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Causes and Mitigations on Trap Ghost Fishing in Oman: Scientific Approach to Local Fishers' Perception

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Abstract: This study aims to investigate the ghost fishing problem in Sultanate of Oman. The questionnaire survey on trap ghost fishing in Oman provided information on rates of trap loss, the financial cost to fishers, the cause of trap loss and the circumstances leading to non recovery of fish traps. Each trap fisher in the Omani fishery owned and fished on average 20.4 traps per fishing day and each trap had a mean useful lifetime of 5.7 months. The study revealed that a total of 15,390 traps or 18 traps per fisher are lost every year in the study area. Once lost, these traps remain functional and on average continue to ghost fish for a period of 3.1 months per year. The three main causes of trap loss were gear interference, theft and/or vandalism, and collisions with boats and ships. Economic losses resulting from ghost fishing by traps was estimated to be 1,011,594 O.R. (US$ 2.63 million), equivalent to 2.1% of the total landing value of the Omani fishery in 2006. To reduce ghost fishing it is recommended that traps be better marked, that they be equipped with timed-release or degradable sections or panels, and that openings be included in the traps for the release of sub legal size fish. Conflicts with other fishing vessels and other types of gear could be reduced by implementing a zonation policy.

Key words: Oman, gear conflict, trap loss rate, questionnaire survey

INTRODUCTION

There are different types of unaccounted fishing mortality: ghost fishing; non-reporting or under reporting of landings; and losses of fish that had encountered fishing gear but were not caught (Chopin *et al*., 1996). Ghost fishing is the ability of fishing gear to continue functioning and induce mortality to aquatic organism after all control of that gear is lost by fishers (Smolowitz, 1978a; Matsuoka, 2005). The impact of ghost fishing on some commercial stocks has been estimated to comprise between 5 and 30% of total annual landings (Laist, 1995). In a trap fishery alone, such fishing may contribute to financial losses ranging from 3 to 13.5% of the total value of the catch (Mathews *et al*., 1987).

The loss of fish to ghost fishing remains of significant concern to both fishers and to fisheries managers (Jennings and Kaiser, 1998). Yet the magnitude of this mortality is seldom quantified. Knowledge of ghost fishing rates will assist in improving fishing methods (to reduce gear loss) and/or to design fishing gear that will become ineffective once lost (Carr and Harris, 1994).

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In trap fisheries in the Sultanate of Oman, a ghost fishing mortality rate of 67 kg trap over a three month period was estimated, with the trapped fish having a value of 55 RO/trap (US$143) over the same period (Al-Masroori *et al*., 2004).

Due to the seasonality of the fishery, most fishers in Oman operate several types of gear *viz*., bottom set and drift gill nets, traps (wire mesh and plastic types), barrier traps, hand lines and cast nets (Siddeek *et al*., 1999). By far the most significant gear employed in the fishery is drift gillnet, (about 56% of total gears used). Fish traps, (about 19% of the total gears used) were the most common passive gears (Al-Oufi *et al*., 2000). Traps are constructed of wood, wire mesh, plastic coated steel mesh or netting, using designs developed to suit local conditions. Generally, Omani fishers employ wire basket traps that are semi-circular in cross-section. Two methods are used to mark traps at fishing grounds; marking each trap with a buoy (increasing the risk of theft and vandalism), or by connecting a group of traps by rope. Other fishers rely on their experience and on landmarks to identify trap positions which are retrieved using a drag anchor to pick up the rope connecting the traps.

The causes of trap losses and their consequences on Omani fish stocks and on the well being of traditional fishers were investigated in this study. The study presents estimates of the number of traps fished, their loss rate and recommend solutions to mitigate the impact of ghost fishing on the marine environment.

MATERIALS AND METHODS

Data for this study were gathered from a cross-sectional survey (Bulmer and Warwick, 1993) conducted in five coastal towns (Barka, Al-Seeb, Busher, Mutrah and Muscat) along the Gulf of Oman (Fig. 1). This survey is a face-to-face situation, in which the interviewer asks respondents questions

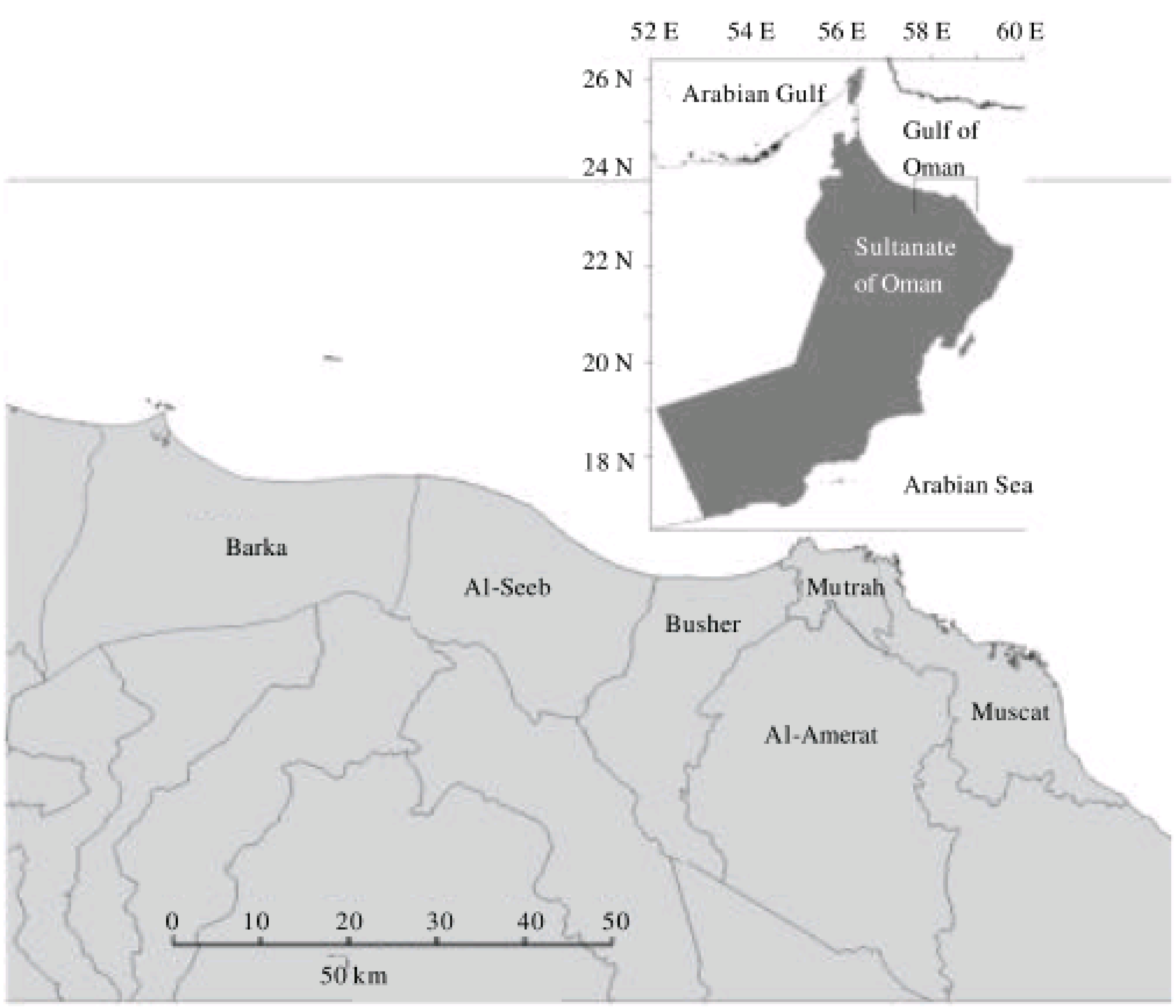

Fig. 1: A map depicting the survey study site

designed to obtain answers pertinent to the research hypothesis. It is a schedule-structure interview, in which the questions, their wording and their sequence are fixed and identical for every respondent. The aims of this questionnaire survey were to estimate the loss rate of the traps, the cost of trap loss to fishers, the reasons for losses and the location and timing of trap loss. In addition, the survey addressed information related to characteristics of the trap fishery in the research area and ways to mitigate the ghost fishing problem.

The questionnaire in this study was divided into five sections including closed-ended, open-ended and contingency questions (Frankfort-Nachmias and Nachmias, 1997). The first section concerned general personal information, such as the fisherman's age and the village where they live. The second section explored the fishing assets of the fishermen. The third section was about trap fishing activities, the cost of fishing activities and their income from fishing. The fourth section was about the current status of demersal fish resources in the study area. The last fifth section was on the trap fishery and ghost fishing, which focused mainly on the reasons behind ghost fishing and the solutions suggested to solve the problem.

Before administering the questionnaire to the fishers it was sent to a panel of experts in the field (academics and managers) to determine its content validity. They were asked to give their opinion regarding each question and their relevance to the issue of the sections. Also they were asked to list any areas that are pertinent to the issue measured in the section but not covered in the questions. The comments received from the panel of experts were used to reconstruct the questionnaire. It was then translated into Arabic language by the researcher and the translation was appraised by other Arabic speaker researchers. Then, the final format was pre-tested on five fishers to ensure that the questions and issues regarding the subject of the study were included and clear of any ambiguities and that the respondents could answer the questions without significant constraint.

As the questionnaire was aimed at estimating a proportion of a population (proportion of traps lost per year), Eq. 1 (Ott, 1988; Thompson, 1992) was used to determine the required sample size for precise estimates (95% confidence level; Z = 1.96).

$$n = \frac{Z^2P(1-p)}{d^2} \tag{1}$$

Where:

n = Required sample size
Z = Value of the desired level of confidence
P = Expected proportion of trap lost per year
d = Maximum allowable error

A pilot study was conducted by personally interviewing 22 fishers in the research area before starting to conduct the main questionnaire. It aimed to define the study area and its zones through meetings with the local trap fishers and to determine an estimation of some related parameters. The proportion of trap lost per year (P) was found to be between 10 to 30%, so 20% (P = 0.20) was used as the expected proportion. Using 95% confidence intervals, which means that the estimate of the population proportion is within ±10% (0.1) of the true proportion, then:

$$d = 0.1\ \ P = 0.1\times0.2 = 0.02$$

The finite population correction following Eq. 2 (Frankfort-Nachmias and Nachmias, 1997) was then added to calculated the final reliable sample size.

$$n' = \frac{n}{1 + \frac{n}{N}} \qquad (2)$$

Where:
N = Population size
n = Sample size
n' = Optimal sample size

Some trap fishers were selected, by a proportional random sampling method, and interviewed using validated and pre-tested questionnaire according to the principles described by Frankfort-Nachmias and Nachmias (1997). The population of fishers surveyed was stratified in relation to geographic location, i.e., the sampling frame was divided into towns (strata). Within each fishing town, fishers were further stratified according to their respective fishing villages. One to three days was assigned to cover each village. The interviews took place mostly in the afternoon between 4 and 7 pm. During this time most of the fishermen were available on the beach for interviews as they were engaged in different activities such as mending their nets and preparing their gear and boats for the next fishing trip. Sometimes, the fishermen were interviewed in the mosque after prayer and few were interviewed in their houses.

Data obtained from the questionnaire were first coded and then entered into Statistical Package for Social Science (SPSS 9.0) ®. Single factor Analysis of Variance (ANOVA) was used in this study to test the variation in trap loss rate between cities.

RESULTS AND DISCUSSION

There were 1709 registered fishers in the study area, 855 (or 50%) of whom used traps (amongst other fishing gear). Individual fishers own an average of 15 traps. The results of the survey indicated that among the 92 fishers interviewed in the survey, 88 of them (95.7%) were aware that the lost traps will continue to fish for a period of time. However, only a few of them (27.2%) recognized or believed on a negative impact of ghost fishing, which indicate a need for an extension program. Results in Table 1 indicated that trap losses were distributed evenly at different depths in fishing grounds; with a higher percentage (26%) of lost traps reported at 20-40 m water depth (the preferred fishing ground).

Most of the trap fishers surveyed (88%) confirmed losing an average of 18 traps per year. When the rate of lost traps was compared among towns, the results showed no significant difference (ANOVA; P = 0.372, d.f = 80). Based on the above rate, the estimated number of lost traps per year was 15,390 traps or 88.2% of total number of traps deployed yearly in the study area (i.e., 17, 442 traps). The life span of new traps under normal operating usage was estimated to be 5.7 months. Survey results indicated that lost traps have an average age of 2.6 months when lost, suggesting that

Table 1: Percentage of fishermen reported lost traps according to water depth (n = 90)

Depth (m)	Fishermen (%)
Less than 20	23.7
20-40	26.0
40-60	18.8
60-80	16.0
More than 80	15.5

Table 2: Reasons, proposed solutions and percentage of fishermen citing each reason

Reason	Percentage	Solution	Percentage
Gear interference	33.3	Zonation	78.8
Theft/vandalism	32.9	Surveillance and law enforcement	10.6
Boats collision	21.9	Surveillance and law enforcement	10.6
Strong current	5.9	-	-
Bad weather	4.2	-	-
Bottom snag	1.7	-	-

Table 3: Senat Al-Bahar rules and actions that used to govern the trap fishery in the study area

Rule	Fishermen identified the rule (%)
Zonation	44.8
Ban on driftnet	20.7
Ban on encircling nets	17.2
Respect other fishermen	10.3
Sentence	7.0

traps will remain functional and effectively ghost fish for at least 3.1 months. Thus the annual impact of ghost fishing is estimated to be 1,102.4 metric tons worth 910,574 RO per year (US$ 2.4 million).

Six main causes for the loss of traps were stated by interviewed fishers. More than two thirds of the fishers agreed that interference by other gear (33.3%) and theft and/or vandalism (32.9%) were the two main reasons for lost gear. Loss because of natural reasons (current, wind and bottom snag) were reported by 11.8% of the fishers. Boat collisions were responsible for about 21.9% of gear losses (Table 2). Such a high rate of trap losses due to boat collision was predicted because of the lack of proper marking of traps when deployed. These same causes were also recognized by Smolowitz (1978a, b), Breen (1990) and Laist (1995).

Fishers proposed a number of solutions to the problem of trap losses. Introducing zones specific to each type of gear could solve gear conflicts as reported by 78.8% of the interviewed fishers, but the social problem of theft and vandalism is more likely to be resolved by an effective surveillance and law enforcement (Table 2). Other solutions such as the use of Global Positioning System (GPS) to mark trap position were stated by some fishers (8.2%).

Historically, almost all the solutions identified above were practiced and enforced in the past under the indigenous management institution Senat Al-Bahar. Senat Al-Bahar has been governing the traditional fishery in the study area for many centuries until 1970 when the governance of coastal fisheries. In Oman was transferred from the local communities to the central government (Al-Oufi *et al*., 2000) (Table 3). About one half of the fishers included in this study claimed that, in the past, fishing grounds for active gear were separated from passive gear (zonation rules). Fishers indicated that in some areas local communities prohibited the use of drift nets and encircling nets. In the present study, prohibition of such gear was proposed by 20.7 and 17.2% of the fishers respectively (Table 3).

Only 11.5% of those surveyed indicated compliance with traditional rules of Senat Al-Bahar listed in Table 3. More than 84% of the respondents agreed to use a release device in their traps, whereas the remainder of fishers feared additional cost burdens and negative effects on catching efficiency.

Although 27.2% of the fishers appear to be aware that lost traps affect the environment and 43.5% agreed that they can deplete fisheries resources, paradoxically 64.1% of fishers actually discard damaged traps in the sea. This again emphasizes the need for extension efforts to educate fishers about the consequence of dumping traps into the sea.

As discussed above, the main cause of trap loss was due to gear interference between traps and active gear (Table 2) with drifting gillnets being most the damaging gear when it

Table 4: Percentage of fishermen who reported the impact of active fishing gear on trap losses

Gear	Fishermen identified the gear (%)
Drift gillnet	63.8
Encircling net	31.2
Trawling	3.8
Beach seine	1.2

entangled with trap buoys and buoy lines followed by encircling net as identified by 63.8% and 31.2% of the total interviewed fishers respectively (Table 4).

In addition to lost in income from the sales of fish, other economic losses from ghost fishing include capital cost of the trap and its accessories. Amortizing to 54% of its new value at the time the trap is lost means that a trap value of 6.564 RO can be assigned to each lost trap. Thus the annual loss of traps equates to 101,020 RO (US$ 262,390).

Therefore, the total average equivalent annual tangible economic losses produced by the trap ghost fishing is estimated to be 1,011,594 RO, which amounts to 2.1% of the total landed value of the Sultanate's catch in the year 2006. Annual losses estimated by Mathews *et al*. (1987) in Kuwait were equivalent to 3-13.5% of the value of landing, which accounts for 200,000-400,000 KD (260,000-520,000 RO).

The main findings of this research indicate that the problem of trap ghost fishing in the study area is severe and caused mainly by gear interference and vandalism. Introducing zonation as a management tool could solve this conflict. Another significant cause of trap loss is boat/ship collision with the trap buoys. The use of visible and long lasting buoys as a marking method could solve this problem.

In Oman there were traditional fisheries laws (Senat Al-Bahar) used to govern the fish resources and manage the fisheries in the country and to prevent any conflict between fishing methods. The legislations of this management institution are adopted from Islamic rules as well as traditional convention. The objectives are to define responsibilities, conserve the fishery and limiting personal and communal disputes (Al-Oufi, 1999).

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