill net etc.) Operating period of fishing gear is long	Fishing gear that has average impact on the habitat (bottom longline, bottom drift gill net) Operating period of fishing gear is very long or Fishing gear that has moderately large impact on the habitat (Trap, bottom gill net etc.) Operating period of fishing gear is long	Fishing gear that has moderately large impact on the habitat (Trap, bottom gill net etc.) Operating period of fishing gear is very long or Fishing gear that has large impact on the habitat (Beam-trawl, Danish seine, haul net etc.) Operating period of fishing gear is long	Fishing gear that has large impact on the habitat (Beam-trawl, Danish seine, haul net etc.) Operating period of fishing gear is very long or Fishing gear that has extremely large impact on the habitat (Bottom trawl, dredge, spray fishing gear etc.) Operating period of fishing gear is long	Fishing gear that has extremely large impact on the habitat (Bottom trawl, dredge, spray fishing gear etc.) Operating period of fishing gear is very long

	Pollution rate of spawning and nursery ground (PG/G)	There is information on the magnitude of pollution by the target fisheries on the spawning and nursery grounds, no pollution by the target fisheries on the spawning and nursery grounds no oil spillage accident	There is information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and a few pollution by the target fisheries on the spawning and nursery grounds	There is information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and some pollution by the target fisheries on the spawning and nursery grounds	There is information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and considerable pollution by the target fisheries on the spawning and nursery grounds	There is information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and much pollution by the target fisheries on the spawning and nursery grounds	There is no information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and existence of oil spillage accident within recent 3-5 years	There is no information on the magnitude of pollution by the target fisheries on the spawning and nursery ground and existence of oil spillage accident within recent 3 years

Appendix 2.3 Continued.

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
	Lost fishing gear	Possibility for potential loss of fishing gear is high degree of uncertainty Setting period of fishing gear is extremely short	Possibility for potential loss of fishing gear is highly unlikely Setting period of fishing gear is short	Possibility for potential loss of fishing gear is unlikely Setting period of fishing gear is moderately short	Possibility for potential loss of fishing gear is ambiguous Setting period of fishing gear is average	Possibility for potential loss of fishing gear is likely Setting period of fishing gear is moderately long	Possibility for potential loss of fishing gear is highly likely Setting period of fishing gear is long	Possibility for potential loss of fishing gear is high degree of certainty Setting period of fishing gear is extremely long
Discarded wastes	Discarded wastes	Discarded waste is extremely small	Discarded waste is small	Discarded waste is moderately small	Discarded waste is average	Discarded waste is moderately large	Discarded waste is large	Discarded waste is extremely large or Fatal fishing wastes is being discarded

Appendix 2.4: Target and limit reference points for indicators of socio-economy in the Tier 2 approach of Egypt Red Sea

Attribute	Indicator	Indicator status						
		Better than target		Between target and limit			Beyond limit	
		0	0.5	1.0	1.5	2.0	2.5	3.0
Income	Income per fisherman (IPF)	Income for recent X years is extremely larger than the minimum living cost Income is increasing or stable	Income for recent X years is larger than the minimum living cost Income is increasing or stable	Income for recent X years is moderately larger than the minimum living cost Income is increasing or stable	Income for recent X years is similar to the minimum living cost Income is stable	Income for recent X years is moderately smaller than the minimum living cost Income is stable	Income for recent X years is smaller than the minimum living cost Income is stable or decreasing	Income for recent X years is extremely smaller than the minimum living cost Income is decreasing
Profitability	Ratio of profit to cost(RPC)	Profit by target fisheries (production value-cost) is extremely large	Profit by target fisheries (production value-cost) is large	Profit by target fisheries (production value-cost) is moderately large	Profit by target fisheries (production value-cost) is average	Profit by target fisheries (production value-cost) is moderately small	Profit by target fisheries (production value-cost) is small	Profit by target fisheries (production value-cost) is extremely small
Employment	Employment rate (ER)	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is extremely large	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is large	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is moderately large	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is average	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is moderately small	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is small	Index of fisheries employment (number of fisherman*number of fishing vessels) for recent X years is extremely small

Appendix 2.5. Target and limit reference points for indicators of IUU indicator in the Tier 2 approach of Egypt Red Sea

Attribute	Indicator	Issue	Indicator status						
			Better than target		Between target and limit			Beyond limit	
			0	0.5	1	1.5	2	2.5	3
IUU fishery	Management of IUU fishery	IUU fishery existence	None or extremely small	Small	Moderately small	Considerable	Moderately large	Large	Extremely large

Appendix 3.1.1: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.3	0.07	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.6	0.04	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.95	0.03	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	0.9	0.04	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0.00	5-1. Release fish 5-2. Fish species
ORI_S = 0.89				

Appendix 3.1.2: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.85	0.11	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0.00	7-1. Discards
Diversity index (DI)	Change of species number	1	0.00	8-1. Number of fish species
ORI_B = 0.78				

Appendix 3.1.3: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.9	0.10	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.85	0.17	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.9	0.04	10-1. Wastes
ORI_H = 0.73				

Appendix 3.1.4: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.7	0.07	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1	0	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 0.53				

Appendix 3.1.5: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.1	0.04	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.2.1: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.4	0.04	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.6	0.04	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.7	0.07	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	0.9	0.04	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.85				

Appendix 3.2.2: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.05	0.14	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0	7-1. Discards
Diversity index (DI)	Change of species number	1	0	8-1. Number of fish species
ORI_B = 0.85				

Appendix 3.2.3: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.9	0.10	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.6	0.04	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.9	0.04	10-1. Wastes
ORI_H = 0.66				

Appendix 3.2.4: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.7	0.07	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1	0	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 0.53

Appendix 3.2.5: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.1	0.04	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.3.1: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.3	0.07	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.6	0.04	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.6	0.04	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	0.9	0.04	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.79				

Appendix 3.3.2: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.85	0.11	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0	7-1. Discards
Diversity index (DI)	Change of species number	1	0	8-1. Number of fish species
ORI_B = 0.78				

Appendix 3.3.3: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.9	0.1	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.85	0.17	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.9	0.04	10-1. Wastes
ORI_H = 0.73				

Appendix 3.3.4: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.7	0.07	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1	0	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 0.53

Appendix 3.3.5: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.1	0.04	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.4.1: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.5	0	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.7	0.07	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.55	0.08	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	0.7	0.07	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.81				

Appendix 3.4.2: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.25	0.18	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.25	0.07	7-1. Discards
Diversity index (DI)	Change of species number	0.75	0.07	8-1. Number of fish species
ORI_B = 0.75				

Appendix 3.4.3: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	2	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.4	0.1	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.85	0.06	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.4	0.04	10-1. Wastes
ORI_H = 1.13				

Appendix 3.4.4: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.15	0.06	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.4	0.04	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	0.9	0.04	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 0.4				

Appendix 3.4.5: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.35	0.11	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.5.1: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.5	0	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.7	0.07	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.4	0.04	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	0.7	0.07	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.77				

Appendix 3.5.2: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.1	0.27	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.25	0.07	7-1. Discards
Diversity index (DI)	Change of species number	0.75	0.07	8-1. Number of fish species
ORI_B = 0.7				

Appendix 3.5.3: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	2	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.4	0.1	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.85	0.06	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.4	0.04	10-1. Wastes
ORI_H = 1.13				

Appendix 3.5.4: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.15	0.06	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.4	0.04	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	0.9	0.04	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 0.4

Appendix 3.5.5: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.35	0.11	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.6.1: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	0.7	0.12	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.55	0.03	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.05	0.03	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.55				

Appendix 3.6.2: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.3	0.18	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.05	0.06	7-1. Discards
Diversity index (DI)	Change of species number	0.85	0.06	8-1. Number of fish species
ORI_B = 0.73				

Appendix 3.6.3: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.75	0.29	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.2	0.07	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.8	0.23	10-1. Wastes
ORI_H = 0.39				

Appendix 3.6.4: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.15	0.06	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.2	0.06	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	0.35	0.06	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 0.21				

Appendix 3.6.5: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.1	0.04	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 3.7.1: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	0.7	0.12	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	0.55	0.03	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.15	0.06	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 0.85				

Appendix 3.7.2: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.7	0.07	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.05	0.03	7-1. Discards
Diversity index (DI)	Change of species number	0.85	0.06	8-1. Number of fish species
ORI_B = 0.53				

Appendix 3.7.3: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	0.75	0.29	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.2	0.07	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.8	0.23	10-1. Wastes
ORI_H = 0.39				

Appendix 3.7.4: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.15	0.06	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	0.2	0.07	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	0.35	0.06	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 0.21				

Appendix 3.7.5: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2002 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	0.1	0.04	14-1. IUU occurred 14-2. Description of IUU fishing

Append ix 4.1.1: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	2.8	0.07	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.75	0.07	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	2.15	0.06	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1	0	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 2.03				

Appendix 4.1.2: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.65	0.06	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0	7-1. Discards
Diversity index (DI)	Change of species number	1.7	0.07	8-1. Number of fish species
ORI_B = 0.95				

Appendix 4.1.3: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	2.1	0.4	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	1.4	0.1	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.35	0.06	10-1. Wastes
ORI_H = 1.29				

Appendix 4.1.4: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	2.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.65	0.06	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.5	0	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 1.89				

Appendix 4.1.5: Risk scores for indicators of round scad *Decapterus macrosoma* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	1.55	1.36	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.2.1: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	2.8	0.07	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.75	0.07	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	0.7	0.07	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1	0	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.64				

Appendix 4.2.2: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.85	0.11	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0	7-1. Discards
Diversity index (DI)	Change of species number	1.7	0.07	8-1. Number of fish species
ORI_B = 1.02				

Appendix 4.2.3: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	2.1	0.4	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	1.4	0.1	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.35	0.06	10-1. Wastes
ORI_H = 1.29				

Appendix 4.2.4: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	2.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.65	0.06	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.5	0	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 1.89				

Appendix 4.2.5: Risk scores for indicators of sardinella *Amblygaster sirm* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	1.55	1.36	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.3.1: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	2.8	0.07	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.75	0.07	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	1.75	0.07	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1	0	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.92				

Appendix 4.3.2: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	0.95	0.19	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.5	0	7-1. Discards
Diversity index (DI)	Change of species number	1.7	0.07	8-1. Number of fish species
ORI_B = 1.05				

Appendix 4.3.3: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0.35	0.06	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	2.1	0.4	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	1.4	0.1	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.35	0.06	10-1. Wastes
ORI_H = 1.29				

Appendix 4.3.4: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	2.2	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.65	0.06	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.5	0	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 1.89				

Appendix 4.3.5: Risk scores for indicators of anchovy *Stolephorus indicus* of purse seine fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	1.55	1.36	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.4.1: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	2.1	0.04	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.6	0.04	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	1.65	0.06	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.74				

Appendix 4.4.2: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.55	0.14	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.25	0.07	7-1. Discards
Diversity index (DI)	Change of species number	2.15	0.06	8-1. Number of fish species
ORI_B = 1.32				

Appendix 4.4.3: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	2	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	2.35	0.06	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	1.65	0.06	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.4	0.04	10-1. Wastes
ORI_H = 1.91				

Appendix 4.4.4: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.8	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.1	0.04	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.35	0.06	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 1.01

Appendix 4.4.5: Risk scores for indicators of brushtooth lizardfish *Saurida undosquamis* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	2.45	0.08	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.5.1: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	2.1	0.04	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.6	0.04	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	1.4	0.1	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.67				

Appendix 4.5.2: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.4	0.32	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.25	0.07	7-1. Discards
Diversity index (DI)	Change of species number	2.15	0.06	8-1. Number of fish species
ORI_B = 1.27				

Appendix 4.5.3: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	2	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	2.35	0.06	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	1.65	0.06	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	1.4	0.04	10-1. Wastes
ORI_H = 1.91				

Appendix 4.5.4: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	0.8	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.1	0.04	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.35	0.06	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 1.01

Appendix 4.5.5: Risk scores for indicators of trieadin breams *Nemipterus japonicus* of trawl fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	2.45	0.08	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.6.1: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.9	0.04	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.1	0.10	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	1.2	0.07	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.47				

Appendix 4.6.2: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.1	0.15	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.2	0.07	7-1. Discards
Diversity index (DI)	Change of species number	1.6	0.04	8-1. Number of fish species
ORI_B = 0.97				

Appendix 4.6.3: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	1.85	0.89	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.2	0.07	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.8	0.23	10-1. Wastes
ORI_H = 0.7				

Appendix 4.6.4: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	1.3	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.4	0.04	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.15	0.06	13-1. Number of workers 13-2. Rate of fishermen
ORI_E = 1.29				

Appendix 4.6.5: Risk scores for indicators of groupers *Epinephelus malabaricus* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	1	1.11	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 4.7.1: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Sustainability)

Indicator	Status of indicator	Risk score	Variance	Rationale
Catch per unit effort CPUE	Current CPUE compared with average of CPUE during X years	1.9	0.04	1-1. Catch 2-1. Effort CPUE = Catch / Effort
Fishing mortality or Fishing effort	Effort is compared with average of effort during X years	2.1	0.1	2-1. Trend of fishing effort 2-2. Conduct an activity of fisheries management
Age (or length) at first capture	Average length of catch compared with mature length	1.45	0.08	3-1. Body length 3-2. Regulate of body length
Rate of mature fish	The fishery occurs during the spawning season	1.35	0.06	4-1. Main fishing period of catch 4-2. Matured fishes 4-3. Closed season in spawning time
Ratio of (release stock abundance) /(wild stock abundance) in catch	Release species existence	0	0	5-1. Release fish 5-2. Fish species
ORI_S = 1.54				

Appendix 4.7.2: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Biodiversity)

Indicator	Status of indicator	Risk score	Variance	Rationale
Bycatch rate (BC/C)	Weight ratio of non target (except top X species in catch) species in catch	1.5	0.16	6-1. By-catch
Discards rate (D/C)	Ratio of discarded fish in catch	0.2	0.07	7-1. Discards
Diversity index (DI)	Change of species number	1.6	0.04	8-1. Number of fish species
ORI_B = 1.1				

Appendix 4.7.3: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Habitat quality)

Indicator	Status of indicator	Risk score	Variance	Rationale
Critical habitat damage rate	Characteristic of fishing gear and operating period of fishing gear in the habitat	0	0	9-1. Amount of fishing gear 9-2. Number of fishing gear 9-3. Conduct fishing operations 9-5. Number of fishing days
Pollution rate of spawning and nursery ground	Information on the pollution (oil spillage) by the target fishery on the spawning and nursery grounds	1.85	0.89	10-2. Number of fishing gears used per unit fishing operation 10-3. Oil accident
Lost fishing gear	Extent of potential loss of fishing gear that is operated by target fishery	0.2	0.07	9-4. Lost fishing gear
Discarded wastes	Discard amount of wastes by target fishery	0.8	0.23	10-1. Wastes
ORI_H = 0.7				

Appendix 4.7.4: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (Socio-economy)

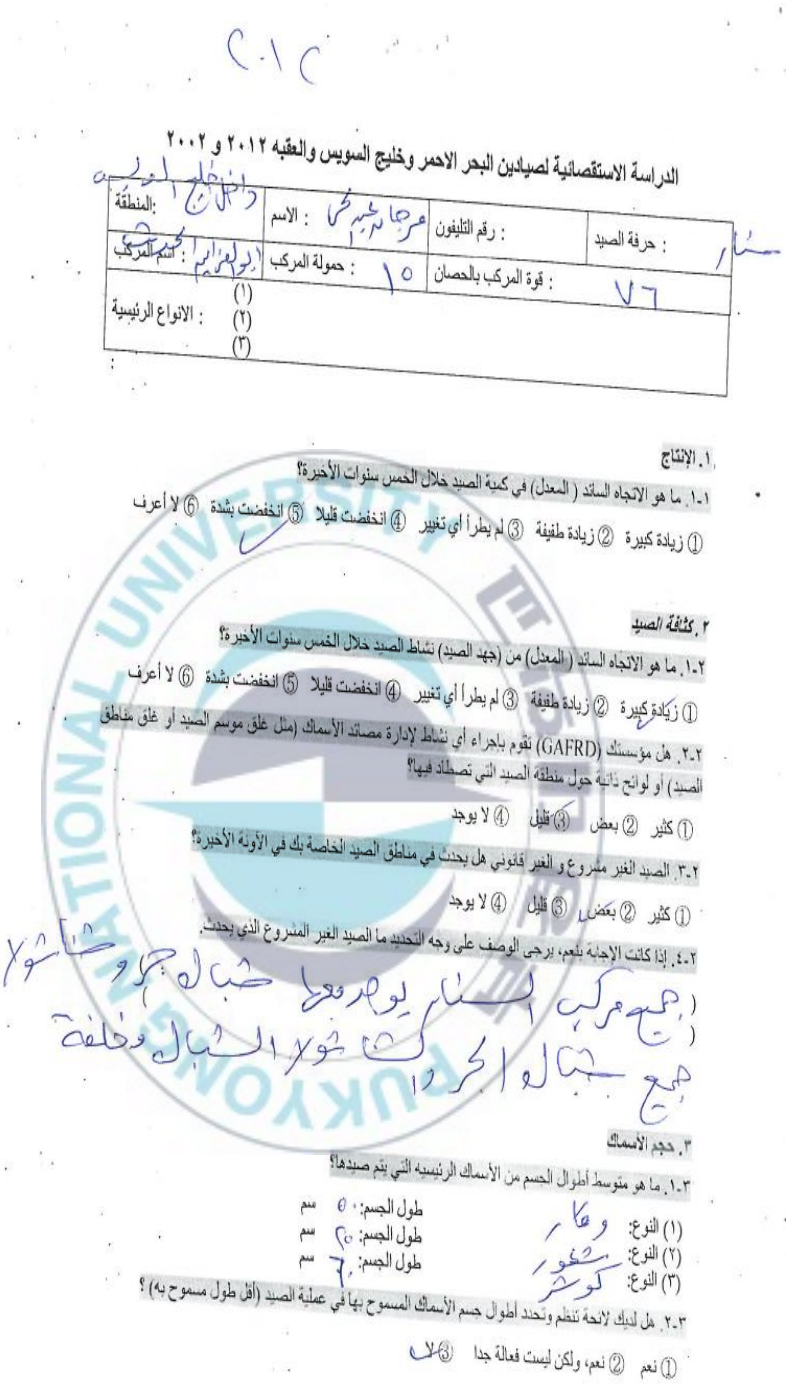
Indicator	Status of indicator	Risk score	Variance	Rationale
Income per fisherman (IPF)	Change tendency of income for recent x years and difference with minimum living cost	1.3	0.07	11-1. Income 11-2. Income rate 11-3. Income / lowest cost
Ratio of profit to cost (RPC)	Cost of target fishery	1.4	0.06	12-1. Fishing cost
Employment rate (ER)	Change tendency of number of fishermen for recent x years or Actual fishing days	1.15	0.06	13-1. Number of workers 13-2. Rate of fishermen

ORI_E = 1.29

Appendix 4.7.5: Risk scores for indicators of emperors *Lethrinus harak* of longline fishery in the Egypt Red Sea 2012 by the Tier 2 approach (IUU)

Indicator	Status of indicator	Risk score	Variance	Rationale
Management of IUU fishery	IUU fishery existence	1	1.11	14-1. IUU occurred 14-2. Description of IUU fishing

Appendix 5: Samples of survey sheet for Tier 2 approach by Egyptian fishermen of the Red Sea to 2002 and 2012.



الدراسة الاستقصائية لصيادين البحر الاحمر وخليج السويس والعقبه ٢٠١٢ و ٢٠٠٢

المنطقة:	الاسم :	رقم التليفون :	حرفة الصيد :
اسم المركب :	حمولة المركب :	قوة المركب بالحصان :	
الانواع الرئيسية : (١) (٢) (٣)			

١. الإنتاج

١-١. ما هو الاتجاه السائد (المعدل) في كمية الصيد خلال الخمس سنوات الأخيرة؟

① زيادة كبيرة ② زيادة طفيفة ③ لم يطرأ اي تغيير ④ انخفضت قليلا ⑤ انخفضت بشدة ⑥ لا أعرف

٢. كثافة الصيد

٢-١. ما هو الاتجاه السائد (المعدل) من (جهد الصيد) نشاط الصيد خلال الخمس سنوات الأخيرة؟

① زيادة كبيرة ② زيادة طفيفة ③ لم يطرأ اي تغيير ④ انخفضت قليلا ⑤ انخفضت بشدة ⑥ لا أعرف

٢-٢. هل مؤسستك (GAFRD) تقوم باجراء اي نشاط لإدارة مصائد الأسماك (مثل غلق موسم الصيد أو غلق مناطق الصيد) أو لوائح ناتجة حول منطقة الصيد التي تصطاد فيها؟

① كثير ② بعض ③ قليل ④ لا يوجد

٢-٣. الصيد الغير مشروع و الغير قانوني هل يحدث في مناطق الصيد الخاصة بك في الآونة الأخيرة؟

① كثير ② بعض ③ قليل ④ لا يوجد

٢-٤. إذا كانت الإجابة بنعم، برجى الوصف على وجه التحديد ما الصيد الغير المشروع الذي يحدث.

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٣. حجم الأسماك

٣-١. ما هو متوسط أطوال الجسم من الأسماك الرئيسيه التي يتم صيدها؟

(١) النوع: وقار طول الجسم: ٥٠ سم
(٢) النوع: شعور طول الجسم: ٢٥ سم
(٣) النوع: كوشر طول الجسم: ٦٠ سم

٣-٢. هل لديك لائحة تنظم وتحدد أطوال جسم الأسماك المسموح بها في عملية الصيد (أقل طول مسموح به) ؟

① نعم ② نعم، ولكن ليست فعالة جدا ③ لا

٤. تكاثر الاسماك والانجابية المحتملة

٤-١. متى تكون الفترة المسموحة والاساسية لصيد أنواع الأسماك الرئيسية لحرفة الصيد الخاصه بك وما هي النسبة لكل نوع في الصيد في تلك الفترة؟

(١) النوع: وقار — الفترة (بالشهر): - من ٩ الي ٦ (٣٠ ٪ من الانتاج السنوي للمركب)
(٢) النوع: سكور — الفترة (بالشهر): - من ٩ الي ٦ (٦٠٪ من الانتاج السنوي للمركب)
(٣) النوع: [illegible] — الفترة (بالشهر): - من ٩ الي ٦ (١٥٪ من الانتاج السنوي للمركب)

٤-٢. هل يوجد أسماك ناضجة جنسيا (بها بطروخ) في الصيد الخاص بك؟

① دائما ② أحيانا ③ لا يوجد

٤-٣. هل يتم منع الصيد (غلق المصيد او غلق موسم الصيد) خلال فترة وضع البيض للاسماك المستهدفة لحرفة الصيد؟

① نعم ② نعم، ولكن ليست فعالة جدا ③ لا يوجد

٥. البنية الوراثية

٥-١. هل تم إطلاق سراح او إنزال زريعة أسماك أواصنعيات من قبل في مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا اعرف

٥-٢. إذا كان الجواب نعم، أي نوع من أنواع الأسماك أطلق سراحه او انزل وما هي السنة؟

(١) النوع: الفترة (بالسنة):
(٢) النوع: الفترة (بالسنة):
(٣) النوع: الفترة (بالسنة):

٦. الصيد العرضي (أنواع الاسماك الأخرى التي يتم صيدها عن غير قصد حين اصطياد بعض الأنواع والاحجام المستهدفة).

٦-١. ما هي النسبة المئوية من الصيد العرضي في محصول الصيد الخاصة بك؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪
⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

٧. الصيد المرتجع (هي جزء من محصول الأسماك التي لا يتم الاحتفاظ به على المركب أثناء عمليات الصيد وتعاد إلى البحر حية او ميتة وغالبا ما تكون الأنواع غير قابلة للتسويق أو الأقل من الحد الأدنى لأحجام الانزال على الارض ولا يسمح بها القانون).

٧-١. ما هي النسبة المئوية من الصيد المرتجع في الحصاد الخاصة بك؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪
⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

٨. التنوع

٨-١. ما هو الاتجاه السائد (المشاهدة) في عدد أنواع الأسماك التي يتم صيدها خلال الخمس سنوات الأخيرة؟

① لا فرق ② زيادة ③ انخفاض ④ لا أعرف

٩. التلوث

٩-١. كيف يمكنك التعامل مع النفايات (أعقاب السجائر ونفايات معدات الصيد، وغيرها) خلال عملية الصيد؟

① الإلقاء في البحر (رميها في الماء) ② إحضارها إلى الأرض ③ كلاهما معا

٩-٢. هل هناك أي وضع بيض للأسماك أو حضانة للزريعة حول مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا أعرف

٩-٣. إذا كان الجواب نعم، كيف يمكن إجراء عمليات الصيد؟

① لا فرق ② عملية الصيد تكون بحرص وعناية لتجنب التدمير أو التلوث

٩-٤. في الأونة الأخيرة، هل هناك أي حادث تسريب للنفط في مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا أعرف

٩-٥ إذا كان الجواب نعم، متى حدث ذلك؟

(السنة:)

١٠. استخدام معدات صيد الأسماك

١٠-١. كم عدد معدات الصيد التي لديك؟ وما هي الكمية؟

(١) معدات الصيد : الكمية: عرض / عدد

(٢) معدات الصيد: الكمية: عرض / عدد

(٣) معدات الصيد: الكمية: عرض / عدد

١٠-٢. كم عدد معدات الصيد التي تستخدمها لكل وحدة عملية الصيد (في المرة الواحده) ؟

(العرض / عدد)

١٠-٣. كم من الوقت (بالساعة) يستغرق لتثبيت الشباك والعناد؟

(ساعات)

١٠-٤. ما هو معدل فقدان معدات الصيد الخاصة بك (الشباك وغيرها) لكل وحدة عملية الصيد (في المرة الواحده) ؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪

⑤ ٢٠ ~ ٤٠٪ ⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

١٠-٥. كم يوما أنت تجري عملية الصيد الخاصة بك في شهر واحد (تصطاد كم يوم في الشهر)؟

(يوم)/ شهر

١١. الدخل

١١-١. ما هو دخلك السنوي؟

(بالالف جنيه مصري)

١١-٢. ما هو الاتجاه السائد (المعدل) من دخلك خلال الخمس سنوات الأخيرة؟

① زيادة ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪

⑥ ٥ ~ ٢٠٪ ⑦ زيادة بنسبة ٥٪

⑧ انخفاض ٩٥٪ ⑨ ٨٠ ~ ٩٥٪ ⑩ ٦٠ ~ ٨٠٪ ⑪ ٤٠ ~ ٦٠٪ ⑫ ٢٠ ~ ٤٠٪

⑬ ٥ ~ ٢٠٪ ⑭ انخفاض ٥٪

١١-٣. ما هي النسبة المئوية من دخلك الشهري مقارنة بالحد الادنى للاجور (حوالي ١٠٠٠ جنيه مصري) خلال الخمس سنوات الأخيرة؟(مثال ٢١٠% أو أكثر او أقل)

(٪)

١٢. تكلفة عملية الصيد

١٢-١. ما هو الاتجاه السائد (المعدل) من تكلفة الصيد السنوي الخاص بك خلال الخمس سنوات الأخيرة؟

① زيادة ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪

⑤ ٢٠ ~ ٤٠٪ ⑥ ٥ ~ ٢٠٪ ⑦ زيادة بنسبة ٥٪

⑧ انخفاض ٩٥٪ ⑨ ٨٠ ~ ٩٥٪ ⑩ ٦٠ ~ ٨٠٪ ⑪ ٤٠ ~ ٦٠٪

⑫ ٢٠ ~ ٤٠٪ ⑬ ٥ ~ ٢٠٪ ⑭ انخفاض ٥٪

١٣. العمالة

١٣-١. كم عدد الأشخاص الذين يعملون على مركب الصيد الخاص بك؟

(عدد: ١٥)

١٣-٢. ما هو الاتجاه السائد (المعدل) في عدد الصيادين على سفينة الصيد الخاصة بك؟

①حدث زيادة (٪) ② لا تغييرات في عددهم ③ حدث نقص (٪)

١٤. تأثير حرفة الصيد الخاصة بك على البيئة البحرية ونسبة التعافي خلال السنوات الاخيرة؟

الشعاب المرجانية ① ضار (%) ② معتدل التأثير والتعافي جيد (%) ③ لا يوجد اي تأثير

الحشائش والاعشاب البحرية ① ضار (%) ② معتدل التأثير والتعافي جيد (%) ③ لا يوجد اي تأثير

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حرفة الصيد:	رقم التليفون:	الاسم:	المنطقة:
قوة المركب بالحصان:	حمولة المركب:		اسم المركب:
			(١) (٢) (٣) الانواع الرئيسية:

١. الانتاج

١-١. ما هو الاتجاه السائد (المعدل) في كمية الصيد خلال الخمس سنوات الأخيرة؟

① زيادة كبيرة ② زيادة طفيفة ③ لم يطرأ اي تغيير ④ انخفضت قليلا ⑤ انخفضت بشدة ⑥ لا أعرف

٢. *كثافة الصيد*

٢-١. ما هو الاتجاه السائد (المعدل) من (جهد الصيد) نشاط الصيد خلال الخمس سنوات الأخيرة؟

① زيادة كبيرة ② زيادة طفيفة ③ لم يطرأ اي تغيير ④ انخفضت قليلا ⑤ انخفضت بشدة ⑥ لا أعرف

٢-٢. هل مؤسستك (GAFRD) تقوم باجراء اي نشاط لإدارة مصائد الأسماك (مثل غلق موسم الصيد او غلق مناطق الصيد) او لوائح ذاتية حول منطقة الصيد التي تصطاد فيها؟

① كثير ② بعض ③ قليل ④ لا يوجد

٢-٣. الصيد الغير مشروع و الغير قانوني هل يحدث في مناطق الصيد الخاصة بك في الأونة الأخيرة؟

① كثير ② بعض ③ قليل ④ لا يوجد

٢-٤. إذا كانت الإجابة بنعم، يرجى الوصف على وجه التحديد ما الصيد الغير المشروع الذي يحدث.

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٣. حجم الأسماك

٣-١. ما هو متوسط أطوال الجسم من الأسماك الرئيسيه التي يتم صيدها؟

(١) النوع: وقار طول الجسم: سم
(٢) النوع: شعور طول الجسم: سم
(٣) النوع: لوخر طول الجسم: سم

٣-٢. هل لديك لائحة تنظم وتحدد أطوال جسم الأسماك المسموح بها في عملية الصيد (أقل طول مسموح به) ؟

① نعم ② نعم، ولكن ليست فعالة جدا ③ لا

٤. تكاثر الاسماك والانجابية المحتملة

٤-١. متى تكون الفترة المسموحة والاساسية لصيد أنواع الأسماك الرئيسية لحرفة الصيد الخاصه بك وما هي النسبة لكل نوع في الصيد في تلك الفترة؟

(١) النوع: وطا الفترة (بالشهر): - من ٦ الي ٩ (٥٠٪ من الانتاج السنوي للمركب)
(٢) النوع: حصور الفترة (بالشهر): - من ٦ الي ٩ (٣٠٪ من الانتاج السنوي للمركب)
(٣) النوع: لوح الفترة (بالشهر): - من ٦ الي ٩ (٢٠٪ من الانتاج السنوي للمركب)

٤-٢. هل يوجد أسماك ناضجة جنسيا (بها بطروخ) في الصيد الخاص بك؟

① دائما ② أحيانا ③ لا يوجد

٤-٣. هل يتم منع الصيد (غلق المصيد او غلق موسم الصيد) خلال فترة وضع البيض للاسماك المستهدفة لحرفة الصيد؟

① نعم ② نعم، ولكن ليست فعالة جدا ③ لا يوجد

٥. البنية الوراثية

٥-١. هل تم إطلاق سراح او إنزال زريعة أسماك او اصبعيات من قبل في مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا أعرف

٥-٢. إذا كان الجواب نعم، أي نوع من أنواع الأسماك أطلق سراحه او انزل وما هي السنة؟

(١) النوع: الفترة (بالسنة):
(٢) النوع: الفترة (بالسنة):
(٣) النوع: الفترة (بالسنة):

٦. الصيد العرضي (أنواع الاسماك الأخرى التي يتم صيدها عن غير قصد حين اصطياد بعض الأنواع والاحجام المستهدفة).

٦-١. ما هي النسبة المئوية من الصيد العرضي في محصول الصيد الخاصة بك؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪
⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

٧. الصيد المرتجع (هي جزء من محصول الأسماك التي لا يتم الاحتفاظ به على المركب أثناء عمليات الصيد وتعاد إلى البحر حية او ميتة وغالبا ما تكون الأنواع غير قابلة للتسويق أو الأقل من الحد الأدنى لأحجام الانزال على الارض ولا يسمح بها القانون).

٧-١. ما هي النسبة المئوية من الصيد المرتجع في الحصاد الخاصة بك؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪
⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

٨. التنوع

٨-١. ما هو الاتجاه السائد (المشاهدة) في عدد أنواع الأسماك التي يتم صيدها خلال الخمس سنوات الأخيرة؟

① لا فرق ② زيادة ③ انخفاض ④ لا أعرف

٩. التلوث

٩-١. كيف يمكنك التعامل مع النفايات (أعقاب السجائر ونفايات معدات الصيد، وغيرها) خلال عملية الصيد؟

① الإلقاء في البحر (رميها في الماء) ② إحضارها إلى الأرض ③ كلاهما معا

٩-٢. هل هناك أي وضع بيض للأسماك أو حضانة للزريعة حول مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا أعرف

٩-٣. إذا كان الجواب نعم، كيف يمكن إجراء عمليات الصيد؟

① لا فرق ② عملية الصيد تكون بحرص وعناية لتجنب التدمير أو التلوث

٩-٤. في الآونة الأخيرة، هل هناك أي حادث تسريب للنفط في مناطق الصيد الخاصة بك؟

① نعم ② لا ③ لا أعرف

٩-٥ إذا كان الجواب نعم، متى حدث ذلك؟

(السنة:)

١٠. استخدام معدات صيد الأسماك

١٠-١. كم عدد معدات الصيد التي لديك؟ وما هي الكمية؟

(١) معدات الصيد : الكمية: عرض / عدد

(٢) معدات الصيد: الكمية: عرض / عدد

(٣) معدات الصيد: الكمية: عرض / عدد

١٠-٢. كم عدد معدات الصيد التي تستخدمها لكل وحدة عملية الصيد (في المرة الواحدة) ؟

(العرض / عدد)

١٠-٣. كم من الوقت (بالساعة) يستغرق لتثبيت الشباك والعتاد؟

(ساعات)

١٠-٤. ما هو معدل فقدان معدات الصيد الخاصة بك (الشباك وغيرها) لكل وحدة عملية الصيد (في المرة الواحدة) ؟

① أكثر من ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪

⑤ ٢٠ ~ ٤٠٪ ⑥ ٥ ~ ٢٠٪ ⑦ أقل من ٥٪

١٠-٥. كم يوما أنت تجري عملية الصيد الخاصة بك في شهر واحد (بتصطاد كم يوم في الشهر)؟

(يوم)/ شهر

١١. الدخل

١١-١. ما هو دخلك السنوي؟

(بالالف جنيه مصري ٥٠ الف جنيه)

١١-٢. ما هو الاتجاه السائد (المعدل) من دخلك خلال الخمس سنوات الأخيرة؟

① زيادة ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪ ⑤ ٢٠ ~ ٤٠٪
⑥ ٥ ~ ٢٠٪ ⑦ زيادة بنسبة ٥٪

⑧ انخفاض ٩٥٪ ⑨ ٨٠ ~ ٩٥٪ ⑩ ٦٠ ~ ٨٠٪ ⑪ ٤٠ ~ ٦٠٪ ⑫ ٢٠ ~ ٤٠٪
⑬ ٥ ~ ٢٠٪ ⑭ انخفاض ٥٪

١١-٣. ما هي النسبة المئوية من دخلك الشهري مقارنة بالحد الادنى للاجور (حوالي ١٠٠٠ جنيه مصري) خلال الخمس سنوات الأخيرة؟(مثال ٢١٠% أو اكثر أو أقل).

(٪)

١٢. تكلفة عملية الصيد

١٢-١. ما هو الاتجاه السائد (المعدل) من تكلفة الصيد السنوي الخاص بك خلال الخمس سنوات الأخيرة؟

① زيادة ٩٥٪ ② ٨٠ ~ ٩٥٪ ③ ٦٠ ~ ٨٠٪ ④ ٤٠ ~ ٦٠٪
⑤ ٢٠ ~ ٤٠٪ ⑥ ٥ ~ ٢٠٪ ⑦ زيادة بنسبة ٥٪

⑧ انخفاض ٩٥٪ ⑨ ٨٠ ~ ٩٥٪ ⑩ ٦٠ ~ ٨٠٪ ⑪ ٤٠ ~ ٦٠٪
⑫ ٢٠ ~ ٤٠٪ ⑬ ٥ ~ ٢٠٪ ⑭ انخفاض ٥٪

١٣. العمالة

١٣-١. كم عدد الأشخاص الذين يعملون على مركب الصيد الخاص بك؟

(عدد: ١٥)

١٣-٢. ما هو الاتجاه السائد (المعدل) في عدد الصيادين على سفينة الصيد الخاصة بك؟

①حدث زيادة (٪) ② لا تغييرات في عددهم ③ حدث نقص (٪)

١٤. تأثير حرفة الصيد الخاصة بك على البيئة البحرية ونسبة التعافي خلال السنوات الاخيرة؟

الشعاب المرجانية ① ضار (%) ② معتدل التأثير والتعافي جيد (%) ③ لا يوجد اي تأثير

الحشائش والاعشاب البحرية ① ضار (%) ② معتدل التأثير والتعافي جيد (%) ③ لا يوجد اي تأثير