Cetaceans and fisheries in Kenya coastal waters: a preliminary study

OMONDI E.O.
Kenya Marine and Fisheries Research Institute
P.O.Box 81651 Mombasa
KENYA

Abstract

Of all marine resources characteristic of the Kenya coast, marine mammals are least studied singly or in association with other resources. In this paper, available records on cetacean catches by districts between 1978-1991 inclusive were used to assess the status and trend of their fishery, distribution, and interactions with sharks, clupeids and tuna landings. Spatial and temporal variations in takes were evident. The Mombasa district led in total catch (62.2 tons) while the Tana River district ranked last (0 tons). Fluctuations in catch were highest in Mombasa ($S_d = 3.8$) and lowest in Lamu ($S_d = 0.7$). The mean annual landings ($X$) at $p < 0.05$ corresponded well with the totals for the districts. The sharks, clupeids and tuna were landed by a range of fishing gears that changed with time. Total fish catch by species fluctuated considerably. Although the lines of ‘best-fit’ showed some relationship between the landings of sharks, clupeids and tuna on one hand and cetaceans on the other, the linear component on the relationships were not highly significant at $P < 0.05 (4.84)$. The possible impacts of other human activities on the cetacean populations are discussed. Priority areas in marine mammal studies and management strategies vital in ensuring a balanced co-existence of the coastal populations and ecosystems are also discussed.

Introduction

Ecological, economic, subsistence and cultural values of marine mammals are well documented (UNEP, 1984, 1985; Holt, 1986; Klinowska, 1991). For centuries, cetaceans (whales, dolphins and porpoises) have continually been killed (Leatherwood et al, 1989). As they are harpooned, shot, netted and trained to jump through hoops, their populations are seriously threatened. Habitat degradation, food depletion, water pollution and invasion of breeding grounds all pose major threats to the mammals (UNEP, 1988). Killing of large cetaceans is regulated by the International Whaling Commission (IWC). Direct takes of small ones have increased in some less developed parts of the world (Perrin, 1989), and careful and tactful monitoring, together with information on direct and incidental takes, is vital (Klinowska, 1991). The status of most species in the less studied oceans, such as area 51 (Western Indian Ocean) are still unknown.

The distribution of cetaceans in the southern and northern hemisphere is well known (Brown, 1986; & Barstow, 1988). Whereas Heintzelman (1981) reported 27 species as occurring in the Indian ocean, Holt (1988) estimated the number to be about 7 baleen whale species and 33 small cetaceans. Mortality of cetaceans in passive fishing nets and traps have also been extensively discussed (IWC, 1990). In the Indian Ocean most of the work has been restricted to the extreme south and the coasts of India (Moses, 1947; Rao, 1962; Alagarswami, et al, 1973). The only records available in Kenya are those compiled by the Kenya Fisheries Department. Although all cetaceans are considered as ‘dolphins’, the data provide a basis for future detailed work. In this
paper catch statistics are analysed in an attempt to describe the distribution of the cetaceans and to identify any interactions between them and selected fisheries resources.

Environment

The Kenya coast is heterogeneous in nature with its 650 km length extending from latitude 1½°S to 4½°S (Fig. 1a) bordering Somalia in the north and Tanzania in the south. It supports fringing reefs and patches of reefs which lie mostly 0.5-0.2 km offshore.

The coastal climate is dominated by seasonal monsoon winds: the southeast Monsoon (SEM) from April to October and the northeast Monsoon (NEM) from November to March. Currents derive from the South Equatorial Current which splits on reaching the African coast to form the East African coastal current (northerly flow). Along the Kenya coast, this causes a northward water movement for most of the year. Current velocity is high averaging 2-4 knots. The influence of the northeast monsoon in the northern part of the coast reverses the current flow southward. Hove (1981) and Newell (1957) present further details. The effect of such changes is reflected on productivity and exploitation of the available marine resources which includes fisheries, mangrove forests, marine algae and seagrasses. The fisheries resources exploited mainly by artisanal fishermen and which the government intends to intensify have performed below expectations (Oduor, 1984). Among other species, sharks, clupeids and tuna used in this study are caught. Although the fishing gears are specific in time and space, sharks were mainly landed by gill nets (polyethylene) polymide ply 2, 24, 36, x 56 MD x 144 m x 152 mm and line fishing. Other mesh sizes; 2", 3" 4" and 4½" are used for smaller species. Tuna were landed by lines whereas modified and/or unmodified beach seines, cast nets and surrounding nets were used in the clupeid fishery (Mbuga, 1981).

Materials and methods

**Catch statistics**

Fish annual landings collected by the Kenya Fisheries Department (KFD) over a thirteen year period (1978 – 1991) were used. Estimates for 1983 were excluded due to an inconsistency in recordings. Total weights were presented in metric tons to the nearest one decimal place.

**Distribution**

The statistics were compared graphically and statistically for each of the fishery and all the five coastal districts; Kwale, Mombasa, Kilifi, Tana-River, and Lamu (Fig. 1a). The outcome of these comparisons were used as indicators of distribution.

(a) Mean landings

This was computed as: \[ X = \frac{X}{N} \text{ met.tons} \]

\[ X = \text{mean landing} \]

\[ X = \text{annual landings in metric tons and} \]

\[ N = \text{total number of years.} \]

To the mean, a 95% confidence limit was attached using the formula:

\[ X \pm t.s/N \]
where \( t \) was read from the Students' table at a selected probability level, \((P<0.05)\) with \(N-1\) degrees of freedom, and being the standard deviation.

(b) Standard deviation

This was used as a measure of fluctuation about the mean using the equation:

\[
S_d = \frac{X^2 - (x)^2}{N}
\]

\( X \) and \( N \) are the same as for mean.

**Fisheries cetacean interaction**

The relationship between landings of cetaceans on the one hand, and sharks, clupeids, and tuna on the other in each of the districts, was studied by regression analysis using the simple regression equation:

\[
b = \frac{\{xy - (x)\}(y)N}{N}
\]

\( b \) = regression coefficient

\( x \) = cetacean catch

\( y \) = landing of each of the fishery used alternately.

The significance of the regression was tested at a probability level \((P<0.05)\) in an analysis of variance. The total sum squares of \( Y \), \((Y^2)\) was partitioned into two, each divided by its number of degrees of freedom, to obtain mean squares. \( F \) was computed as regression mean squares, divided by residual mean squares.

**Results**

**Distribution**

Cetaceans were widely distributed during 1978-91 throughout the Kenya coast with the exception of the Tana-River district. However, sharks, clupeids and tuna were landed in the district. Cetacean landings differed in time and space (Fig.2). The Mombasa district led with a catch total of 62.6 metric tons, followed closely by the Kilifi district, with 62.0 metric tons. Combined statistics for the cetaceans and the four selected fish species indicated that despite this, only 1.1% of Mombasa district’s catches comprised the cetaceans. Other percentages were; Kilifi, 3%; Kwale, 2.8%; Lamu, 0.8% and Tana-River, 0%. Table 1(a) and (b) shows the apparent variations. The highest spread from the mean \((S_d = 3.8)\) was recorded in Mombasa.

**Table 1a: Total landings and standard deviations of landings by districts (1978-91)**

<table>
<thead>
<tr>
<th>District</th>
<th>Cetaceans</th>
<th>Sharks</th>
<th>Clupeids</th>
<th>Tuna</th>
<th>Cetacean</th>
<th>Sharks</th>
<th>Clupeids</th>
<th>Tuna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwale</td>
<td>27.9</td>
<td>321.4</td>
<td>542.4</td>
<td>124.4</td>
<td>1.8</td>
<td>5</td>
<td>15.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Mombasa</td>
<td>62.6</td>
<td>1417.2</td>
<td>3798.2</td>
<td>204.9</td>
<td>3.8</td>
<td>26.9</td>
<td>46.6</td>
<td>5.7</td>
</tr>
<tr>
<td>Kilifi</td>
<td>62</td>
<td>982.7</td>
<td>600.6</td>
<td>422.4</td>
<td>2.9</td>
<td>28.9</td>
<td>20.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Tana R.</td>
<td>0</td>
<td>86</td>
<td>1</td>
<td>20.1</td>
<td>0</td>
<td>4</td>
<td>0.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Lamu</td>
<td>3.6</td>
<td>348.8</td>
<td>0.5</td>
<td>80.7</td>
<td>0.7</td>
<td>10.1</td>
<td>0.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Grand Total</td>
<td>156.1</td>
<td>3156.1</td>
<td>4942.7</td>
<td>849.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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I; The Indian Ocean Whale Sanctuary extends as far south as the 55 degree So thereby excluding the pelagic minke whale grounds in the Arctic. (From Holt, 1986)
Coastal systems studies and sustainable development

Fig. 2

Fig. 3
Fig: 3
Fig 3
Table 1b: Mean landings by districts*

<table>
<thead>
<tr>
<th>District</th>
<th>Cetaceans</th>
<th>Sharks</th>
<th>Clupeids</th>
<th>Tuna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwale</td>
<td>2.1 ± 1.9</td>
<td>24.7 ± 3.02</td>
<td>41.7 ± 9.42</td>
<td>9.3 ± 3.8</td>
</tr>
<tr>
<td>Mombasa</td>
<td>4.8 ± 2.29</td>
<td>109.0 ± 16.24</td>
<td>292.2 ± 28.01</td>
<td>15.8 ± 3.4</td>
</tr>
<tr>
<td>Kilifi</td>
<td>4.8 ± 2.0</td>
<td>75.6 ± 17.40</td>
<td>46.2 ± 12.3</td>
<td>32.5 ± 6.3</td>
</tr>
<tr>
<td>Tana River</td>
<td>0</td>
<td>6.6 ± 2.41</td>
<td>0.5 ± 0.12</td>
<td>1.6 ± 0.7</td>
</tr>
<tr>
<td>Lamu</td>
<td>0.3 ± 0.42</td>
<td>26.8 ± 6.10</td>
<td>0.04 ± 0.12</td>
<td>1.6 ± 0.7</td>
</tr>
</tbody>
</table>

*Data from Kenya Fisheries Department landing records (1978 - 1991)

Except for Tana River, Lamu and Kwale during 1979 and 1980, all the other districts reported catches yearly (Fig. 3a-e).

**Cetacean catches compared to other species.**
For the four districts of Kwale, Mombasa, Kilifi and Tana-River, total cetacean landings were less than that of sharks, clupeids and tuna. Lamu was unique, landing more cetaceans than clupeids.

**Trend of cetacean fishery**

* Kwale district

The district showed a distinct pattern in cetacean fishery. It had slight variations in catch between 1978-85 followed by an increase between 1986-88 and finally, a fall (Fig 3a).

* Mombasa district

Apart from 1979, the years between 1978-82 experienced a constant catch of cetaceans averaging 1.0 met tons per annum. Fig 3b showed that catches then increased gradually until 1990. The tuna fishery had a similar trend but with higher fluctuations (Sd = 5.0).

* Kilifi district

Cetacean landings fluctuated considerably over the period with a lower spread from the mean than that of Mombasa and the other fisheries in the district (Table 1a). From the bar graphs of Figure 3c, it is difficult to relate cetacean catches to any other fishery.

* Tana – River

No cetacean catches were reported. The district was poor in fishery of the fish species compared to other districts. Whereas no tuna was recorded in 1978, sharks dominated the fishery throughout the period.

* Lamu district

Although higher than the total catches of clupeids, cetacean landings were very low, averaging 0.3 metric tons per annum. Figure 3e featured an exceptionally low catch in 1989.

Throughout the period, both tuna and sharks were landed with the former taking the lead.
**Fisheries – cetacean interaction**

From regression graphs, there seems to be some relationship between the landings of the cetaceans and that of sharks, clupeids and tuna (fig. 4-7). Computed values of regression analysis are presented in Table 2. Both at the district and species level, the computed values of F were less than the tabular value for 1/11 ($V_1$, $V_2$) degrees of freedom at p < 0.05 (4.84). This meant however, that the linear component on the relationships were not highly significant.

### Table 2. Regression coefficients ($r$) and variance ratio ($f$).

<table>
<thead>
<tr>
<th>Species</th>
<th>Sharks – Cetaceans</th>
<th>Clupeids – Cetaceans</th>
<th>Tuna – Cetaceans</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td>($r$)</td>
<td>($f$)</td>
<td>($r$)</td>
</tr>
<tr>
<td>Kwale</td>
<td>0.090</td>
<td>0.845</td>
<td>4.970</td>
</tr>
<tr>
<td>Mombasa</td>
<td>2.807</td>
<td>1.050</td>
<td>6.940</td>
</tr>
<tr>
<td>Kilifii</td>
<td>1.232</td>
<td>0.972</td>
<td>3.590</td>
</tr>
<tr>
<td>Tana R.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lamu</td>
<td>28.431</td>
<td>0.302</td>
<td>0.040</td>
</tr>
</tbody>
</table>

### Discussion

That cetaceans were caught along the Kenya coast agrees with Barstow (1988) that they occur in all oceans of the world. A lack of reports on catches in the Tana-River districts could be because cetaceans have preferences (Heintzelman, 1981). In this case however, it may be attributed to a low clupeid fishery output and/or uncontrolled landings. The former would be true in the case of *Delphinus delphis* (common dolphin) whose diet includes commercial species, especially anchovies and clupeids in the Western Indian Ocean. Neither the difference in the area of districts adjacent to the Ocean nor the inaccuracies in the collection of fisheries statistics (Oduor, 1984) convincingly explains the discrepancy in the Tana-River district. Intense agricultural activities, discharge, dumping and damming along the River Tana may have a profound effect on the cetacean populations, distribution and catch within the area, under its influence. Klinowska (1991) explains this to be true for river dolphins. Compared to other parts of the world the takes in Kenya might be considered low. This must not be taken to justify continued or increased exploitation of the cetaceans unless their populations are understood.

Commercial fisheries are reluctant in providing their catch data (Oduor, 1984). The declaration of the Indian Ocean north of Lat. 55°S as a sanctuary (IOS) in 1979 could explain the low catches (Fig. 1b). The use to which caught cetaceans are put to in Kenya is unknown. Catches and their skeletons disappear completely from the beach, suggesting the catches could be intentional although the statistics do not indicate it. The situation in Kenya might be similar to that of Sri Lanka (Leatherwood *et al.*, 1983a) where fishermen, either aware it is illegal to fish dolphins or due to their weights, cut adrift the entangled cetaceans which later die. The records would then be under-estimated. In the tropics, fishermen have long used dolphins especially to locate schools of tuna and other fish (UNFP, 1985) which would then be caught using hook and line or netting techniques. The dolphins are also stranded in the process. The restriction of artisanal fishermen to the inshore waters render their statistics inadequate in clearly establishing the fisheries-cetacean interactions unless supplemented by information from commercial and sports fishermen. This could justify the insignificant linear component observed here.
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Fig. 4

CETACEAN LANDINGS (met tons)

A. $r = 0.003$

$y = 24.70 + 0.009x$

B. $r = 0.569$

$y = 35.06 + 1.97x$

C. $r = 0.094$

$y = 3.74 + 0.28x$
Fig 6

CETACEAN LANDINGS (met tons)
Fig 7

A

\[ y = 28.42 - 5.93x \]

\[ r = 0.376 \]

B

\[ y = 0.05 - 0.03x \]

\[ r = 0.187 \]

C

\[ y = 6.75 - 1.96x \]

\[ r = 0.307 \]
Conclusion

Cetaceans are widespread along the Kenya coast where they are landed together with fish each year. Catches fluctuate in time and space. No fishery is apparently specifically responsible for the cetacean takes. Other fisheries (apart from those considered in this paper) require examination. It is the intention of the Kenya Government to utilize all the available exploitable marine fisheries resources to provide food for the growing population, to the rural and coastal population and to earn foreign exchange from export. Her target landing of 20,000 metric tons per annum by the year 1988 has not been realised as only 10,000 metric tons were landed in 1991 (Fisheries Dept. 1992, unpublished). Any attempts to intensify fishing could be extremely detrimental to the cetaceans of the Kenya coast unless the effects of the fishing gears on the mammals are firmly established. It is imperative that urgent back-up studies on cetacean taxonomy, distribution and incidental entanglement be conducted and used as a basis for future development in both the sector of marine fisheries and cetacean conservation in Kenya.

Acknowledgements

I am extremely grateful to the Kenya Fisheries Department (Marine Sector) for their invaluable help in collecting data in the field. I am also indebted to Dr. Ezekiel Okemwa, Director Kenya Marine and Fisheries Research Institute who helped in one way or the other. The patience of my wife Susan during the course of this work is heartily acknowledged. Finally I sincerely thank Mrs. Grace Kondi who typed this work.

References


