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THE STOCK ASSESSMENT OF THE KENYAN
DEMERSAL OFFSHORE RESOURCES, SURVEYED
IN THE PERIOD 1979-1980-1981.

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Summary.

From February 1979 until June 1981 the trawler "R/V UJUZU" surveyed the offshore Kenyan waters. The results of this vessel, supplemented by the results of three other trawlers, have been used for this stock assessment. The method used is the "swept-area method". A three-level stratification has been applied to all data (twelve fishing-grounds, two monsoon-periods, fifteen groups of species).

For the total trawlable surface of 3234 nm² (see charts 3 and 2), the total standing stock amounts to approximately 33,000 ton, the maximum sustainable yield is approximately 9,000 ton (the totals of table 4 plus the "KUSI-area" plus the "WESTYATSEW-area"). About half of these quantities consists of small fishes without any commercial value. The densities vary from 4.5 ton/nm² ("WESTYATSEW-area") to 25.2 ton/nm² (stratum I). The results show further that, compared with other parts of the world, the productivity of the offshore demersal resources of Kenya is very low.

A simple feasibility-study for each defined sub-area is added, showing that offshore trawling in Kenya is not profitable.

1. Introduction.

One of the objectives of project KEM/74/023 was to survey the offshore waters off Kenya and gather information about composition, distribution and magnitude of the fishery resources. This report will try to give a quantitative analysis of the trawlable resources, which have been surveyed by the project's vessel "R/V UJUZU" from February 1979 until June 1981.

To supplement the results of this survey, the findings of the research vessel "DR. FRIDTJOF NANSSEN" have been incorporated in the stock assessment. This vessel visited the Kenyan waters in 1980 during the month of December.

Furthermore, some additional data collected by the survey vessel "PROFESSOR MESYATSEV" (irregular sampling from December 1975 to November 1977) and the commercial trawler "M/V KUSTI" (January 1978 - March 1979) have been used.

2. Description of the area (see chart 1).

The Kenyan waters can be divided roughly into four parts; 1) the North Kenya Bank, 2) the area off Ungama Bay, 3) the Malindi Bank and 4) the area between the Malindi Bank and Pemba Island.

The North Kenya Bank has a hard bottom, mostly corals. Great numbers of large sponges do occur, and here the big commercial fishes like Lutjanidae, Pomadasysidae, Lethrinidae and Serranidae can be found.

Off Ungama Bay, the situation is more complex. A rather narrow strip is formed by the 10 to 100 fathoms depth lines. The southern part of this strip is under the influence of the Sabaki river, especially during rainy periods. The yellow/brown coloured water of this river, mixed with the seawater, flows to the north (due to the East African Coastal Current) and can be seen up to Ras Ngomeni. The bottom of the narrow strip off Ungama Bay consists mostly of sand, the characteristic fishes of this area are the semi-pelagic and pelagic species like *Leiognathus*, *Gerrus* and *Caranxoides* in the southern part and sharks and rays in the northern part. The deeper waters off Ungama Bay have a more muddy bottom, where lobsters and shrimps can be caught.

South of Malindi is the Malindi Bank, of which very little is known, except that it is almost completely untrawlable.

The area between Malindi Bank and Pemba Island has a very steep depth-gradient near the coast. The bottom is sometimes rocky, but most of it is mud. Deeper than 100 fathoms small amounts of non-commercial deep-sea fishes occur. Only near Pemba Island some shrimps can be caught.

3. The wind.

Two monsoon-periods can be distinguished, the southeast monsoon (March till October) and the northeast monsoon (November - February).

The wind-force during the northeast monsoon is usually less than during the southeast monsoon. During every haul "R/V UJUZU" made, the direction and strength of the wind was measured. The results are shown in figure 1.

4. The currents.

The main current off the coast of Kenya is the East African Coastal Current, which flows northwards. During the southeast monsoon, the wind reinforces the current and gives the water a speed up to 5 knots. During the northeast monsoon the wind is against the current and in the northern part of Kenya a southward flowing stream appears, the so-called Somalian Current. This current reaches in the end of the northeast monsoon (February) to the area off Malindi. South of Malindi the current remains to flow northwards. There are a few places where some turbulence is present throughout the year; near Pemba Island, near Malindi (off Sabaki river) and in the northern part of the deeper waters off Ungama Bay.

For a more detailed description of the currents, see anon. (1981 d).

5. The data.

For the stock assessment, the following records have been used:

- 1) "R/V UJUZU": haul record and catch record (see annex 1)
- 2) "DR. FRIDRICH NANSSEN": catch record (see annex 2).

6. General description of the method used.

The usual technique for the estimation of potential yield is the analysis of the data of catch and effort of commercial trawling. These data are not present in Kenya, so the data of exploratory fishing vessels have been used. With this, a rough estimate of the biomass of fishes that

can be caught by trawling, can be made. With some knowledge about the biological and ecological characteristics of the species it is possible to give an estimate of the yearly production that can be obtained from that biomass, without the risk of the depletion of the stock.

6.1 Calculation of biomass.

The result of a haul is considered to be representative for the biomass of fishes, present in the volume of water that passes the net. Therefore it is necessary to know the vertical and horizontal opening of the net and the distance covered by the net during the time of the haul.

But the distribution of the fishes on the bottom is not homogeneous; the fishes are more or less grouped into schools. Repetition of hauls under the same conditions in the same area gives results which are very different.

In order to cope with this heterogeneous distribution, a number of hauls should be made at random in an area, which is supposed to be more or less homogeneous. In practice it is generally assumed that in each homogeneous area at least thirty hauls are necessary (Saville, 1977). For each haul, the density of fishes can be calculated in kilogrammes per square nautical mile (kg/nm^2). The mean of all these densities gives an estimate of the density of the population with ⁱⁿ the homogeneous area. Thus the estimation of the trawlable biomass of a homogeneous area is the product of the mean density by the trawlable surface of that area.

6.2 Calculation of potential yield.

The trawlable fish resources in the deeper waters have not been exploited so far, except by two large trawlers: "M/V KUSTI" (during one year in a very restricted area) and the "AEGINA" (during five weeks in another very restricted area). Therefore the stock can be considered as virgin. It has been demonstrated and proved by experience that, as a first approach, the relation between the biomass of a virgin stock (B_0) and the maximum sustainable yield (MSY) can be very simply translated by the formula: $\text{MSY} = 0.5 \cdot B_0 \cdot M$ where M stands for the natural mortality rate of the stock.

7. Detailed description of the method used.

7.1 Definition of trawlable areas.

First of all, the trawlable and non-trawlable grounds have been defined. For this, data of "DR. FRIDRICH NANSSEN", the data of "R/V UJUZT" and the experience of the staff of the project have been used. The result is plotted on chart 2. A criterion for the definition of the trawlable grounds the capacity of "R/V UJUZT" with the available gears has been taken.

7.2 Three level stratification.

(This applies to the data of "R/V UJUZT" and of "DR. FRIDRICH NANSSEN", some results of the "W/V KUST" and the "PROFESSOR NESTLERSIV" are presented separate in chapter 9 and chapter 10 respectively).

- It was necessary to make a three level stratification because of:
- the heterogeneity of the grounds (coral, sand mud; hard, soft; even, uneven) and the heterogeneity in density of observations
 - the heterogeneity of the seasons (NE and SE monsoon)
 - the heterogeneity of the species composition in the catches.

7.2.1 The homogeneous areas (species composition, environmental conditions) have been defined. The result is shown on chart 3, descriptions of the defined areas are listed below.

North Kenya Bank: North boundary: $01^{\circ} 39'$ South. The area is enclosed by the 10 and 100 fathoms depth lines. In the south, between the 10 and 20 fathoms depth lines, the boarder has been defined $02^{\circ} 36'$ South, rectangular on the depth gradient. Between 20 and 100 fathoms the boarder is $02^{\circ} 48'$ South, rectangular on the depth gradient.

Stratum I: Is situated between the 10 and 100 fathoms depth lines. The boundaries in the north are as described above. In the south between 10 and 20 fathoms, the area ends at $03^{\circ} 04'$ South (rectangular on the depth-gradient) and between 20 and 100 fathoms at $03^{\circ} 01'$ South, rectangular on the depth-gradient.

Stratum II: Between 10 and 20 fathoms; northern boundary described above, south-boundary $03^{\circ} 13'$ South, rectangular on the depth-gradient.

Stratum III: Between 20 and 100 fathoms; north-boundary described in stratum I, south-boundary $03^{\circ} 15'$ South, rectangular on the depth-gradient.

Stratum IV: In the northeast the boundary is the 100 fathoms depth line. The northern point is at $02^{\circ} 47'$ South, the southern point at $03^{\circ} 00'$ South, the western point at $40^{\circ} 25'$ East, the two eastern points at $40^{\circ} 34'$ East.

Stratum V: Between the 100 and 200 fathoms lines; in the north the boundary is the North Kenya Bank and the line on $40^{\circ} 46'$ East.

In the South the boarder is $03^{\circ} 26'$ and the line from $03^{\circ} 16'$ South $40^{\circ} 13'$ East to $03^{\circ} 26'$ South $40^{\circ} 16' 5''$ East. This area does not include stratum IV. Furthermore a part of the "KUSI-area" (description below) has to be deducted.

"KUSI-area": A rectangle, the four corners are:

$03^{\circ} 04'$ S	$40^{\circ} 31'$ E
$03^{\circ} 05'$ S	$40^{\circ} 34'$ E
$03^{\circ} 17' 5''$ S	$40^{\circ} 26' 5''$ E
$03^{\circ} 18' 5''$ S	$40^{\circ} 29' 5''$ E

Stratum VI: The boundaries in the northeast are the 200 fathoms line and the "KUSI-area". In the East the line $40^{\circ} 46'$, in the South $03^{\circ} 26'$.

Malindi Bank: In the north the boarders are as described in II, III and V. In the west the boundary is the 10 fathoms line, in the east $40^{\circ} 17'$ East. In the south the $03^{\circ} 43'$ line and the line $03^{\circ} 22'$ $40^{\circ} 02'$ and $03^{\circ} 43'$ $40^{\circ} 11'$.

Malindi Bank - Pemba Island: Boundaries in the north; described above. In the west the 10 fathoms - line. In the east the line between $03^{\circ} 43'$ $40^{\circ} 11'$ and $04^{\circ} 42'$ $39^{\circ} 48'$. In the south the line on $04^{\circ} 42'$. From this area a part should be deducted, that is the part taken by 'Pemba Island', see below.

Pemba Island: Defined by the four points:

04° 36' S	39° 39' 5" E
04° 36' S	39° 54' E
04° 42' S	39° 36' E
04° 42' S	39° 54' E

"WESTYANGJEW-area": Defined by the four points:

04° 42' S	39° 36' E
04° 42' S	39° 54' E
04° 47' S	39° 32' 5" E
04° 47' S	39° 54' E

7.2.2 All the data have been split into two groups; those collected during the southeast monsoon, and those collected during the northeast monsoon (for the definitions of the monsoons, see figure1).

7.2.3 Because of the large heterogeneity of the fishes caught, it was practically impossible to calculate the biomass and potential yield for every single species. Therefore the fishes have been grouped into fifteen categories, taking into account their economic value as well as their estimated natural mortality rate (see annex 4). The latter should be more or less equal for each species within each group, as the calculation of the maximum sustainable yield uses this natural mortality rate.

7.3 Swept areas.

For each separate haul, the area swept by the net was calculated ("Working sheet no. 1", see annex 5). The swept area is the product of the distance covered by the net on the bottom and the distance between the wings. For "R/V UJUZI", the latter has been provided by the captain, the former has been extracted from the haul records in three different ways, in order of preference and with a percentage, indicating how often it has been applied:

- 1) Calculated from start and end position of the ship (49%)
- or 2) Copied from the haul records (18%)

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- or 3) Calculated by vector analysis from the captain's
- observation of the direction of the vessel and
 - estimation of the speed of the vessel through the water and
 - estimation of the direction of the current and
 - estimation of the speed of the current and
 - observation of the duration of the haul (33%)

For "DR. FRIDTJOF NANSEN", there were no data on the wingspread of the net available. But the "R/V UJUZI" and "DR. FRIDTJOF NANSEN" carried out "comparative fishing", and the calculated correction factor for

"DR. FRIDTJOF NANSEN" (see 7.5) has been based on the assumption that the wingspread of the net of "DR. FRIDTJOF NANSEN" was equal to that of the High Opening Fish cum Shrimp trawl of "R/V UJUZI", that is 0.0091 nm.

7.4 The use of different nets.

"R/V UJUZI" has used several nets, the High Opening Fish cum Shrimp trawl (HOFS), the Lobster trawl, the Balloon trawl and the Beam trawl.

The results of the Beam trawl have not been incorporated in this report for three main reasons:

- this trawl has only been used during two trips
- compared with the Balloon trawl, the HOFS and the Lobster trawl, the rigging of the Beam trawl was very different
- for unknown reasons, the catches of the Beam trawl have always been very poor (the polishing of the shoes indicated that the trawl was working properly).

As the mesh-sizes of the three remaining nets differed from each other and the size of the nets also, there was need for a correction of the results of these three nets. Because of the availability of only one vessel, "comparative fishing" could not be carried out. To solve this problem, the three nets have been compared two by two. The comparison between HOFS and the Lobster trawl is given in table 1. For each stratum and for each type of net, the total area swept and total catch is given.

With these figures, an average density has been calculated, without the use

of any correction factor: density (kg/nm^2) = $\frac{\text{catch (kg)}}{\text{area swept (nm}^2\text{)}}$.

The quotient of each pair of densities gives as result, the number of times one net catches more than the other. Because the number of hauls that were made in each stratum vary, an "overall mean correction-factor" for HOFs/Lobster has been calculated by giving each factor per stratum a certain "weight", that is the lowest number of hauls made in that stratum by one type of net. The result of HOFs/Lobster is 2.4/1. Similar tables for HOFs/Balloon and Lobster/Balloon gave respectively 7.7/1 and 2.5/1. The correction-factor for HOFs/Lobster seemed to be appropriate, as the Lobster trawl has a wider mesh-size in the cod-end and as it is smaller than the HOFs. But the poor results of the Balloon trawl are strange, as the Balloon trawl has more or less the same size as the HOFs. An explanation for this could be that the Balloon trawl (always used with bobbins) was too heavy for "R/V UJUZI", an assumption also made by the captain. For those reasons, the results of the Balloon trawl have not been used in this report.

7.5 Comparative fishing between "R/V UJUZI" and "DR. FRIDTJOF NANSEN".

The two vessels have done 7 hauls side by side. The results, grouped into the 15 groups of species, are shown in table 3. Because of lack of data on the wingspread of the bottom trawl of "DR. FRIDTJOF NANSEN" the net used by "DR. FRIDTJOF NANSEN" was assumed to be similar to that of "R/V UJUZI", and linear regression was applied on the catches of both vessels. This means that any difference between the nets is already incorporated in the correction factors found. Viewing the results, an overall correction factor of 1.2 has been applied for the results of "DR. FRIDTJOF NANSEN".

7.6 Calculation of densities.

For each stratum, "Working sheet no. 2" (see annex 6) has been completed. The swept surface has been taken from "Working sheet no. 1". The correction factors for the Lobster trawl and the trawl of "DR. FRIDTJOF NANSEN" have been calculated in 7.4 and 7.5.

Each catch has been divided into the 15 groups of species. For each group the density has been calculated:

$$\frac{\text{catch (kg)} \times \text{correction factor}}{\text{swept surface (nm}^2\text{)}} = \text{density (kg/nm}^2\text{)}.$$

For this calculation, the efficiency of the net has been assumed to be 100%. Some factors that can influence this percentage are:

- herding by the bridles (overestimation)
- herding by the wings not 100%, fishes escape the net, fishes are distributed above the headline, fishes are hurried in the bottom, selection by the mesh-size in the cod-end (underestimation).

7.7 Calculation of biomass.

For each group of species, "Working sheet no. 3" (see annex 7) has been completed.

The trawlable surface of each stratum has been defined by drawing the area on chalkpaper, cutting and weighing this. Comparison with the weight of a 'standard-piece' of chalkpaper revealed the surface. The total and trawlable surfaces of each stratum are listed in table 3.

The total number of hauls, the average density and the confidence limits have been calculated from the data on "Working sheet no. 2", according to the formula:

$$\bar{x} \pm \frac{(\bar{x}-\bar{x})^2}{n-1} \cdot t \quad (\text{Saville, 1977}),$$

where n stands for the number of hauls

x stands for the density per haul

\bar{x} stands for the mean density per stratum

t stands for the student's value

(95% confidence limits, the number of degrees of freedom is n-1).

The confidence limits have been expressed as a percentage of the mean density. The mean density and the trawlable surface give the estimated biomass per stratum (expressed in metric tons), while the calculated confidence limits and biomass give the minimum and maximum estimates of that biomass.

7.8 Calculation of maximum sustainable yield (MSY).

According to the formula $MSY = 0.5 \cdot B_0 \cdot W$ (see 6.2) the MSY has been calculated for each stratum for each group of species (see table 4). The biomass has been copied from "Working sheet no. 3", and for each group of species a natural mortality rate was estimated. In the calculation the mean of the two values listed in table 5 has been applied.

For the strata III and IV, the data collected during the two main seasons have been processed. The results are significantly higher for the southeast monsoon data. In the absence of any other hypothesis, this fact has been attributed to a difference of availability of the fish to the trawl. So, the data collected during the SE monsoon have been taken into consideration in order to approach better the real situation.

8. Limitations.

In part 6.1 it was mentioned that, in order to obtain an accurate estimation of the biomass, a number of hauls should be made at random within each homogeneous area. In this survey the distribution of the hauls is not at random.

Certain area's in which it was easy to fish or had a high density have been over-sampled, (especially stratum III) whereas in others the density of hauls is very low. In particular the strata I and VI and "Pemba Island" have not enough hauls to give a precise estimation of the biomass. Furthermore, certain (non-trawlable) areas could not be investigated. Also it was impossible to calculate for each stratum the biomass in both the southeast and northeast monsoon, due to lack of hauls in these areas.

The wingspread of the net was not recorded in 24% of the hauls.

In these cases, a mean value of wingspread had to be applied:

Type of net	Wingspread (mm.)
Lobster trawl	0.0077
HQFS (1979)	0,0106
HQFS (1980)	0.0091
HQFS (1981)	0.0087

As the wingspread depends on the speed of the net through the water, which was varying considerably due to the changing currents, this can cause some inaccuracy.

The distance covered by the net over the bottom had to be calculated in 33% of all hauls from the estimated/observed directions and speeds of the vessel and the current, and the duration of ^{the} haul. The calculations with these estimations are not as precise as when the distance covered was measured by using radar and recorded during the haul and/or could be calculated from the recorded start- and endposition of the vessel (also by using radar).

The comparison between the HOFBS and Lobster trawl had to be done in an unusual way. It would have been better to compare the results of both nets for each different group, like it was done for "DR. FRIDTJOF NANSEMN" versus "R/V UTUZI", This because the HOFBS is a much higher net than the Lobster trawl so that for example the ^{for} semi-pelagic fishes (= "small commercial fishes") a different correction-factor is likely to be found than for small demersal fishes (= "small non-commercial fishes"). But the results of this detailed comparison were not satisfying: HOFBS/ Lobster gave for small demersal fishes 3.6/1, whilst for small semi-pelagic fishes 2.0/1 was found.

The biomass has been calculated based on the trawlable grounds, which are flat in comparison with the non-trawlable areas. It is very likely that the composition and density of fishes in the non-trawlable areas differ from those in the trawlable areas, so in order to get the biomass for the total area, the estimated biomass for trawlable areas can not simply be raised by the quotient total area/trawlable area.

The lumping of all fish-species into 15 groups was inevitable but as a result the calculation of the MSY's had to be based on more or less rough estimates of the natural mortality rates for each group as a whole.

9. The "KUSI-area".

The "KUSI", a 40m large trawler, tried to operate off the Kenyan coast on a commercial base for the period of one year. In "voyage 13" the "KUSI" discovered what in this report is called the "KUSI-area". The last three voyages of the "KUSI" (15, 16 and 17) went again to this area.

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The results of these cruises are listed below.

Trip no.	Period	Type of net	No. of hauls	Mean density prawns (kg/nm ²)	Mean density lobster (kg/nm ²)
15	NE monsoon	Shrimp Bottom Trawl	29	720	244
16	NE monsoon	Beam Trawl	22	3362	-
17	SE monsoon	Beam Trawl	27	5540	-

For the calculation of the densities the data in the logbook of the captain have been used (annex 3). The wingspread of the Shrimp Bottom Trawl has been estimated from the contraction of the trawl (0.0023nm). The total "wingspread" of the two Beam Trawls was $2 \times 10.5 = 21$ meters (0.011nm). The results are a bit strange, especially the differences between the results of the Shrimp Bottom Trawl and the Beam Trawls. The calculated biomass and MSY are listed below:

	Mean density (ton/nm ²)	Biomass (ton)	MSY (ton)
Prawns	3.2	144	108
Lobster	0.1	5	2
Total	3.3	149	110

The "KUSTI" could only operate with great losses (de Boer and Hoogenraad, 1979). Only the last trip (of which the high density of 5.5 ton shrimps/nm² has been derived) made some profit. The area is just like stratum IV with its lobsters, very small (45nm²) and fishing without the depletion of the stock will only be possible for a very limited period.

10. The "MESYATSEV - area".

The vessel made 9 hauls north of Pamba Island, here called "MESYATSEV-area". The trawl that the "PROFESSOR MESYATSEV" used had a wingspread of 16.4 meters, 0.0089nm. The mean catch per mile trawled was 40 kg, thus the density is 4494 kg/nm². As the trawlable surface of the

"MESYATSEW-area" is 76m^2 , the biomass amounts to 342 ton. If we assume that the catch composition of "Pemba Island" equals that of the "MESYATSEW-area", the relation between biomass and MSY of "Pemba Island" (table 4) can be applied: $\text{MSY} = 342 \times \frac{193}{663} = 100 \text{ ton}$.

11. Discussion of the results by stratum.

The average densities for each group of species for each stratum are shown in table 6.

- On the North Kenya Bank the snappers, grunTERS, groupers and emperors are of relatively great importance (46%). The high figure for the crabs can be explained by some incidental catches of schools of swimming crabs (Portunidae), up to 800 kg/hour.

- In stratum I, the high density of sharks and rays is striking but the result is based on 7 hauls only. Still the "PROFESSOR MESYATSEW" found that in the same area the sharks and rays were of relative great importance (Birkett, 1979).

- In stratum II the small commercial fishes form half of the total density. Here the "jumbo-shrimps" can be caught (0.3 ton/m^2). Unfortunately there are no data on the area between the coast and west-boarder of stratum II, where small commercial shrimpers operate.

- The division of stratum III in northeast monsoon and southeast monsoon shows that in the southeast monsoon the density of almost every group of species is higher than in the northeast monsoon. The composition of the catch remains remarkably constant. The "small commercial fishes" and *Pamamba* and *Chana* are the most important.

- Like in stratum III, the mean densities of stratum IV in the south-east monsoon are higher than those in the northeast monsoon. Like in stratum III, the composition remains constant, with one exception: lobster (mainly *Puerulus angulatus*), which has an average density of 1.4 ton/m^2 in the northeast monsoon and 5 ton/m^2 in the southeast monsoon.

A report on the survey of "PROFESSOR MESSYANSEV" (VNIRO, 1978) already indicated a possible explanation for this phenomenon; seasonal migration between waters of 210-230 meters in the southeast monsoon and waters of 260-300 meters in the northeast monsoon. However, "R/V UJUZI" only found lobsters in waters of 230-289 meters depth; in the northeast monsoon 230-289 meters, in the southeast monsoon 243-280 meters.

- The number of hauls in stratum V was too low for a presentation of the results with northeast and southeast monsoon separated. But for lobsters, the mean density for V - northeast is 773 kg/m^2 (22 hauls) and for V - southeast 2099 kg/m^2 (15 hauls plus one semi-commercial haul in which only the catches of shrimps (mainly Heterocarpus woodmasoni) and lobsters (mainly Puervulus angulatus) were recorded). Thus migration of lobsters from stratum IV towards stratum V in the northeast monsoon does not seem to be likely. If migration does not occur, the difference found in stratum IV might be an "artefact": for a similar density of population, the efficiency of gear and/or the availability of the lobster to the gear are different.

The cause for the differences between northeast and southeast monsoon could be the current: For the strata IV and V, the current in the northeast monsoon flows to the south and during the southeast monsoon to the north.

The "small non-commercial fishes" form half of the total density in stratum V. Shrimps become more abundant (6% of the total density) while on the other hand the amount of lobsters decreases.

- In stratum VI again half of the total density is formed by "small non-commercial fishes" while the tendency of the increasing amount of shrimps and decreasing amount of lobsters continues.

- In the "KUSI-area" the lobsters are almost absent and the biomass of crustaceans consists almost completely of shrimps. The densities of shrimps and lobsters in the strata IV, V and VI and the "KUSI-area" are plotted in figure 2.

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- In "Malindi Bank - Pemba Island" 71% of the total density consists of "small ^{non-}commercial fishes". The total density is low, 7.7 ton/nm².

- In "Pemba Island", the total density of 7.1 ton/nm² is even lower. Here some shrimps have been found (0.6 ton/nm²).

- The "MESYATSEW-area" has the lowest density of all strata: 4.5 ton/nm². However, this result is based on 9 hauls only.

12. Judging the maximum sustainable yield.

In tropical ecosystems on a continental shelf the yields per unit area are very similar all over the world (Poinard, pers. comm.);

- More than 35 ton/nm² in estuaria and very shallow waters

- Between 15 and 30 ton/nm² on reefs and rather shallow waters (down to approximately 40 fathoms)

- Less than 15 ton/nm² in waters, between 40 and 80 fathoms

The results of the survey of "R/V UJUZI" are (from table 4):

AREA, STRATUM	MSY (ton/nm ²)	DEPTH (fathoms)
North Kenya Bank	2.6	10-200
I	3.7	10-100
II	4.6	10-20
III	4.4	20-100
IV	6.3	130-160
V	3.5	100-200
VI	3.7	200-400
KUSI-area*	2.4	190-220
Malindi Bank - Pemba Island	2.2	10-430
Pemba Island	2.1	200-300
MESYATSEW-area	1.3	50-200

* only shrimps and lobster

As most of the strata are deeper than 80 fathoms, comparison is difficult. Stratum I and III (two of the "richer" strata of the survey) are far below the observed productivity in other parts of the world. The yield of stratum II (4.6 ton/nm²) is particularly low compared with 15-30 ton/nm². The very low productivity of the Kenyan waters off the coral reefs can be explained by:

cont 17...

- the coral reef and the area inside the reefs take **almost** all the inland output as far as nutrients are concerned.
- the waters off Kenya are a zone of oceanic convergence. The masses of water transported by the surface-currents towards the Kenyan coast deviate to below. This is the contrary of "upwelling": nutritive salts are washed away, the primary production is low and the overall productivity is low.

13. Feasibility of trawling.

13.1 Assumptions.

The assumption has been made that the "R/V UJUZU" fishes according to the scheme below, with Mombasa as home-port.

Day 1 : Operations, loading ice, food, water, fuel.
Night 1-2 : Journey to fishing grounds.
Day No. 2-7: Fishing. Commercial trips of "R/V UJUZU" learned that during favourable weather trawling can be done for 6 hours; 3 hours are spent on winch operations, cleaning and repairing the nets; 3 hours steaming is necessary to travel from/to the fishing grounds for anchorage during the night.
Night 7-8 : Journey to Mombasa.
Day No. 8 : Unloading fish, maintenance.
Day No. 9 : Rest.

With this scheme, 40 trips/year can be made. It is assumed that the net used is the HOFFS, at a bottom speed of 3 nm/h.

Furthermore it is assumed that the total fishing effort within each stratum/area, corresponds with MSY/MONEY. In figure 3, the relations between fishingeffort and total costs of fishing, value of the total catch, net economic yield and value of the catch per unit effort are plotted. In general, these curves are the observed results of the different kind of mathematical models (Garcia and Le Restec, 1981). Two levels of fishing-effort are of special interest:

- The value of the total catch is at a maximum (the total catch is at a maximum, MSY)

- The net economic yield is at a maximum (MONEY).

Depending on the objectives of the management of the stock, the optimum level of fishing-effort will be at a level corresponding to MSY or MONEY. For this report, the important result of this graph is that the (value of) the catch per unit effort, that corresponds to MSY or MONEY is (roughly) half the catch per unit effort in the "virgin-stock", that is, the catch per unit effort corresponding to a level of fishing-effort which is nearly zero. This factor 0.5 will be used for the calculation of the value of the total catch (13.3).

13.2 Costs (see table 7).

The calculation of the costs has been based on the actual costs of "R/V UJUZU" during its operation as far as fuel costs, operational costs and service costs are concerned. The salaries have been estimated.

13.3 Revenue.

The calculation of the value of the total catch (see table 7) has been done as follows. After one hour trawling with the "R/V UJUZU" and the High Opening Fish cum Shrimp trawl the average catch to be expected in each stratum/area is the product of the wingspread of HOPS (0.0091 nm) by the distance covered by the net (3 nm) by the average density within that stratum/area (kg/nm², see table 6) by 0.5 (see 13.1). The value of the catch has been calculated according to the current prices observed on the Mombasa fish market and in the main processing units (see table 8). The predicted catches and their total value are listed in table 9.

13.4 Discussion.

The results of this simple approach (table 7) show already that offshore trawling in Kenya is not profitable. One area seems to be an exception, that is stratum IV. The area is only very small (66 nm²) and with an average density of lobster of 5.0 ton/nm² (SE monsoon data), a biomass of 330 ton, a MSY of 140 ton/year and an average catch rate of 68 kg/hour, the fishing-effort of one vessel similar to "R/V UJUZU" corresponds already almost to the MSY (40 trips x 6 fishing-days x 6 fishing-hours x 68 kg lobster per hour is a yearly total catch of lobster of 98 ton).

However, the practice has proven that even trawling in stratum IV is not viable. The "ALGINA" (the only offshore operating trawler observed during the project) has been fishing in stratum IV. After five weeks the vessel stopped the operations and went again to the very shallow waters at the border of Ungava Bay. The reasons to abandon these fishing-grounds were: too little catch and the large risk of loosing/ damaging the nets, this because the lobsters are accumulated at the bottom of a rather steep rocky slope.

CHART 1: CURRENTS
DURING THE SE-MONSOON
AND NE-MONSOON.

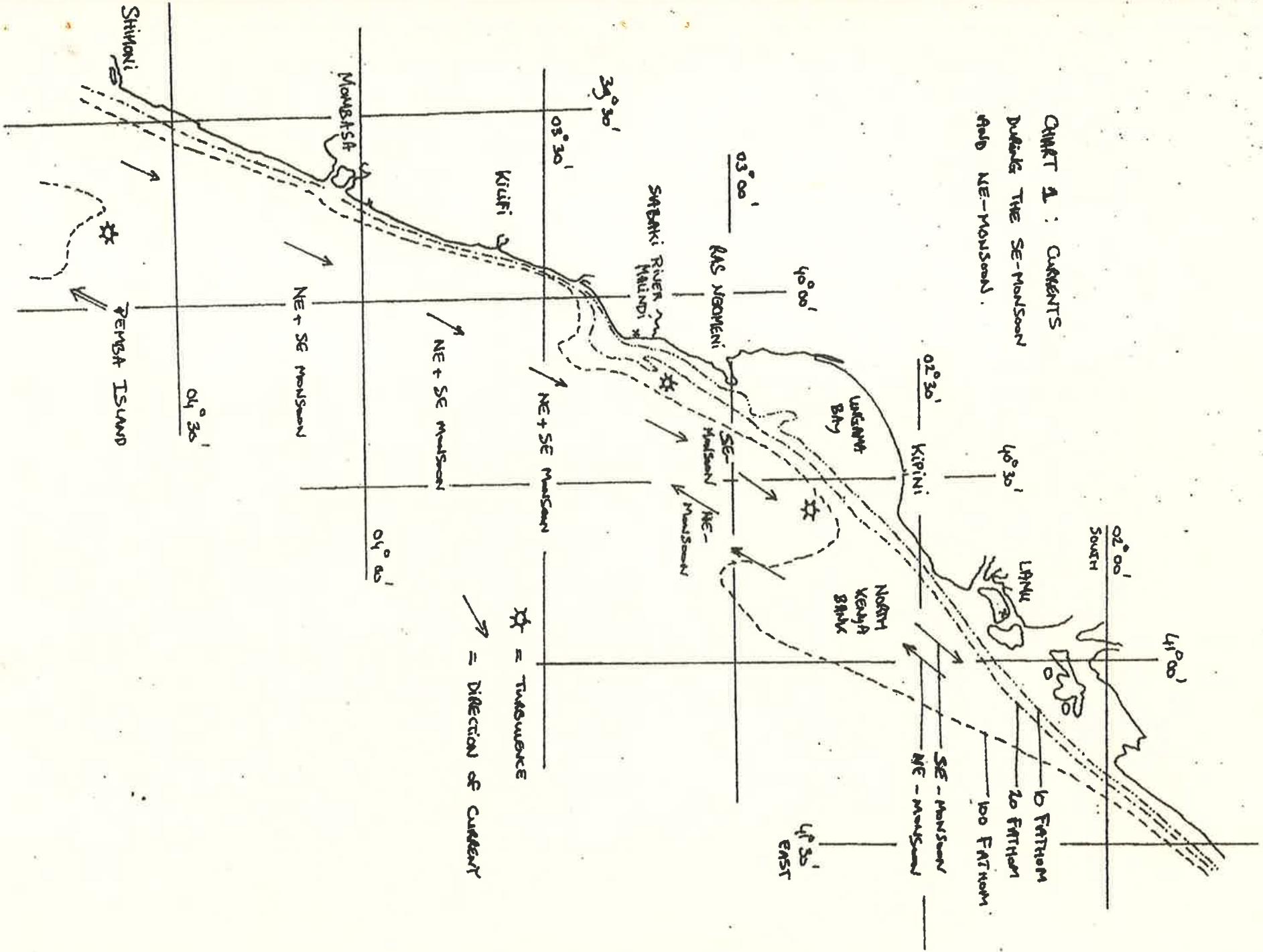


CHART 2:
TRIMURBIS AND
NON-TRIMURBIS GROUNDS

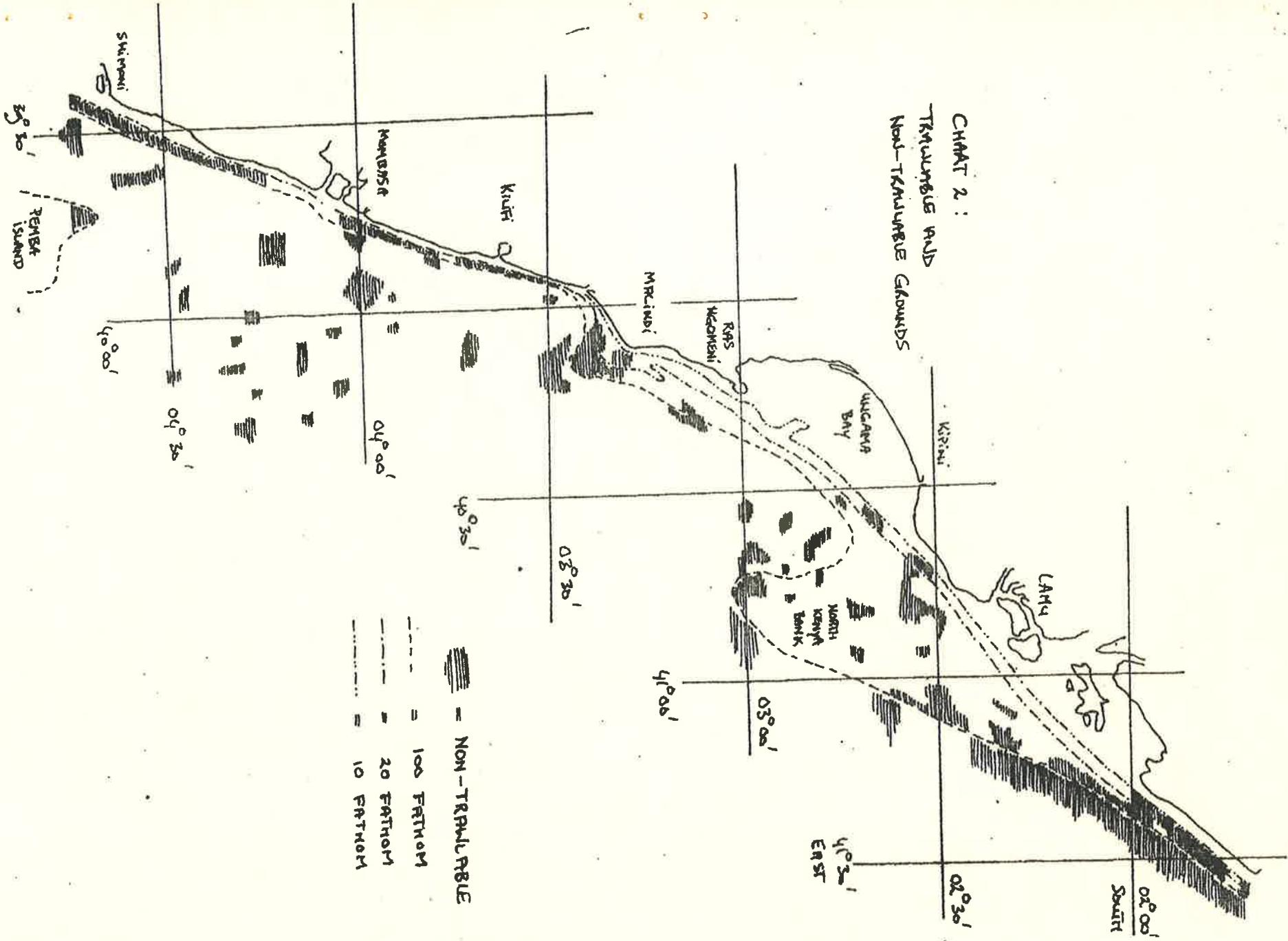
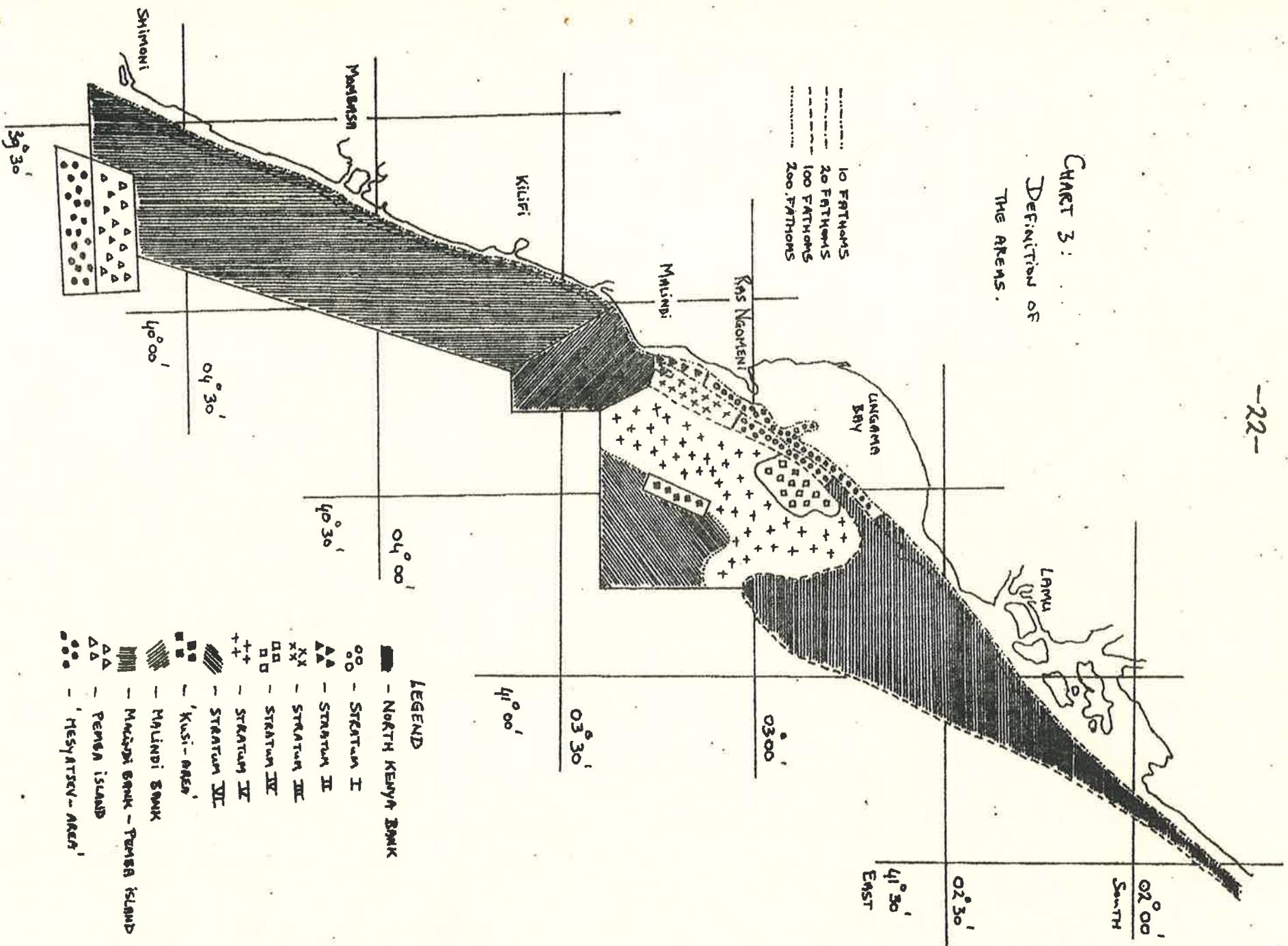


CHART 3:
DEFINITION OF
THE AREAS.



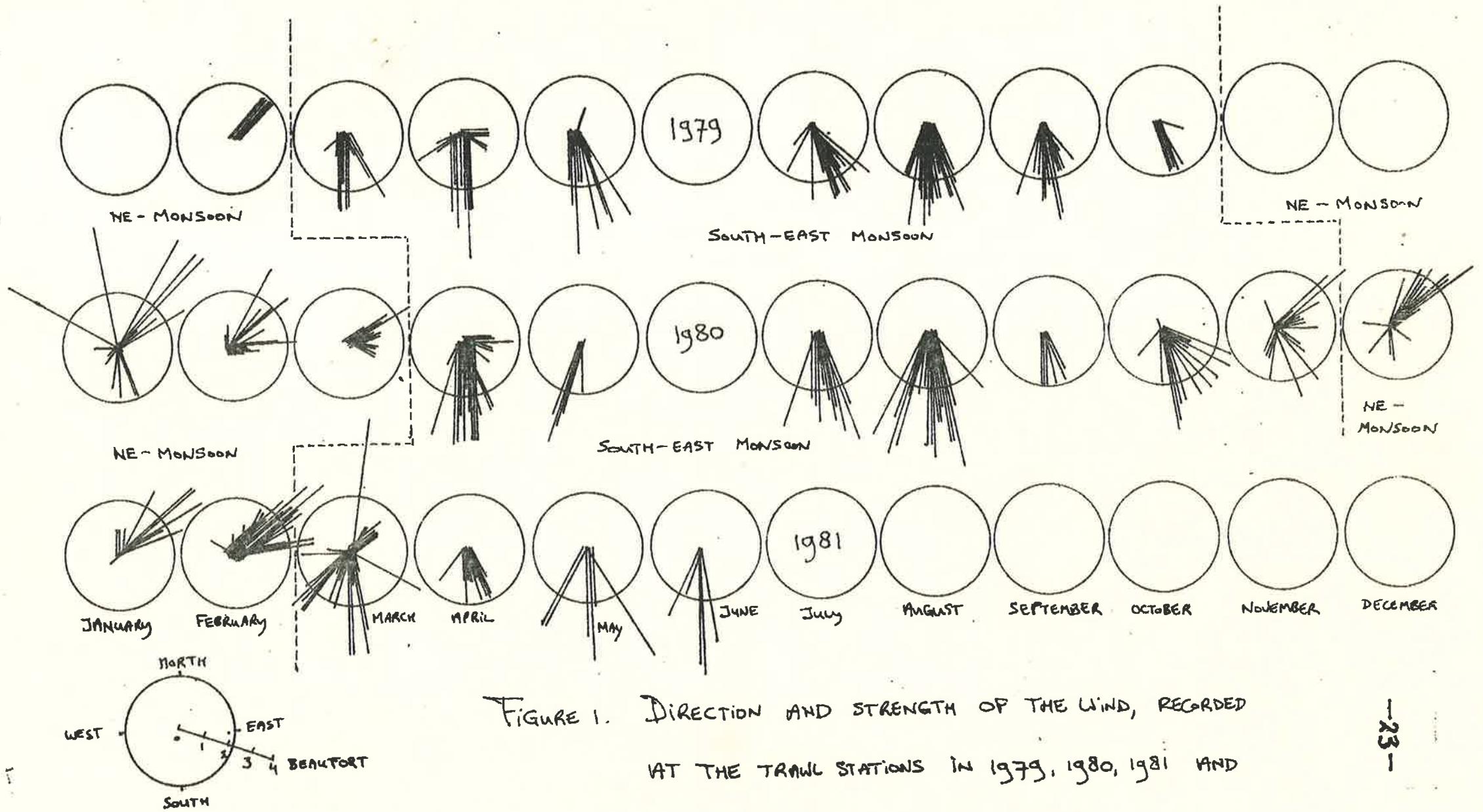


FIGURE 1. DIRECTION AND STRENGTH OF THE WIND, RECORDED AT THE TRAWL STATIONS IN 1979, 1980, 1981 AND THE DEFINITION OF THE MONSOONS.

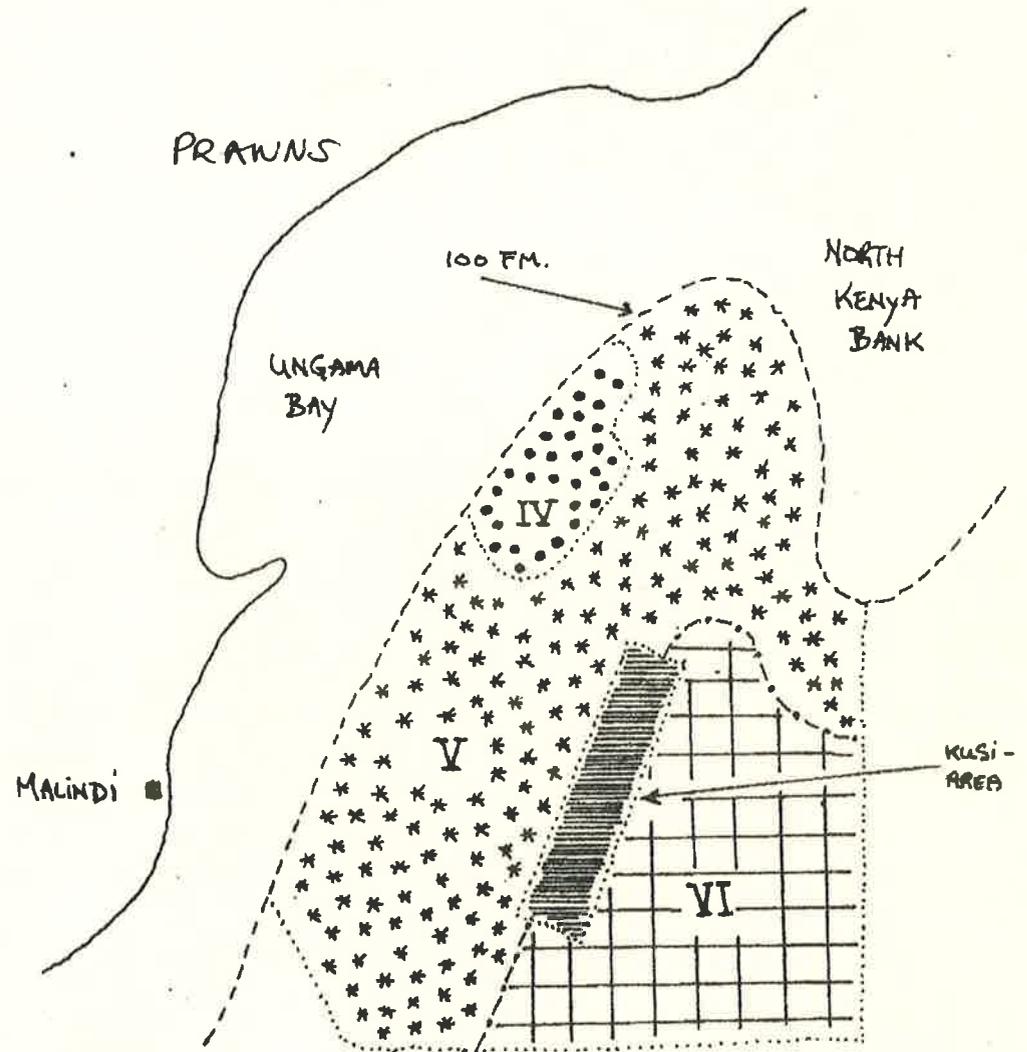
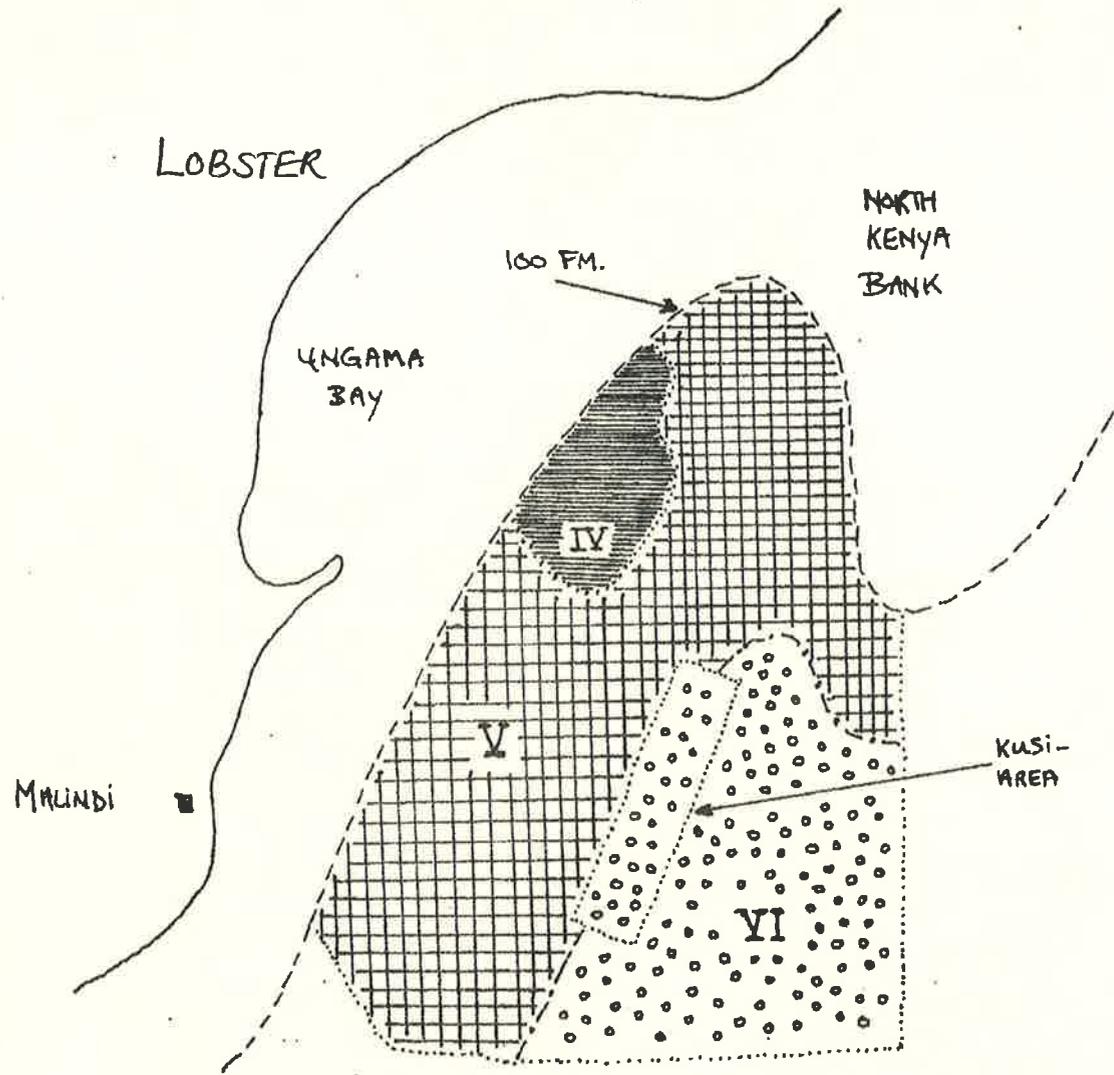


FIGURE 2: DENSITIES IN TON/NM² FOR LOBSTER AND PRAWNS.

○ ○ ○ ○ 0.1 T/NM²

* * * * 0.6 T/NM²

▤ ▤ ▤ ▤ 1.3 T/NM²

● ● ● ● 0.3 T/NM²

▨ ▨ ▨ ▨ 1.0 T/NM²

▩ ▩ ▩ ▩ 3.2 T/NM²

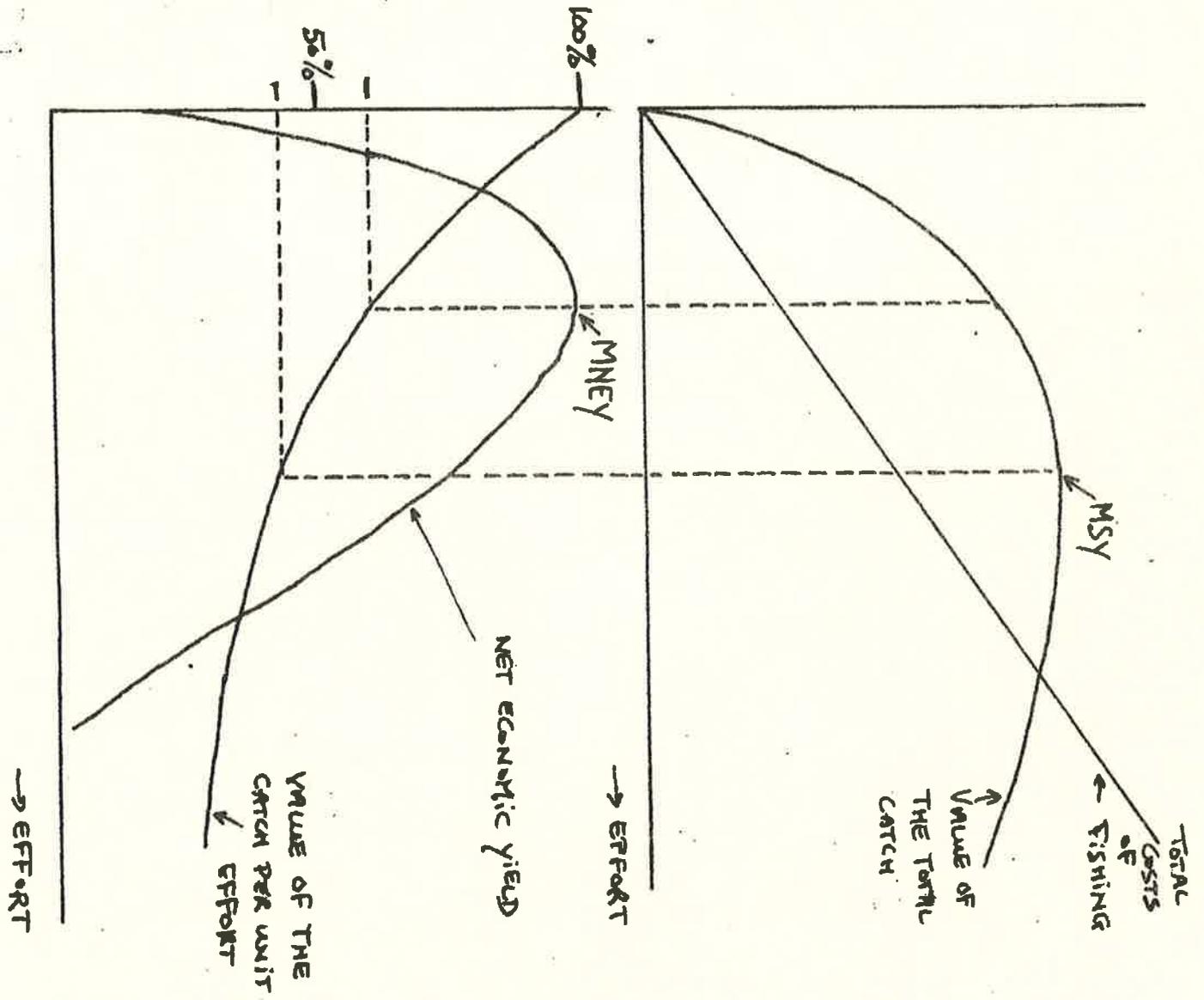


Figure 3: Relation between effort and total costs of fishing, value of the total catch, net economic yield (= value of the total catch minus total costs of fishing) and value of the catch per unit effort (after Garcia and Le Raste, 1981).

Table 1: Comparison between the HOFs trawl and the Lobster trawl.

Area	Mon- soon	Type of net	No. of hauls	Total area swept (nm^2)	Total catch (kg)	Density (kg/nm^2)	Factor
NK	NE	HOFs	10	0.1626	2120.28	13040	
NK	NE	Lobster	13	0.2563	925.67	3612	3.61
I(1)	SE	HOFs	1	0.0594	1999.80	33667	
I(1)	SE	Lobster	2	0.0494	1144.30	23164	1.45*
II	NE	HOFs	10	0.4142	5006.30	12087	
II	NE	Lobster	2	0.0365	432.20	11841	1.02-
III	NE	HOFs	37	1.4108	18752.25	13292	
III	NE	Lobster	7	0.3261	2174.53	6668	1.99
III	SE	HOFs	53	2.1748	41104.70	18900	
III	SE	Lobster	7	0.2152	1021.89	4749	3.98
IV	SE	HOFs	13	0.4412	4949.02	11217	
IV	SE	Lobster	14	0.5861	5763.12	9833	1:14
V(1)	SE	HOFs	2	0.0616	1937.93	31460	
V(1)	SE	Lobster	1	0.0443	605.91	13677	2.30*
V(2)	SE	HOFs	10	0.3062	1638.05	5350	
V(2)	SE	Lobster	2	0.0814	244.05	2998	1.78*
Weighted Mean :							2.37

NK = North Kenya Bank.

* At first, the areas were divided into smaller parts. In this table 'I(1)' is a part of the Stratum I and 'V(1)' and 'V(2)' form the Stratum V.

Table 2: Comparative fishing "R/V UJUZI" and "DR. FRIDTJOF NANSEN", catches in kgs.

Original Station number	Sharks and Rays	Grunters minus Pamamba	Pamamba	Chana	Small comm. fishes	Big fishes mixed	Small non-comm. fishes	Shrimps, shallow water	Shrimps, deep water	Löbster	Crab	Total
"DR. FRIDTJOF NANSEN"												
891	76.90	0.22	118.00		472.89	115.05	5.88					792.20
892	62.50				790.08	7.45	1.97					862.00
894	5.47					9.54	12.13		16.60	41.40		87.59
895	0.16					0.06	4.70			0.75		5.73
896						4.24	5.80		0.25	5.60		16.04
897	5.62					1.75	4.33		1.90	8.20		21.90
898	1.20					35.33	24.55		6.05	31.72	0.02	100.41
"R/V UJUZI"												
3001	136.50	9.20	14.50	0.01	78.22	25.41	46.04	0.01				309.90
3002	227.50	3.20	26.50	6.40	736.00	45.41	115.20	0.02				1160.23
3003	7.50					33.00	79.83		14.00	48.50		201.83
3004	1.50					0.30	10.71			1.50		14.53
3005	1.80					13.80	66.70		0.01	15.00		117.01
3006	111.50					2.40	9.12		1.50	13.00	0.20	142.22
3007	102.80					24.80	37.80		1.20	18.00	2.20	202.10
Linear regression, slope =	1.93	-	-	-	-	0.09	-0.63	-	0.86	0.85	-	1.50
Corr. coefficient =	0.75	-	-	-	-	0.23	0.13	-	0.96	0.87	-	0.85

Note: The linear regression for the total has been based on the last five hauls as with the first two hauls the group of variables is not homogeneous, a condition for linear regression.

Table 3: Trawlable and non-trawlable surfaces in nm².

	Trawlable	Non-trawlable	Total
North Kenya Bank	726	207	933
I	84	0	84
II	24	0	24
III	53	4	57
IV	66	0	66
V	523	35	558
VI	390	0	390
"KUSI-area"	45	0	45
MALINDI BANK	50	165	215
MALINDI BANK - PEMBA ISLAND	1154	176	1330
PEMBA ISLAND	93	6	99
"MESSYATSEV-area"	76	35	111

Table 4: Biomass (B, in tons) and Maximum Sustainable Yield (MSY, in tons). Tr: trawlable surface (nm²), To: total surface (nm²). Band MSY based on trawlable surface.

	North Konya Bank		I		II		III		IV		V		VI		Malindi Bank-Pemba Island		Pemba Island		Total	
	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY	Tr. B.	To. MSY
Sharks and Rays	1285	161	1416	177	43	5	167	21	154	19	569	71	2009	251	1313	164	215	27	7171	896
Snappers	1385	173	37	5	5	1	5	1	-	-	1	0	-	-	93	12	-	-	1526	192
Grunters (minus Pamamba)	1047	131	6	1	6	1	5	1	-	-	-	-	-	-	-	-	-	-	1046	134
Groupers	420	53	121	15	2	0	1	0	-	-	-	-	-	-	-	-	-	-	544	68
Emperors	442	55	-	-	-	-	1	0	-	-	-	-	-	-	-	-	-	-	443	55
Pamamba	-	-	57	10	29	5	109	19	-	-	-	-	-	-	-	-	-	-	195	34
Chana	15	3	110	19	2	0	137	24	-	-	-	-	-	-	-	-	-	-	264	46
<u>Big comm. fishes (sub-total)</u> +	3309	415	331	50	44	7	258	45	-	-	1	0	-	-	93	12	-	-	4036	529
Small commercial fishes	48	14	43	13	209	63	308	92	1	0	347	104	-	-	93	28	4	1	1053	315
Big fishes mixed	582	102	234	41	53	9	133	23	158	28	401	70	106	19	540	95	43	8	2250	395
Small non-commercial fishes	470	141	81	24	48	14	150	45	414	124	2648	794	2656	797	6369	1911	318	95	13154	3945
Shrimps, shallow waters	-	-	-	-	8	10	1	1	-	-	-	-	-	-	-	-	-	-	9	11
Shrimps, deep waters	68	51	-	-	-	-	-	-	29	22	295	221	405	304	150	113	59	44	1006	755
Lobsters	-	-	-	-	0	0	-	-	330	140	696	296	29	12	122	52	0	0	1177	500
Crabs	1265	949	-	-	0	0	-	-	21	16	18	14	10	8	8	6	4	3	1326	996
<u>Crustaceans (sub-total)</u> +	1333	1000	-	-	8	10	1	1	380	178	1009	531	444	324	280	171	63	47	3518	2262
<u>Cephalopods</u> +	102	77	9	7	2	2	5	4	87	65	352	264	94	71	248	186	20	15	919	691
Totals	7129	1910	2114	312	407	110	1022	231	1194	414	5327	1834	5309	1462	8936	2567	663	193	32101	9033

Table 5: Groups of fishes and their estimated natural mortality rates.

Group	Minimum natural mortality rate	Maximum natural mortality rate
Sharks and Rays	0.2	0.3
Snappers	0.2	0.3
Grunters (minus Pamamba)	0.2	0.3
Groupers	0.2	0.3
Emperors	0.2	0.3
Pamamba	0.3	0.4
Chana	0.3	0.4
Small commercial fishes	0.5	0.7
Big fishes mixed	0.3	0.4
Small non-commercial fishes	0.5	0.7
Shrimpers, shallow waters	2.0	3.0
Shrimps, deep waters	1.0	2.0
Lobsters	0.7	1.0
Crabs	1.0	2.0
Cephalopods	1.0	2.0

Table 6: Densities in kg/nm².

	North Kenya Bank	Off Malindi, shallow waters				Off Malindi, deep waters				Malindi Bank - Pemba Island	Pemba- Island
		I	II	III		IV	V	VI			
				NE-monsoon	SE-monsoon				NE-monsoon		
Number of hauls	43	7	28	44	60	25	27	37	9	30	13
Sharks and Rays	1770	16862	1784	2900	3146	1448	2327	1088	5151	1138	2308
Snappers	1908	442	201	18	92	-	-	1	-	81	-
Grunters (minus Pamamba)	1442	77	236	203	101	-	-	-	-	-	-
Groupers	579	1446	102	127	16	-	-	-	-	-	-
Emperors	609	-	-	-	17	-	-	-	-	-	-
Pamamba	-	663	1218	2200	2059	-	-	-	-	-	-
Chana	20	1308	68	1639	2580	-	-	-	-	-	-
<u>Big commercial fishes</u> + (sub-total)	4558	3936	1825	4187	4865	-	-	1	-	81	-
Small commercial fishes	66	516	8708	4738	5814	6	20	664	-	81	40
Big fishes mixed	801	2780	2196	809	2511	1687	2390	766	272	468	464
Small non-commercial fishes	648	959	2006	1897	2824	3785	6266	5064	6810	5519	3419
Shrimps, shallow waters	-	-	321	0	22	-	-	-	-	-	-
Shrimps, deep waters	94	-	-	-	-	200	440	564	1038	130	637
Lobster	-	-	1	-	-	1430	5001	1331	75	106	3
Crabs	1743	-	1	-	-	21	319	35	26	7	44
<u>Crustaceans (sub-total)</u> +	1837	-	323	0	22	1651	5760	1930	1139	243	684
<u>Cephalopods</u> +	141	108	82	106	97	760	1314	673	242	215	212
Total	9821	25161	16924	14637	19279	9337	18077	10186	13614	7745	7127

Table 7: Costs and revenue.

(Amounts in thousands of Shs)

	North Kenya Bank	I	II	III (SE)	IV (SE)	V	VI	Malindi Bank - Pemba Island	Pemba Island
Fuel costs: Journey to fishing grounds. Example: North Kenya Bank - 40 trips x 10 hours steaming x 80 litre/hour x KShs 2.5/litre	80	56	40	40	72	52	52	16	76
Six hours trawling each fishing day: 40 trips x 6 days x 6 hours x 65 litre/hour x KShs 2.5/litre	234	234	234	234	234	234	234	234	234
Three hours winch operation, etc.;	117	117	117	117	117	117	117	117	117
40 trips x 6 days x 3 hours x 65 litre/hour x KShs 2.5/litre	117	117	117	117	117	117	117	117	117
Three hours steaming for anchorage: 40 trips x 5 nights x 3 hours x 80 litre/hour x KShs 2.5/litre	120	120	120	120	120	120	120	120	120
Journey to Mombasa. Example: North Kenya Bank - 40 trips x 20 hours steaming (against the current) x 80 litre/hour x KShs 2.5/litre	160	112	80	80	144	108	108	16	36
Salaries: 13 crew members, 12,000 Shs each/year	156	156	156	156	156	156	156	156	156
Captain, Engineer, 50,000 Shs each/year	100	100	100	100	100	100	100	100	100
Operational costs as food, water; 30 Shs per person per day: 40 trips x 7 days x 15 men x 30 Shs	126	126	126	126	126	126	126	126	126
Service costs for the vessel per year (depreciation, insurance, maintainance)	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104
Total estimated costs	2,197	2,125	2,077	2,077	2,173	2,117	2,117	1,989	2,069
Value of fish: 240 days x 6 hours trawling x value of catch/hour	510	950	747	737	2,287	727	357	130	204
Net loss per year	1,687	1,175	1,330	1,340	-114	1,390	1,760	1,859	1,865

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Table 8: Prices of fish in Kshs/kg.

Group of fishes	Prices of 'Kenya Cold Storage'	Prices of 'Kenya Fishing Industries'	Prices used for calculations
Sharks and Rays	0.50	1,00-3,00	1.50
Snappers	4.50	-	4.50
Grunters (minus Pamamba)	4.50	-	4.50
Groupers	3.00	4.50	3.50
Emperors	4.50	-	4.50
Pamamba	4.50	4.00-4.50	4.50
Chama	2.50	1.50-4.50	2.50
Small commercial fishes	1.50	0.50-1.60	1.50
Big fishes mixed	-	3.00-4.50	3.00
Small non-commercial fishes	0	0	0
Shrimps, shallow waters	25.00	-	25.00
Shrimps, deep waters	-	7.00-7.50	7.50
Lobster	15.00	20.00-30.00	20.00
Crab	0	0	0
Cephalopods	2.00	-	2.00

Table 9: The predicted average catch per hour and the value of it.

	North Kenya Bank		I		II		III (SE)		IV (SE)		V		VI		Malindi-Pemba I.		Pemba I.	
	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h	kg/h	shs/h
Sharks and Rays	24	36	230	345	24	36	43	65	32	48	15	23	70	105	16	24	32	48
Snappers	26	117	6	27	3	14	1	5	0	0	0	0	0	0	1	5	0	0
Grunters (minus Pamamba)	20	90	1	5	3	14	1	5	0	0	0	0	0	0	0	0	0	0
Groupers	8	28	20	70	1	4	0	0	0	0	0	0	0	0	0	0	0	0
Emperors	8	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pamamba	0	0	9	41	17	77	28	126	0	0	0	0	0	0	0	0	0	0
Chana	0	0	18	45	1	3	35	88	0	0	0	0	0	0	0	0	0	0
Small commercial fishes	1	2	7	11	119	179	79	119	0	0	9	14	0	0	1	2	1	2
Big fishes mixed	11	33	38	114	30	90	34	102	33	99	10	30	4	12	6	18	6	18
Small non-commercial fishes	9	0	13	0	27	0	39	0	86	0	69	0	93	0	75	0	47	0
Shrimps, shallow waters	0	0	0	0	4	100	0	0	0	0	0	0	0	0	0	0	0	0
Shrimps, deep waters	1	8	0	0	0	0	0	0	6	45	8	60	14	105	2	15	9	68
Lobsters	0	0	0	0	0	0	0	0	68	1360	18	360	1	20	1	20	0	0
Crabs	24	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0
Cephalopods	2	4	1	2	1	2	1	2	18	36	9	18	3	6	3	6	3	6
Total	134	354	343	660	230	519	261	512	247	1588	138	505	185	248	105	90	99	142

HAUL RECORDSCRUISE: 8022

CAPTAIN R/V UJUZI KEN/74/023 "OFFSHORE TRAWLING SURVEY"

FROM: DATE/TIME 24-7-80 17.30

TO: DATE/TIME 31-7-80

DATE: 30-7-80

HAUL NO: 08

TIME / START: 0.8.50 03° 48' 5" S 39° 55' 3" E

TYPE OF GEAR: HOFS MINUS GROUND GEAR

POSITION END: 09.50 03° 43' 5" S 39° 57' 0" E

COD-END MESH SIZE: 32 MM WING SPREAD: 16 M.

DURATION: 60 MIN DISTANCE COVERED: 4.5 NM

TOWING - DIRECTION: 25° -SPEED THROUGH THE WATER: 1.0 KN.

DEPTH - START: 345 M. END: 310 M.

WARP: 1000 M.

MINIMUM: 310 M. MAXIMUM: 345 M.

BOTTOM/ X
-EVEN -UNEVEN -ROUGH

SEA STATE: 3-4 CLOUDS: 8

CONDITIONS X
- MUD -SAND -CORAL -ROCK

WIND - DIRECTION: 160° -FORCE: 4-5

TOTAL CATCH (KG): 67.9

CURRENT - DIRECTION: 210 → 30 -FORCE: 3.5 KN.

COMPOSITION: LOBSTER (2 KG) PRAWNS (11.5 KG)

REMARKS:

ANNEX 1 : HAUL RECORD "R/V UJUZI"

.../...

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CANOE RECORDS

CRUISE#

8022

BIOLOGIST: R/V UJUZU KEN/14/023 *OFFSHORE TRAWLING SURVEY*

FROM: date/time 24-7-80 17.30 TO: date/time 31-7-80

DATE: 30-7-80

DURATION: 60 min.

HAUL No: 2208

SURFACE TEMP: —

BT: —

BT: —

SEAGHI DECK: —

BOTTOM DEPTH: 310-345 M.

TOTAL CATCH:

67.9 KG

SPECIES NAME	QUANTITY		SIZE RANGE (cm)	SAMPLE		
	KG	NUMBERS		L/P	B/A	LAB
SHARKS	6.0					
BABY SHARKS	6.0					
RAYs	2.8					
SAURIDA UNDOSQUAMIS	2.0					
ARGYROPS	7.2					
POLYMIKIA NOBILIS	4.0					
PARASHEMANTHIAS WEBERI	1.0					
CHLOROPHTHALMUS	12.0					
EPINNULA	2.0					
CHAUNAX PICTUS	2.0					
MYCTOPHIDAE	2.0					
PERISTEDION	2.0					
CYNOGLOSSUS	0.4					
EELS, PRIACANTHUS	TRACE					
TRIGLIDAE, MACROCEPHALUS	TRACE					
LOBSTER (Palaemonus arguatus)	2.0					X
SHRIMP (Paraplenicus rectacutus)	11.5					X
CUTTLEFISH	5.0					
RUBBISH	2.4					

ANNEX 1 -
CONTINUATION:

CATCH RECORD
OF
" R/V UJUZU "

Annex 2: Catchrecord of Dr. Fridtjof Hansen.

SHIP: DR. FRIDTJOF HANSEN		GEAR TYPE: BOTTOM TRAWL		DATE: 10-12-80		
FISHING GEAR: NO. 858		POSITION: S 04° 22' E 40° 12'		AREA: KENYA, E. OF MOMBASA		
Plating	Time	Log	Bottom depth	Wind Dir.	Total oston Catch/Hour	
Start	06.45	258.8		Force		
Stop	07.15	259.3	Sea			
Time/dst.	30	0.5	Towing dir. 030			
Wire out	1900	Speed	1.0	Total oston: 3.36 KG		
SPECIES	Length range	Tax. sample	Total oston N	N	N	
COELOMNYCHUS FLABELLISPINUS	47-53	X	1.35	3	2.7	6
SATYRICHTHYS SP.	18-24		0.7	11	1.4	22
HALBELURUS LATERIUS ♀ (SHARK)	34		0.1	1	0.2	2
HRGYROTELECUS SP.	7-11		0.05	8	0.1	16
TRINCANTHIDRE 1) SHORT SNOUT	9-10	X	0.05	3	0.1	6
TRINCANTHIDRE 2) VERY LONG SNOUT	10-17	X	0.02	2	0.05	4
TRICANTHIDRE 3) LONG SNOUT	8	X	0.01	1	0.02	2
BENTHODESMUS ELONGATUS ELONGATUS	27-68		0.3	6	0.6	12
CHAUCIOPUS SLOANI	21-26			2		4
GONOSTOMATIDAE	12-14		0.2	16	0.4	32
NETTASTOMA PARVICEPS	27-68		0.4	7	0.8	14
DEEP-SEA FISH (FAT)		X	0.05	2	0.1	4
Squid	3-6		0.08	2	0.16	4
SHRIMP			0.05	9	0.1	18
(1 MEDIUM PINK + WHITE						
3 SMALL PINK						
1 DARK RED (SMALL)						
5 VERY SMALL, HARD, RED)						
			3.36		6.73	

Annex 4 Grouping of the fishes.

Sharks and rays	Carcharhinidae
	<i>Carcharhinus sealei</i> <i>Eridacnis radcliffei</i> <i>Hemigaleus</i> sp. <i>Hypogaleus kyugaensis</i> <i>Mustelus manazo</i> <i>Rhizoprionodon acutus</i> <i>Rhizoprionodon</i> sp. <i>Chiloscyllium indicum</i> <i>Halaelurus hispidus</i> <i>Halaelurus lutarius</i> <i>Halaelurus</i> sp. <i>Holohalaelurus punctatus</i> <i>Holohalaelurus</i> sp. <i>Centrophorus granulosus</i> <i>Centrophorus lusitanicus</i> <i>Centrophorus scalpratus</i> <i>Centrophorus</i> sp. <i>Etmopterus sentosus</i> <i>Squalus blainvilliei</i> <i>Squalus megalops</i> <i>Pristis pectinatus</i> <i>Pliotrema warreni</i> <i>Dasyatis favus</i> <i>Dasyatis sephen</i> <i>Dasyatis uarnak</i> <i>Dasyatis</i> sp. <i>Urotrygon daviesi</i> <i>Gymnura natalensis</i> <i>Myliobatis cervus</i> <i>Stoasodon narinari</i> <i>Raja alba</i> <i>Raja miraletus</i> <i>Raja ocellifera</i> <i>Raja springeri</i> <i>Raja stenorhynchus</i> <i>Raja</i> sp. <i>Rhinobatos holcoorthynchus</i> <i>Heteronarce garmani</i> <i>Torpedo fuscomaculata</i> <i>Torpedo marmoratus</i> <i>Hydrolagus africanus</i>
	<i>Chimaeridae</i>
	<i>Rhinobatidae</i> <i>Torpedinidae</i>
Snappers	<i>Lutjanidae</i>

.../...

Annex 4 -- continuation

	Pentapodidae		<i>Pristipomoides argyrogrammicus</i> <i>Pristipomoides typer</i> <i>Pristipomoides</i> sp. <i>Gymnocranius griseus</i> <i>Gymnocranius robinsoni</i> <i>Monotaxis grandoculis</i>
Grunters (minus Pamamba)	Pomadasyidae		<i>Gaterin batata</i> <i>Plectrorhynchus nigerus</i> <i>Plectrorhynchus pictus</i> <i>Pomadasygus guoraka</i> <i>Pomadasygus hasta</i> <i>Pomadasygus maculatus</i>
Groupers	Serranidae		<i>Cephalopholis miniatum</i> <i>Cephalopholis sonnerati</i> <i>Epinephelus areolatus</i> <i>Epinephelus caeruleopunctatus</i> <i>Epinephelus diacanthus</i> <i>Epinephelus fasciatus</i> <i>Epinephelus fario</i> <i>Epinephelus flavocaeruleus</i> <i>Epinephelus grammatophorus</i> <i>Epinephelus guaza</i> <i>Epinephelus morrhua</i> <i>Epinephelus morrhua</i> <i>Epinephelus tauvina</i> <i>Epinephelus ryncholepis</i> <i>Epinephelus undulosus</i> <i>Epinephelus</i> sp. <i>Holanthias</i> sp. <i>Plectranthias morgansi</i>
Emperors	Lethrinidae		<i>Lethrinus borbonicus</i> <i>Lethrinus choerorhynchus</i> <i>Lethrinus crocineus</i> <i>Lethrinus harak</i> <i>Lethrinus kallopterus</i> <i>Lethrinus lentjan</i> <i>Lethrinus miniatum</i> <i>Lethrinus nebulosus</i> <i>Lethrinus reticulatus</i>
Pamamba	Pomadasyidae		<i>Pomadasygus opercularis</i>
Chana	Drepanidae		<i>Drepane punctata</i>
Small commercial fishes	Carangidae		<i>Alectis indicus</i> <i>Alepes</i> sp. <i>Atropus atropus</i> <i>Carangoides chrysophrys</i> <i>Carangoides coeruleopinnatus</i> <i>Carangoides equata</i> <i>Carangoides malabaricus</i> <i>Carangoides</i> sp. <i>Decapterus lajang</i> <i>Decapterus macrosoma</i> <i>Decapterus maruadasi</i> <i>Decapterus kurroides</i> <i>Decapterus</i> sp.

Annex 4 - continuation

Clupeidae	<i>Etrumeus</i> teres <i>Busumiera</i> sp. <i>Ilisha</i> sp. <i>Pellona ditchela</i> <i>Sardinella gibbosa</i> <i>Sardinella</i> sp. <i>Thryssa satirostris</i> <i>Thryssa vitritostris</i> <i>Thryssa</i> sp. <i>Formio niger</i> <i>Gerres filamentosus</i> <i>Gerres oyena</i> <i>Gerres</i> sp.
Leiognathidae	<i>Leiognathus bindus</i> <i>Leiognathus egyptula</i> <i>Leiognathus fasciatus</i> <i>Leiognathus</i> sp. <i>Gazza minuta</i> <i>Secutor insidiator</i> <i>Mene maculata</i> <i>Rastrelliger kanagurta</i> <i>Argyrops filamentosus</i> <i>Argyrops spinifer</i> <i>Cramidens crenidens</i> <i>Sparus major</i> <i>Sparus</i> sp.
Big fishes mixed	<i>Acanthurus strigosus</i> <i>Acanthurus</i> sp. <i>Naso brevirostris</i> <i>Naso fageni</i> <i>Naso</i> sp. <i>Arius sagor</i> <i>Tachysurus dussumieri</i> <i>Tachysurus felioeps</i> <i>Abalistes stellaris</i> <i>Balistapus undulatus</i> <i>Balistes</i> sp. <i>Arnoglossus</i> sp. <i>Chascanopsetta lugubris</i> <i>Citharoides macrocephis</i> <i>Bagropropon valdeirostratus</i> <i>Laeops pectoralis</i> <i>Laeops</i> sp. <i>Brama raii</i> <i>Carangoides ferdau</i> <i>Carang hippos</i> <i>Carang ignobilis</i> <i>Carang</i> sp. <i>Gnathanodon speciosus</i> <i>Megalaspis</i> sp. <i>Scomberoides commersonianus</i> <i>Seriola bonariensis</i> <i>Seriola</i> sp. <i>Seriolina nigrofasciata</i> <i>Seriolina</i> sp. <i>Trachinotus blochii</i> <i>Coryphaena hippurus</i> <i>Chirocentrus dorab</i> <i>Ariosoma</i> sp. <i>Coloconger raniceps</i>
Bramidae	
Carangidae	
Bathidae	
Balistidae	
Ariidae	
Acanthuridae	
Menidae	
Scombridae	
Sparidae	
Gerreidae	
Formionidae	
Leiognathidae	
Coryphaenidae	
Chirocentridae	
Congridae	

Annex 4 - continuation

Denticidae	<i>Chemimerius nufar</i>
	<i>Polysteganus coeruleopunctatus</i>
	<i>Polystoganus praeorbitalis</i>
Echeneidae	<i>Echeneis naucrates</i>
	<i>Remora remora.</i>
	<i>Thyrsites atun</i>
Gempylidae	<i>Lobotes surinamensis</i>
Lobotidae	<i>Muraenesox sp.</i>
Muraenesocidae	<i>Echidna polyzona</i>
Muraenidae	<i>Lycodontis johnsoni</i>
	<i>Lycodontis undulatus</i>
	<i>Lycodontis sp.</i>
	<i>Muraena sp.</i>
	<i>Poecillopsetta natalensis</i>
Pleuronectidae	<i>Plotosus lineatus</i>
Plotosidae	<i>Psettodes erumei</i>
Psettodidae	<i>Priacanthus boops</i>
Priacanthidae	<i>Rachycentron canadus</i>
Rachycentridae	<i>Argyrosomus hololepidotus</i>
Sciaenidae	<i>Atrabuca nibe</i>
	<i>Johnius dussumieri</i>
	<i>Otolithes ruber</i>
	<i>Auxis thazard</i>
Scombridae	<i>Euthynnus affinis</i>
	<i>Sarda orientalis</i>
	<i>Scomber australasicus</i>
	<i>Scomberomorus commerson</i>
	<i>Scomberomorus guttatus</i>
	<i>Thunnus obsus</i>
	<i>Thunnus sp.</i>
	<i>Solea sp.</i>
Soleidae	<i>Sphyraena barracuda</i>
Sphyraenidae	<i>Sphyraena flavicauda</i>
	<i>Sphyraena japonica</i>
	<i>Sphyraena jello</i>
	<i>Sphyraena obtusata</i>
	<i>Sphyraena sp.</i>
	<i>Saurida undosquamis</i>
Synodontidae	<i>Synodus indicus</i>
	<i>Abudefduf sp.</i>
Abudefdufidae	<i>Acropoma japonicum</i>
Acropomidae	<i>Xenodermichthys socialis</i>
Alepocephalidae	<i>Planctanthias praeopercularis</i>
Anthidae	<i>Argentina euchus</i>
Argentinidae	<i>Glossanodon sp.</i>
	<i>Nansenia macroplepis</i>
Apogonidae	<i>Apogon sp.</i>
	<i>Apogon nigrifus</i>
	<i>Apogonichthys nigripinnis</i>
	<i>Archamia macroptera</i>
	<i>Synagrops japonicus</i>
	<i>Synagrops sp.</i>
	<i>Foa brachygramma</i>
	<i>Ariomma indica</i>
Ariomnidae	<i>Astronesthes bouleengeri</i>
Astronethidae	<i>Astronesthes richardsoni</i>
	<i>Astronesthes sp.</i>
	<i>Ateleopus natalensis</i>
Ateleopidae	<i>Ateleopus sp.</i>
	<i>Bembrops caudimacula</i>
Bembropsidae	<i>Bembrops platyrhynchus</i>

Small non-commercial
fishes

1956

Annex 4 - continuation

Berycidae	Beryx splendens
Branchiostegidae	Branchiostegus <i>adliatus</i>
Bregmacerotidae	Branchiostegus japonicus
Brotulidae	Bregmaceros maclellandi
Caesioidae	Cateetyx messieri
Callionymidae	Caesio sp.
	Callionymus kaianus
	Callionymus sp.
	Synchaetropus monacanthus
Callyodontidae	
Canthigasteridae	Canthigaster sp.
Carapidae	Pyramodon ventralis
Centriscidae	Aeoliscus punctulatus
Chaetodontidae	Chaetodon leucopleura
	Chaetodon sp.
Champsodontidae	Champsodon capensis
Chauliodontidae	Chauliodus sloani
Chaunacidae	Chaunax pencilatus
	Chaunax pictus
Chlorophthalmidae	Chlorophthalmus agassizi
Cirrhitidae	Cyprinocirrhites polyactis
Cynoglossidae	Cynoglossus abbreviatus
	Cynoglossus marleyi
	Cynoglossus sp.
Diodontidae	Cyclichthys echinatus
	Cyclichthys orbicularis
	Dicotylichthys punctulatus
	Diodon holocanthus
	Diodon hystrix
	Lophodiodon calori
Diretmidae	Diretmus argenteus
Duleidae	Dules taeniurus
Missumierinae	Etrumeus micropus
Tagranulidae	Stålephorus sp.
Fistulariidae	Fistularia commersonii
	Fistularia petimba
	Fistularia sp.
Gempylidae	Epinmula orientalis
	Promethichthys promethcus
	Rexea prometheoides
	Thyrsitoides marleyi
	Gonostoma sp.
Gonostomatidae	
Grammicolepidae	Histiopterus spinifer
Histiopteridae	Holocentrus sp.
Holocentridae	Hoplichthys acanthopleurus
Hoplichthyidae	Cheilinus trilobatus
Labridae	Cheilio incrimus
	Novaculichthys macrolepidotus
Lagoccephalidae	Pealopesia genogenys
	Pterogegus flagellifera
	Gastrophysus lunaris
	Lagocephalus lagocephalus
	Lagoccephalus sp.
	Sphaeroides
Lophiidae	Lophiodes multus
	Lophiodes sp.
	Lophius sp.
Lutjanidae	Lutjanus fulviflamma
Macrorhamphosidae	Macrorhamphosus gracilis

Annex 4 - continuation

Macrouridae

- Coelorrhynchus denticulatus
- Coelorrhynchus fasciatus
- Coelorrhynchus flabellispinus
- Coelorrhynchus parallelus
- Coelorrhynchus sp.
- Hymenococephalus sp.
- Malacocephalus laevis
- Malacocephalus sp.
- Mataeocephalus microstomus
- Ventri fossa sp.
- Malacoosteus indicus
- Monacanthus sp.
- Paramonacanthus barnardi
- Stephanolepis auratus
- Thamnaconus modestoides
- Monocentris japonicus

Malacosteiidae

Monacanthidae

Monocentridae

Moridae

Mullidae

- Physiculus peregrinus
- Mulloidichthys flavolincatus
- Pseudupeneus faterculus
- Pseudupeneus pleurotaenia
- Pseudupeneus sp.
- Upeneus bonsai
- Upeneus crosnieri
- Upeneus moluccensis
- Upeneus sulfureus
- Upeneus tragula
- Upeneus vittatus

Mycetophidae

Nemichthyidae

Nemipteridae

Neoscopelidae

Nettastomatidae

Ogcocephalidae

Ophidiidae

Oreosomatidae

Owstoniidae

Ostraciontidae

- Paralepididae
- Peristediidae

Photichthyidae

Platacidae

Platycephalidae

Polyr. iridae

- Avocettina infans
- Nemipterus sp.
- Scolopsis bimaculatus
- Scolopsis vosmeri
- Neoscopelus macrolepidotus
- Nettastoma parviceps
- Dibranchus stellatus
- Haliutæa fitzsimonsi
- Malthopsis triangularis
- Dicrolene sp.
- Glyptophidium sp.
- Lampogrammus sp.
- Monomitopus sp.
- Pyenocraspedum sp.
- Neocyttus acanthorrhynchus
- Parasphenanthias weberi
- Sphenanthias sp.
- Lactoria cornutus
- Lactoria diaphana
- Lactoria formasini
- Ostracion melægris
- Ostracion tuberculatus
- Tetrosomus sp.
- Lestrolepis intermedia
- Peristedion weberi
- Peristedion sp.
- Satyrichthys adeni
- Satyrichthys investigatoris
- Polymetme corythaeola
- Platax pinnatus
- Platycephalus horai
- Platycephalus indicus
- Platycephalus sp.
- Polymixia berndti
- Polymixia nobilis

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Annex 4 - continuation

Polynemiidae	Polynemus sp.
Pomacanthidae	Centropyge acanthops
Pomadasyidae	Pomacanthus semicirculatus
Priacanthidae	Rhoniiscus stridens
	Priacanthus arenatus
	Priacanthus cruentatus
	Priacanthus hamrur
	Pristigenys nipponius
	Calotomus spinidens
Scaridae	Scarus globban
Scopelarchidae	Scopelarchus sp.
Scorpaenidae	Ectreposebastes imus
	Scorpaena sp.
	Scorpaenodes guamensis
	Scorpaenodes sp.
	Setarches Guentheri
	Setarches longiceps
	Pterois sp.
Serrivomeridae	Serrivomer beani
Siganidae	Siganus rivulatus
Sillaginidae	Sillago sihama
Sparidae	Sillago sp.
Sternoptychidae	Rhabdosargus globiceps
	Argyropolecus gigas
	Argyropolecus sladeni
	Polyipnus meteori
	Polyipnus spinosus
Stromatoidae	Cubiceps sp.
	Psenes sp.
	Schedophilus ovalis
	Schedophilus sp.
Synodontidae	Trachinocephalus kyops
Tetraodontidae	Amblyrhynchotes spinosissimus
	Arothron immaculatus
	Arothron sp.
	Chelonodon patoca
	Sphoeroides pachygaster
	Pelates quadrilincatus
Theraponidae	Therapon jarbua
	Therapon theraps
Trachichthyidae	Hoplostethus mediterraneus
Trachipteridae	Paratrachichthys sp.
Triacanthodidae	Trachipterus sp.
	Bathyphylax sp.
	Halimochirurus alcocki
	Halimochirus centriscooides
	Macrorhamphosodes platychellus
	Macrorhamphosodes sp.
	Paratriacanthodes retrospinis
	Triacanthodes sp.
	Tydemaniid navigatoris
Trichiuridae	Benthodesmus elongatus
	Trichiurus lepturus
Triglidae	Lepidotrigla multispinosus
	Lepidotrigla spiloptera
	Trigla sp.
Uranoscopidae	Uranoscopus archionema
Veliferidae	Velifer africanus
	Velifer hypselopterus

Annex 4 - continuation

Zeidae

Zenion leptolepis
Zenion hololepis
Zenopsis conchifer
Zenopsis sp.
Zeus faber

Shrimps, shallow waters

all shrimps caught in shallow waters
(mainly *Penaeus* sp.)

Shrimps, deep waters

all shrimps caught in deep waters
(mainly *Heterocarpus woodmasoni*)

Lobster

all lobsters, exclusive *Scyllaridae*
(mainly *Puerulus angulatus* and some
Metanephrops andamanicus)

Crabs

all crabs and *Scyllaridae*

Cephalopods

Squid, cuttlefish and incidental *sepia*
and *loligo*.

Annex 5: Working sheet no. 1.

Stratum IV NE-monsoon
(continuation)

Serial no.	Survey vessel	Original haul no.	Gear type	Effective distance (nm, from positions)	Effective distance (nm, from record)	Effective distance (nm, from calculated)	Effective sweep (nm)	Swept (nm ²)
19	UJUZI	1706	HOF5	-	-	3.5	0.0086	0.0301
20	UJUZI	1708	HOF5	-	-	7.0	0.0092	0.0644
21	UJUZI	3005	HOF5	-	-	1.8	-	0.0164
22	UJUZI	1203	HOF5	4.1	-	-	-	0.0435
23	UJUZI	1204	HOF5	3.0	-	-	-	0.0318
24	UJUZI	1209	HOF5	4.1	-	-	-	0.0435
25	UJUZI	*1210	HOF5	-	-	-	Doors twisted	
26	UJUZI	*3102	HOF5	3.9	4.0	-	Cod-end open	
27	F. NANSEN	896	BOTTOM TRAWL	-	1.1	-	0.0091	0.0100
28	F. NANSEN	897	BOTTOM TRAWL	-	1.1	-	0.0091	0.0100
29	F. NANSEN	898	BOTTOM TRAWL	-	0.7	-	0.0091	0.0064

Annex 6: Working sheet no. 2.
(catch in kgs, density in kgs/nm²)

STRATUM: V

	Haul No.	Swept (nm ²)	Corr. Fact.	Sharks and Rays		Snappers		Grunters (minus Pamamba)		Groupers		Emperors		Pamamba.		Chana	
				Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density
1	2009	0.0443	2.4	117.4	6360		0										
2	2008	0.0277	2.4	0.5	43		0										
3	2012	0.0537	2.4	96.9	4331		0										
4	871	0.0127	1.2	6.75	638		0										
5	872	0.0182	1.2	0.24	16		0										
6	886	0.0100	1.2	0.66	79	0.37	44										
7	887	0.0027	1.2	0.78	347		0										
8	870	0.0027	1.2	5.4	2400		0										
9	894	0.0109	1.2	5.47	602		0										
10	1701	0.0276	1.0	29	1051		0										
11	1702	0.0416	1.0	63	1514		0										
12	1703	0.0057	1.0	6.11	1072		0										
13	1707	0.0473	1.0	44	930		0										
14	1709	0.0258	1.0	14.6	566		0										
15	1806	0.0182	1.0	52	2857		0										

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	Small commercial fishes		Big fishes mixed		Small non-comm. fishes		Shrimps, shallow waters		Shrimps, deep waters		Lobster		Crab		Cephalopods	
	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density	Catch	Density
1	6.5	352	17.4	943	39.31	2130			16	867	388.5	21047		0	20.8	1127
2		0	2.9	251	20.82	1804				0	3.02	262	0.5	43	15.8	1369
3		0	9.8	438	44.2	1975			31.65	45	36.5	1631	1.6	72	10.5	469
4		0	8.04	760	11.28	1066			34.85	3463	12	1134	0.05	5	1.83	173
5		0	5.63	371	5.24	345			1.2	79	0.18	12		0	1.21	80
6	80.05	21606	0.12	14	1.94	233			0.25	30		0		0	2.32	278
7	0.62	276	0.38	169	4.48	1991			0.77	342		0		0	6.87	3053
8		0	0.56	249	3.75	1667				0	1.17	520		0	0.21	93
9		0	9.54	1050	12.13	1335			16.6	1828	41.4	4558		0	2.45	270
10		0	23	833	113.03	4095			149	5399	3	109	3	109	13	471
11		0	15	361	185	4447			74	1779		0	5	120	28	673
12		0	8.11	14.21	64.91	11388			3	526	3	526		0	3.5	614
13		0	136	2875	176	3721				0	10	211		0	93	1966
14	0.01	0	9.81	380	176.42	6838			40	1550	1	39	0.01	0	20	775
15		0	25.3	1390	144.92	7963			14.2	780	1.5	82		0	17	934

Annex 7: Working sheet no. 3, complete for all 15 groups.

Group: Sharks and rays.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kg/nm ²)	Con. Lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	1770	72	1285	360	2210
I	84	7	16862	173	1416	0	3866
III	24	28	1784	58	43	18	68
III NE	53	44	2900	34	154	102	206
III SE	53	60	3146	25	167	125	209
IV NE	66	25	1448	48	96	50	209
IV SE	66	27	2327	39	154	94	214
V	523	37	1088	40	569	341	797
VI	390	9	5151	134	2009	0	4701
MB-PI	1154	30	1138	36	1313	840	1786
PI	93	13	2308	63	215	80	3950

Group: Snappers.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. Lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	1908	79	1385	291	2479
I	84	7	442	191	37	0	108
III	24	28	201	202	5	0	15
III NE	53	44	18	86	1	0	2
III SE	53	60	92	78	5	1	9
IV NE	66	25	0	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	1	193	1	0	3
VI	390	9	-	-	-	-	-
MB-PI	1154	30	81	106	93	0	275
PI	93	13	-	-	-	-	-

NK = North Kenya Bank
 NE = North East Monsoon
 SE = South East Monsoon
 MB-PI = Malindi Bank - Pemba Island
 PI = Pemba Island

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annex 7.- continuation

Group: Grunters (minus Panama).

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	1442	75	1047	262	1832
I	84	7	77	218	6	0	19
II	24	28	236	54	6	3	9
III NE	53	44	203	115	11	0	24
III SE	53	60	101	95	5	0	10
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

Group: Groupers.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	579	52	420	202	638
I	84	7	1446	170	121	0	327
II	24	28	102	120	2	0	4
III NE	53	44	127	85	7	1	13
III SE	53	60	16	130	1	0	2
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

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annex 7 - continuation

Group: Emperors.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	609	86	442	62	822
I	84	7	-	-	-	-	-
II	24	28	-	-	-	-	-
III NE	53	44	-	-	-	-	-
III SE	53	60	17	200	1	0	3
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

Group: Pamamba.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	-	-	-	-	-
I	84	7	663	162	57	0	149
II	24	28	1218	83	29	5	53
III NE	53	44	2200	48	117	61	173
III SE	53	60	2059	22	109	85	133
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

annex 7 - continuation

Group: Chama.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	20	202	15	0	45
I	84	7	1308	204	110	0	334
II	24	28	68	144	2	0	5
III NE	53	44	1639	48	87	45	129
III SE	53	60	2580	33	137	92	182
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

Group: Small commercial fishes.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	66	80	48	10	86
I	84	7	516	184	43	0	122
II	24	28	8708	58	209	88	330
III NE	53	44	4738	55	251	113	389
III SE	53	60	5814	32	308	209	407
IV NE	66	25	6	129	0	0	0
IV SE	66	27	20	136	1	0	2
V	523	37	564	177	347	0	961
VI	390	9	-	-	-	-	-
MB-PI	1154	30	81	106	93	0	192
PI	93	13	40	216	4	0	13

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annex 7 - continuation

Group: Big fishes mixed.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	801	88	582	70	1094
I	84	7	2780	80	234	47	421
II	24	28	2196	40	53	32	74
III NE	53	44	809	34	43	28	58
III SE	53	60	2511	82	133	24	242
IV NE	66	25	1687	34	111	73	149
IV SE	66	27	2390	54	158	73	243
V	523	37	766	35	401	261	541
VI	390	9	272	112	106	0	225
MB-PI	1154	30	468	47	540	286	794
PI	93	13	464	64	43	15	71

Group: Small non-commercial fishes.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	648	39	470	287	653
I	84	7	959	207	81	0	249
II	24	28	2006	55	48	22	74
III NE	53	44	1897	58	101	42	160
III SE	53	60	2824	54	150	69	231
IV NE	66	25	3785	33	250	168	333
IV SE	66	27	6266	47	414	219	609
V	523	37	5064	79	2648	556	4720
VI	390	9	6810	111	2656	0	5604
MB-PI	1154	30	5519	53	6359	2993	9745
PI	93	13	3419	53	318	149	487

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annex 7 - continuation

Group: Shrimps, shallow waters.

Area	Trawlable surface (mm ²)	No. of hauls	Mean density (kgs/mm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	-	-	-	-	-
I	84	7	-	-	-	-	-
II	24	28	321	47	8	4	12
III NE	53	44	0	202	0	0	0
III SE	53	60	22	171	1	0	3
IV NE	66	25	-	-	-	-	-
IV SE	66	27	-	-	-	-	-
V	523	37	-	-	-	-	-
VI	390	9	-	-	-	-	-
MB-PI	1154	30	-	-	-	-	-
PI	93	13	-	-	-	-	-

Group: Shrimps, deep waters.

Area	Trawlable surface (mm ²)	No. of hauls	Mean density (kgs/mm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	94	200	68	0	204
I	84	7	-	-	-	-	-
II	24	28	-	-	-	-	-
III NE	53	44	-	-	-	-	-
III SE	53	60	-	-	-	-	-
IV NE	66	25	200	81	13	2	24
IV SE	66	*39	440	25	29	22	36
V	523	*38	564	64	295	106	484
VI	390	9	1038	115	405	0	871
MB-PI	1154	30	130	95	150	8	293
PI	93	13	637	104	59	0	120

* : semi-commercial hauls incorporated, during which only the catches of shrimps and lobsters were recorded.

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annex 7 - continuation

Group: Lobsters.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	-	-	-	-	-
I	84	7	-	-	-	-	-
II	24	28	1	157	0	0	0
III NE	53	44	-	-	-	-	-
III SE	53	60	-	-	-	-	-
IV NE	66	25	1430	44	94	53	135
IV SE	66	*39	5001	34	330	218	442
V	523	*38	1331	85	696	104	1288
VI	390	9	75	209	29	0	90
MB-PI	1154	30	106	59	122	50	194
PI	93	13	3	216	0	0	0

Group: Crabs.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	1743	133	1265	0	2974
I	84	7	-	-	-	-	-
II	24	28	1	153	0	0	0
III NE	53	44	-	-	-	-	-
III SE	53	60	-	-	-	-	-
IV NE	66	25	21	107	1	0	2
IV SE	66	27	319	87	21	3	39
V	523	37	35	69	18	6	30
VI	390	9	26	168	10	0	27
MB-PI	1154	30	7	99	8	0	16
PI	93	13	44	107	4	0	8

* : semi-commercial hauls incorporated, during which only the catches of shrimps and lobsters were recorded.

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annex 7 -- continuation

Group: Cephalopods.

Area	Trawlable surface (nm ²)	No. of hauls	Mean density (kgs/nm ²)	Con. lim. (%)	Mean estimate (ton)	Min. estimate (ton)	Max. estimate (ton)
NK	726	43	141	63	102	38	166
I	84	7	108	189	9	0	26
II	24	28	82	58	2	1	3
III NE	53	44	106	38	6	4	8
III SE	53	60	97	42	5	3	7
IV NE	66	25	760	35	50	33	68
IV SE	66	27	1314	39	87	53	121
V	523	37	673	33	352	236	468
VI	390	9	242	118	94	0	205
MB-PI	1154	30	215	26	248	184	312
PI	93	13	212	83	20	3	37

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