

Full Length Research Paper

Maximum sustainable yield, swept area and biomass of some biota from the Southern trawlable areas, Red Sea, Sudan

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Recently no proper study on stock assessment has been done in Sudanese Red coast. Estimated of marine potential ranges between 10000 to 35 000 tones and the annual production are around 8000 tons. The Maximum Sustainable Yield and the a swept area of the trawling area for the bulk of seven categories (*Saurida undosquamis*, *Nemipterus japonicas*, *Mulloides flavolineatus*, Shrimp, Squid, Discard, and Other Commercial fishes) had been estimate. The maximum catch is high in Discard (3071.0 tons), while the high optimum efforts appear for Squids (766 days). The lower maximum catches for Squids (34.0 tons), and the lower effort for *N. japonicas* (95 days). The maximum catch for the seven fishes categories were 4593 tons. Maximum area swept by the trawler was in year 2004 (784.0 km²) and the lowest for the year 1984 (20.0 km²). The higher biomass estimated in year 2004 (32521 kg/km²), and the lowest in year 2002 (1224 kg/km²). The Potential yield due to reach the optimum annually point in year 2005 (1830 tons). Study indicates that from 1984 to 2008 the annual catch increased with increased effort. This means that more effort can be used to obtain more catch.

Keywords: stock assessment, trawling, maximum catch, optimum effort, discard.

INTRODUCTION

Sudan Red Sea fisheries are artisanal, coastal, semi-industrial and industrial (trawling). Both artisanal and semi industrial are small scale fisheries performed with Huris (4 m), mechanized and non- mechanized (sailing) Felukas (6-8m). This is because fishing is performed in the shallow boat channel or at the fringing reef next to boat channel. Both areas are only few kms from the coast. In some cases launches could fish in deep channel zone (next to fringing reef which varied in depth from 40-200 fathoms. As artisanal and semi-artisanal fisheries is confined to close -by fishing grounds and not very deep waters (known as the Sudan shelf area zone), handlining, shallow water seines, gill nets and terminal nets, trolling and cast nets are the main fishing methods employed (Mishrigi *et al.*, 1993). The exploitable area of Sudan's shelf is 9800 km², of which only about 800 km² are deep waters, flat bottomed suitable for trawling (Mishrigi *et al.*, 1993). The rest, 9000 km², are solely artisanal fisheries grounds. No proper study on marine

stock assessment has been done in Sudan. It is estimated that the Sudanese marine potential ranges between 10000 (ODA, 1983) to 35 000 tones (FAO, 1985). The annual production is estimated 8000 (El naiem and Elawad 2008). PERSGA (2001) reported 14000 tones. Survey of Branford, 1980, have identified 700 km² of potential trawlable grounds off Delta Tokar and 422 km² to the south of Dongonab Bay in the north. The rest of the Sudanese Red Sea coast is coral and is unsuitable for bottom trawling. Of the trawlable ground in the South about 60km² are in Mersa Maqdam and off Trinkitat, about 92 km² in the Gulf of Agig, about 5 km² in Khor Nawarat and about 50 km² off the Tokar Delta. In these areas the sea bed is muddy and slopes gently from the coastline to depths of 30 to 40 m. The northern trawlable area in Dongnab bay is a small area approximately 3 km². The other are approximately 10 km² north of Sararat Island (Mishrigi *et al.*, 1993). The objectives of this paper are:

18. Glob. Res. J. Fish. Sci. Aquacult.

1. To give a real estimate of maximum catch and effort for (*Saurida undosquamis*, *Nemipterus japonicus*, *Mulloides flavolineatus*, Shrimp, Squid, Discard, and Other Commercial fishes).
2. To estimate the swept area in the trawling area of Sudan.

MATERIAL AND METHOD

The study area

The study area is a trawling ground extending from Marsa Heduib (longitude 37° 44' N 18° 52' E) to Rass Kassar (38° 25' L and 18° 1', E). The trawling is concentrated around Tala-Tala Sagir and Kabir 165 km south of Port Sudan (the Southern Area). The area is enriched by huge Khours carrying in fluvial from the Red Sea Hills. These are Ashat, Seatrab, Barka and Norat. They carry sediments that build the bed of the Southern Area. The Southern Area contains more than 15 islands. The famous ones are Magadam and Tala – Tala. The main Marsas there are Heduib, Sheakh Ibrahim, Sheakh Saad, Ashat and Trinkitat. The main boats used here are trawling vessels and boats with in board and out board engines. The area is flat enough to support trawling operations. This area is part of the continental shelf. The maximum width reaches 1200 m.

Estimation of maximum sustainable yield using surplus production model

The entire stock, fishing effort and total yield obtained from the stock. They are often referred to were calculated following Finlay (1935) also referred to as "Schaefer-models".

The Schaefer model

The maximum sustainable yields (MSY) for shrimps, squids and other commercial Fishes, and discard in the trawling area were estimated by Schaefer (1954) model uses the input data (the annual catch for the years 1983 to 2008) for the categories of the catch.

$f(i)$ = effort in year i , $i = 1, 2, \dots, n$.

Y/f = Yield (catch in weight) per unit of effort in year i .

Y/f may be derived from the yield, $Y(i)$, of year i for the entire fishery and the corresponding effort, $f(i)$, by

$Y/f = Y(i)/f(i)$, $i = 1, 2, \dots, n$

Or by direct observations on the basis of samples from the fishery.

The simplest way of expressing yield per unit of effort, Y/f , as a function of the effort, f , is the linear model suggested by Schaefer (1954):

$Y(i)/f(i) = a + b*f(i)$ if $f(i) \leq -a/b$

The slope, b , must be negative if the catch per unit of effort, f , decreases for increasing effort, f . The intercept, a , is the Y/f value obtained just after the first boat fishes on the stock for the first time. The intercept therefore must be positive. Thus, $-a/b$ is positive and Y/f is zero for $f = -a/b$. since a negative value of catch per unit of effort Y/f is absurd.

The equation of Schaefer model for the M S Y was:

$MSY = -0.25*a^2/b$

Effort of MSY = $-0.5*a/b$

The swept area

During 1984 to 2005 about 111 Egyptian trawlers worked in the Southern Area. The trawl sweeps a well defined path, the area (the length of the path times the width of the trawl net), called the "swept area" or the "effective path swept". The swept area, a , was estimated following Per Sparre, (1992):

$$a = D*h*X_2, \quad D = V*t$$

Where:

V = is the velocity of the trawl over the fishing ground when trawling, usually equals 8.9 km/hr

h = is the length of the head-rope (m) equal 10 m.

t = is the time spent trawling.

X_2 = is that fraction of the head-rope length, h , which is equal to the width of the path swept by the trawl, the "wing spread", $h*X_2$ equal 0.5.

Biomass estimation by the swept area

Let C_w be the catch in weight of a haul. Then C_w/t is the catch in weight per hour, when t is the time spent hauling. Let (a) be the area swept. Then a/t is the area swept per hour, and:

$C_w/t/a/t = C_w/a$ kg/nm² catch of haul per unit area.

Becomes the catch in weight per unit of area. Let X_1 be the fraction of the biomass in the effective path swept by the trawl which is actually retained in the gear and let C_w/a be the mean catch per unit area of all hauls. Then an estimate of the average biomass per unit area, b , is:

$b = (C_w/a)/X_1$ kg/nm²

Let A nm² be the total size of the area under investigation. Then an estimate of the total biomass, B , in this area, A , is obtained from:

$B = (C_w/a)*A/X_1$

RESULTS

Maximum sustainable yield and effort

The correlation between effort and catch per unit effort was highly significant ($p < 0.001$) in all fish categories except for shrimp and discard (Table 1). From Table 2 it

Table 1: The linear model suggested by Schaefer (1954) and the values of the intercept (a) and the slope (b) for the seven group studies.

| Group | Model | a | b | R ² |
|-------------------------|-----------------------|------|--------|----------------|
| <i>S. undosquamis</i> | Y/f=1.517441-0.00145f | 1.6 | -0.001 | 0.5105 |
| <i>N. japonicas</i> | Y/f=-9.894+0.052014f | -9.9 | 0.05 | 0.5537 |
| <i>M. flavolineatus</i> | Y/f=0.8-0.001f | 0.80 | -0.001 | 0.5941 |
| Shrimp | Y/f=1.194-0.002f | 1.2 | -0.002 | 0.1948 |
| Squid | Y/f= 0.0089-0.0058f | 0.01 | -0.006 | 0.585 |
| Other fishes | Y/f=1.8885-0.003f | 1.9 | -0.003 | 0.5253 |
| Discard fishes | Y/f=21.3487-0.03709f | 21.3 | -0.04 | 0.4973 |

Table 2: The Maximum Sustainable Yield ($-0.25*a^2/b$) and the optimum effort for the 7 groups studied.

| Group | Maximum catch(tons) MSY | Optimum effort (days) |
|-------------------------|-------------------------|-----------------------|
| <i>S. undosquamis</i> | 396.0 | 523.0 |
| <i>N. japonicas</i> | 470.0 | 95.0 |
| <i>M. flavolineatus</i> | 146.0 | 372.0 |
| Shrimp sp | 177.0 | 296.0 |
| Squid sp | 34.0 | 766.0 |
| Other fishes | 299.0 | 317.0 |
| Discard fishes | 3071.0 | 287.0 |
| Sum | 4593 | |

appears that the maximum catch (tons) and optimum effort (days) differ from one fish species to the other. The maximum catch is high in discard (3071.0 tons) and *N. japonicas*. While the high optimum effort appear for Squids (766 days) and *S. undosquamis* (523 days). The lower maximum catches for squids (34.0 tons) and shrimps (177 tons), and the lower effort for *N. japonicas* (95 days) and Discard (287 days). The summation of the maximum catch for the fish was 4593 tons.

Swept area by trawlers, maximum sustainable yield and potential yield

From table 3 it is appear that the maximum area swept by the trawler was in the year 2004 (784.0 km²) and The lowest swept area was recorded for the year 1984 (20.0 km²). The higher biomass estimated in year 2004 (32521 kg/km²), and the lowest was in the year 2002 (1224 kg/km²). The maximum sustainable yield for the fishing and catch from trawling area was in the year 2005 (1830 tons).

Dissection

When describing the dynamics of an exploited aquatic resource, a fundamental concept is that of the "stock" or the maximum sustainable yield (MSY). A stock is a sub-

set of a "species" which is generally considered as the basic taxonomic unit (Per Sparre, (1992). This paper described dynamic of the availability of the trawling fishery in the southern area using the holistic models in instead of analytical models as recommended by Per Sparre, (1992) and (Gulland, 1985). MSY and corresponding efforts this is indicated that the resource is under exploited, because the actual annual catches for each of the seven major categories during the years 1984- 2005 do not exceed predicted MSY. The potential yield (MSY) estimated for the whole fishes categories were under the annual catch record. The same finding of was reported by ODA Project 1983 (10000 tons) and FAO/UNDP Regional Project 1979-1985 (35000 tons). However, those estimates were not based on catch effort data covering many years. Chance to increase the maximum sustainable yield was possible, because this study indicates that from 1984 to 2008 the annual catch increased with increased effort This means that more effort can be used to obtain more catch.. This is accord with Ross (1979). The present record annual yields of only 6000 to 8000 tons. In the present study the swept area and biomass were determined for all seasons from 1984 to 2005 (Table 3). The areas swept differ from season to another, depending on the number of operating vessels and the number of operation days. During 1984 to 2005 about

Table 3: The area swept by trawlers in Southern Area during 1984 to 2005, the biomass and MSY

| Year | Number of vessels | Swept area(km ²) | Biomass (kg/km ²) | Potential yield (MSY) tones |
|---------|-------------------|------------------------------|-------------------------------|-----------------------------|
| 1984 | 2 | 20 | 2098 | 839 |
| 1991 | 3 | 31 | 2738 | 1095 |
| 1998 | 13 | 283 | 2412 | 965 |
| 1999 | 11 | 360 | 1972 | 788 |
| 2000 | 2 | 214 | 2270 | 908 |
| 2002 | 12 | 482 | 1224 | 489 |
| 2003 | 18 | 395 | 2532 | 1013 |
| 2004 | 31 | 784* | 32521 | 1301 |
| 2005 | 11 | 222 | 4576 | 1830 |
| Average | | | 5815 | 1025 |

111 Egyptian trawlers worked in the Southern Area. The area swept by all trawlers during this period was 2592 km², the maximum area swept was 784 km² in 2004 when a large number of trawlers (31 vessel) were operating. These estimate (784km²) is close to the area estimated by Branford 1984 (710 km² and Mishirgi et al, 1993 (800 km²). Generally Stocks and MSY obtained in the present study must be considered preliminary and need further future verification. It is recommend that Discard should be used as ingredient in fish and poultry feeds. Selective gears that can avoid catching discards may be used to reduce its amount.

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