The University of Hull

SOCIAL AND ECONOMIC FACTORS INFLUENCING THE EMERGENCE OF COLLECTIVE ACTION IN A TRADITIONAL FISHERY OF OMAN: AN EMPIRICAL ASSESSMENT OF THREE COASTAL FISHING TOWNS IN SOUTH AL-BATINAH

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ABSTRACT

Overexploitation of many fish stocks underlines the need for more effort directed towards stock management so that the sustainability of resources is assured. To avert the tragic consequences of overfishing in coastal waters, a growing body of theoretical and empirical research provides evidence in support of cooperation among resource users to manage their commons. This study aimed to investigate the factors that contribute to the emergence and evolution of collective action in fishermen's communities to manage their coastal fish resources in South Al-Batinah, Sultanate of Oman. The study emphasises the importance of a collective action approach to fish resource management with examples from three fishing towns.

In order to understand why fishermen choose to participate (or not to participate) in local collective action to manage fish resources, the researcher focuses on six main sets of issues that influence fishermen's decisions: economic factors; awareness of resource exploitation problems; institutional rules in use; social identity, group size and heterogeneity among resource users. Social and demographic factors as well as vessel configuration were also considered.

Data collection for the study was carried out using three methods: questionnaire, semi-structured interview and observations of fishermen's activities. Statistical reports and other research papers carried out in Oman were also reviewed.

The study found that there is a management institution that governs the fishing activities of the fishermen in the study area. Fishermen in the area inherited an indigenous management institution, which was established hundreds of years ago. It was also found that fishermen were very aware of the resource exploitation problems. High awareness of the resource exploitation problems coupled with high interdependence among users might induce them to work collectively to mitigate harm to their long-term welfare.

The results of testing a number of hypotheses indicated that among the reasons which may influence collective action, are high economic dependence on the fishery, individuals' social identity as fishermen, awareness of the resources exploitation problems, risk aversion and heterogeneity (differences in objectives and interests).

The study findings indicated that individuals using common resources are faced by various "assurance" and "chicken" problems. In both the PD game and the Assurance game, the preferred outcome is mutual cooperation. Whereas the predicted outcome of the former is defection, the latter suggests the possibility that the preferred outcome (i.e., cooperation) will occur, because individuals' decisions in the commons are influenced by a complex set of factors, rather than strictly materialistic self-interest. The analysis presented in this study examined several of those factors for their influence on individual behaviour.

The findings of this study strongly suggest that the presence of local management institutions to coordinate the fishermen's activities in the study area is the key factor in avoiding the worst outcome (universal defection). The game structure has been changed from a Prisoner's dilemma to a Privileged game or a game of Chicken where the benefits from cooperation are maximized. It is the role of the institutions to determine how the cost of providing the public goods might be shared among participants.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Fish resources can be appropriately utilised and managed in common, but at the same time they are susceptible to destruction by the users themselves in what has been called the "tragedy of the commons" (Hardin, 1968). The literature abounds with examples of overfished fisheries around the world. Fisheries management has often failed in Europe and America and threatens to fail in developing countries too (Baland and Platteau, 1996). The following quotation highlights this fact: "*it is in the light of the perverse logic of open access that the following distressing facts must be understood. Almost all the world's 200 fisheries monitored by the FAO are today fully exploited. One in three is depleted or heavily overexploited, almost all in developed countries*" (Baland and Platteau, 1996; p. 28).

Overexploitation of many fish stocks underlines the need for more effort directed towards stock management so that sustainability of resources is ensured. To avert the tragedy, a growing body of theoretical and empirical research developed during the last twenty years provides evidence in support of cooperation among resource users to manage their commons as an alternative to the expensive and often inappropriate state management. There are many researchers who have focused on factors that appear to influence individuals' decision-making in the commons. All these experimental and empirical researches have contributed toward the development of theory pertaining to the use of common property resources. These advances will help to apply the theory and its applications in policy formulation and implementation in a field setting.

1.2 Statement of the Problem

The inshore fish resources of Al-Batinah can be regarded as common pool resources; they can be used jointly, because of the high cost of excluding fishermen in the community, and their consumption is subtractive in the sense that fish caught by one fisherman are not simultaneously available for another fisherman (Wade, 1987; p. 96). So, when fish are scarce, congestion is likely, causing conflicts and yield reduction in the catch of individual fishermen. The coastal fisheries form vital parts of the livelihoods of large sections of the population in the country, and the issue of how to prevent their over-exploitation as population grows is of great importance for development policy in Oman.

The inshore fisheries resources of the Sultanate of Oman have witnessed the symptoms of overfishing especially the high value commercial species such as the kingfish, lobster, shrimp, abalone, sardine and many other demersal species (Siddeek, 1995; Sultan, 1996; Moore and Dorr, 1994; Hooker and Parsons, 1995). A steep decline in annual landings and in catch per unit of effort of many high value commercial species is a testimony to the current situation.

Jentoft and Kristoffersen (1989) argued that management of fisheries resources is commonly regarded as synonymous with management by the state as predicted by the Hardin (1968) model and its sweeping pessimism about collective action. Resource management of developing countries, as well as of many developed countries, is concerned with regulating fishermen's activities to comply with the legislation.

The case of the Omani fishery is similar to the one stated above where the Government provides measures to regulate fishermen's activities. However, failures of state control to solve the problem of the commons are well documented in the literature all around the world (Baland and Platteau, 1996; Runge, 1986; Berkes, 1989 and Ostrom, 1990). But, in contrast, there are numerous instances of indigenous local groups who, with or without government support, have succeed in conserving and managing their common property resources (see: Berkes, 1989; Baland and Platteau, 1996; Jentoft and Kristoffersen, 1989; Jentoft and McCay, 1995; Ostrom, 1990; Runge, 1986 and Scott, 1993). However, there are few examples in the literature where states, on their own initiative, have successfully maintained common property resources for an extended period of time. The existing situation points to the need for a management strategy that will solve the common problems through cooperation between resource users and the state.

The fishery of Oman is managed by a Directorate-General within the Ministry of Agriculture and Fisheries. A system of licensing small fishing vessels and fishermen is in place, but remains unenforced. This is generally attributed to the fact that fishermen in Oman are spread throughout the country in numerous villages, both small and large, scattered along the 1,700 kilometres coastline. Lack of financial resources can be added, as the Ministry has to spend a substantial amount of money to enforce its licensing programme.

Looking at fish landings during the past few years, it can be seen that landing of major groups of fish has been on the decline, despite the increase in the number of fishermen and fishing boats, but within the group of commercially important species, they have been affected severely (Siddeek, 1995). The population of kingfish (*Scomberomorus commerson*), for example, has witnessed a steep decline during the last nine years. The annual catch of kingfish declined from 25,000 metric tonnes between 1987 and 1990 to 3,000 metric tonnes between 1991 and 1994 (Hooker and Parsons, 1995). Based on late 1980 data, Dorr (1991) observed that sardine was caught close to the optimum. Recent landing indicated a decline in the catch of many demersal species of high market value, supporting the concern that overfishing has taken place.

The government in Oman is facing a challenge of balancing resource exploitation and conservation. Fish resources in Oman are facing the tragedy of the commons as individual fishermen invest in new fishing gear and increase their fishing effort to raise their catch. The remedy to this situation is collective action by resource users to limit fishing effort (Ostrom, 1990 and Runge 1986).

The approach taken in this thesis is that a social institution is needed to evolve rules which fishermen understand, agree upon and are willing to monitor and comply with. Mearns (1996) argued that the management of common-pool natural resources, in particular, may be approached theoretically as a collective action problem, which arises as a result of their subtractibility (rivalry) in use, and the difficulty of excluding unauthorised users (nonexcludability). One good reason to use collective action in resource management is because it is much cheaper in term of state resources than state control or private ownership regimes. State control and private ownership are expensive to implement, especially over a stretched coastline like the Omani coast.

Overexploitation of fish resources in Oman and particularly in South Al-Batinah result from a number of reasons. One reason is the rapid change in the institutional setting in Oman. The traditional fisheries laws (Senat Al-Bahar or the local fisheries management institution) which were governed by Islamic rules as well as customary rules (established practices) have been changed. As argued by Dybro (1995), "*In relation to the development of agriculture in Oman, adhering to Islamic law (sharia) was not only exercising a strict will to order, of "going by the book (Quran)", but also flexibility and cooperation*". Historically, the laws of Senat Al-Bahar were used to govern the fish resources in the country. The objective is always to define responsibilities, conserve the fishery and limiting personal and communal disputes. With modern fisheries management the government has declared all fish resources to be a national resource and as such empowers the relevant governmental agencies to develop and protect these resources according to laws declared by Royal Decree. The result of the new fisheries management institutions has been a need for more coordination of policies between the various governmental agencies involved with fisheries management. Each agency currently designs and implements policies aimed at achieving each agency's objectives. Differences of interest and some duplication of effort have occurred.

Overexploitation of fish resources resulted from the changes mentioned in the above subsection. These have led to an increase in the number of fishermen and fishing effort. Access to large urban markets (and markets in neighbouring Arabian Gulf countries) increased the price of fish in the local markets. The rise in fish prices led to an increase in the average revenue of the fishermen, and investment in fishing activities became more lucrative which attracted more people to enter the fishery. This was coupled with a government subsidised scheme to attract more Omani nationals to the fishing occupation without due knowledge of the availability of sufficient fish resources. Fishermen increase the numbers of units of gill nets or the number of traps every year as the fish gets scarce, in their effort to achieve a higher economic gain. Fish stocks have been exploited beyond their maximum sustainable yield and thus to rent dissipation following intense competition between users for the resource.

Violence erupting over the fishing ground is common, causing boat and gear damage. The local authority, in its effort to resolve the problem, passes new regulations to allocate fishing grounds, though few have been obeyed by fishermen. Allocation of resources among fishermen must be carried out in a fairly and efficient manner (Ostrom, 1990). If fishermen feel that the allocation of the fish resource is unfair and not efficient, they have no motivation to contribute to the provision of the collective goods. Gardner and Ostrom (1991) point out that unless the fishermen themselves accept legislation as effective rules, they continue to play the fishing game as if the legislation did not exist.

All this leads us to conclude that the inshore fish resources in Oman are overexploited and there is a need for a new approach toward the management of fish resources.

1.3 Theoretical and Conceptual Background

Several theories of collective action are commonly used to model common-pool resources. These theories are: Garrett Hardin's Tragedy of the Commons; the Prisoners' Dilemma Model of Strategic Choice; and Mancur Olson's Logic of Collective Action. The public good theory (a sub-theory of collective action) can answer our question here, as to the conditions under which fishermen commonly using fish resources may agree on a set of rules to reduce fishing effort without external enforcers of the agreement.

The starting point for any analysis of common-pool resources is Garrett Hardin's (1968) "tragedy of the commons" which has become the standard frame for so much of the common-pool resources management (Blair, 1996). Hardin (1968) assumes that common property resources users are individualistic and are unable to co-operate in their collective interest. However, much empirical evidence challenges the use of Hardin's model and its sweeping pessimism about collective action in general or some kinds of common-pool resources management in particular. Co-operative means to manage common pool resources have achieved successful results in many parts of the world (see: McCay and Acheson, 1987; Ostrom, 1990; Berkes, 1987; Baland and Platteau, 1996 and Salim, 1996).

Mancur Olson (1965) in his book, "The Logic of Collective Action", states that provision of the public good depends largely on group size. He divides groups into "small", "intermediate" and "large". As the size of the group increases, free riding becomes a dominant strategy according to Olson. Olson argues that the likelihood of voluntary collective action (without selective punishments or inducements) is high for small groups, low for large ones, and indeterminate for intermediate ones.

Sandler (1992) provides a more rigorous analysis of collective action. His analysis shows that important exceptions exist to the themes proposed by Olson. For example, the extent of suboptimality may be independent of group size. Large, homogenous groups may be privileged, and their provision levels may increase with group expansion (Sandler, 1992; p. 19). The provision of public good depends largely on the notion of privilege. A privileged group will form when at least one individual derives sufficient net benefits from the collective action to go it alone. The conditions for a privileged group may depends on the technology of publicness and its relationship to the underlying game structure (Sandler, 1992).

Ostrom (1990) argues that control of overexploitation of common property resources can be achieved through institutional arrangement. Contracting is one possibility to solve this problem. However, Johnson and Libecap (1982; pp. 19 - 20) have shown that contracts are difficult to formulate when the group is not homogenous. They reasoned this from the fact that agreement on effort restrictions is more costly for heterogeneous groups (see also Libecap, 1994; pp. 589 - 590).

The aim of this study is to examine situational and individual factors that affect individual co-operation and collective action to resolve problems in the commons. Chapter Three provides a general literature review of the theoretical and empirical background for the study.

1.4 Purpose and Objectives of the Study

The goal of this exploratory study is a contribution to ongoing theoretical development in the field of collective action by examining individual and institutional factors that affect individual participation in collective action to resolve the commons problem. The study examines the factors that motivate individual fishermen to co-ordinate their collective decisions to improve their collective well-being. The collective action studied includes voluntary fishermen contributions to restrain resource overexploitation. Reduction in fishing effort will establish a balance between overexploitation and resource conservation for sustainable production. The research focuses on those factors which foster collective action.

The capture fishery is a frequently cited example of collective failures in which exploiters' pursuit of profits lead to the attainment of their private interest and not the group interest. A static analysis of the fishery will be demonstrated by this study based on the work of Cornes and Sandler (1996), and Sandler (1992).

The collective choice of fishermen will be analysed by a game theory approach. There are a number of games of relevance for the collective action problems: the Privileged game, the Assurance game (also called the game of trust); the game of Chicken; and the Battle of the Sexes. This approach will be used to find the type of game used by the fishermen in the study area.

The study undertaken by this thesis will investigate the factors that enhance fishermen's co-operation in the study area to solve their common problem of reducing fishing effort which threaten their common survival as the fish resource they depends on is overexploited. To address the research questions the following objectives were developed:

1. to provide a general picture of the structure, standard of living and other activities of fishermen in the study area, and to explain the effects of these socio-demographical factors on fishermen's ability to participate on collective action;

2. to investigate the influence of institutional characteristics on fishermen's effort to participate in collective action to co-ordinate resource use;

3. to investigate the influence of group size and group heterogeneity on individual fishermen's collective decisions to manage their fishery;

4. to determine the factors which are influential on individual fishermen's decisions to co-operate.

1.5 Scope of the Study

The study of collective decisions of fishermen in South Al-Batinah, Sultanate of Oman, focused on three towns: Barka, Al-Masn'a and Suwaiq. These three coastal towns were selected to represent three groups of different fishermen population, to enable examinations of the differences in individuals' attributes among the three towns and their relationship to fishermen's decision to co-operate in the commons.

For the purpose of this study, the questionnaire methodology was complemented by a semi-structured interview and observation technique to enhance the accuracy of the findings. This study seeks to provide further evidence about the factors that enhance collective action and the appropriateness of the collective action approach to fisheries management to solve the commons problem.

1.6 Thesis Organisation

The thesis covers the factors that appear to be responsible to enhance or hinder the emergence of collective action and the appropriateness of collective action to be used as an alternative to state management or private ownership of common property resources. It comprises ten chapters, including this introductory chapter. This chapter (Chapter One) has stated the problem and the importance of the study, as well as highlighting the theoretical background for the study of collective action. The remaining chapters are organised as follows: Chapter Two provides a review of the Sultanate of Oman Fishing sector with special reference to the traditional fisheries. It discuses the importance of the fisheries sector to the Omani economy, trends in fish landings and fishing efforts and the current fisheries management approach as well as the problem of overfishing in coastal areas. Chapter Three presents a literature review for the study of collective action in the commons. It explores the theoretical and empirical development in the field of collective action and focuses on the different factors that might be selected to test hypotheses designed for this study. Chapter Four investigates the influence of institutional characteristics on fishermen's effort to participate in collective action to co-ordinate resource use. It explores the changes in the underlying game structure with different institutional arrangements.

Chapter Five presents the conceptual framework for the study. Chapter Six outlines the research methodology selected and then explains in detail the application of that methodology to the South Al-Batinah fishery. Then Chapter Seven presents a detailed statistical analysis of the study population covering its economic, social and demographic profile. Chapter Eight discusses the characteristics of the fishery studied and gives the background to common dilemmas that confront the fishermen and the way they are solved. It also highlights the local indigenous management institution that has been used to manage the fisheries for several generations. Chapter Nine identifies and quantifies factors or attributes that are influential in fishermen's decision to participate in collective action to manage the coastal fishery in South Al-Batinah. Chapter Ten presents the findings about the collective action problems facing fishermen in their use of the fishery. Then in Chapter Eleven, the researcher presents a conclusion and recommendations, as well as suggestions for further research.

CHAPTER TWO

AN OVERVIEW OF THE FISHERIES SECTOR IN THE SULTANATE OF OMAN

2.1 Introduction

The main aim of this chapter is to provide an overview of the fisheries sector, in both its traditional and commercial dimensions. More emphasis is devoted to the activities of the traditional sector as this is the main concern of this study. In this chapter the importance of the fishery among other sectors, its economic significance, and the potential of fish resources in the Omani waters are discussed. The chapter will also describe the technological changes that have taken place during the last two decades and the effect of these on landings of the traditional fishermen. The last section is concerned with the management of the fisheries in Oman and the problem of overfishing in coastal waters.

2.2 Country Profile

The Sultanate of Oman forms the south-eastern part of the Arabian Peninsula. Oman, with its 309,500 square kilometres of very varied, striking terrain and its two million inhabitants is the second largest state (after Saudia Arabia) in the Arabian Peninsula. Its geographical location on the map lies between latitudes 16° 40' and 26° 20' North and longitudes 51° 50' and 59° 40' East. The country is bounded to the south by the Republic of Yemen; to the west by Saudi Arabia and the United Arab Emirates; to the north by the Strait of Hormuz; and to the east by the Arabian Sea. The coast stretches a distance of 1,700 kilometres, from Ras Musandam, on the southern side of the Strait of Hormuz in the north, to the Batinah plain that inclines south-east towards Muscat through the A'Sharquiyah region to the near-tropical Salalah region in the south near the Republic of Yemen.

With its subtropical location, Oman's rainfall is relatively low and irregular with the exception of the southern region, where heavy rains occur during the Monsoon season (June - September). The climate varies across the regions. In the coastal areas it is hot and humid in summer (May - September), but pleasant in winter (October -

April). In the interior, it is hot and dry during summer, although it is temperate all year around in some higher locations such as the Jabal al-akhdar plateau which is 3,075 metres above sea level.

Geographically, the country is divided into five administrative divisions called regions (Al-Batinah, A'Dakhliya, A'Sharquiyah, A'Dahira, Al-Wusta) and three other divisions called governorates (Muscat, Dhofar, Musandam). Each of these regions and governorates is divided into smaller administrative divisions called Walayat. There are 59 Walayats (towns), each administered by Government representative called a Wali (Governor) (Ministry of Development, 1993; p. 28).

According to Donaldson, (1980; p. 480) *"fishing communities along the coast of Oman have existed certainly for many centuries and probably for several millennia, and most travellers in the area over the years have testified to the large quantities of fish caught"*. The sea has contributed much to the character of the coastal Omani settlers. The Omani maritime trade flourished between the seventh to the fifteenth centuries, during which period a major trading empire was formed in the region. Omani ships regularly called at ports in Persia, India and South East Asia (Ministry of Information, 1995; p. 27). They also reached Canton in China as early as the eighth century. In 1507, the famous Omani navigator Ahmed bin Majid guided the Portuguese sailor Vasco da Gama round the Cape of Good Hope, discovering an important sea route to India (ibid.).

Since the first export shipment of oil from the country in late 1960s Oman has had an oil-based economy (70 % of the national income), affected by the fluctuation in world oil prices. The major violent slump in oil prices witnessed in 1986 resulted in a 11.3 percent devaluation of the Omani Rial. Although world oil prices have made considerable recovery since then, during the last quarter of 1998 the Omani crude was sold at $9 a barrel, well below the $18 which would be a comfortable price for the Omani economy and resulting in 50 percent reduction on oil revenue compared to previous years.

Due to the uncertainty of world oil prices the Government has been exerting efforts to diversify the economy away from its dependency on oil revenue, and a considerable degree of success has been achieved. The major non-oil resources are agriculture, fisheries and minerals. To these can be added tourism, trade and light to medium industries, which have developed rapidly during the last 15 years, and contribute to the national income. These non-oil sectors have the potential to make substantial contributions to the national economy and their share of the GDP is steadily increasing. For example, the manufacturing sector, which contributed less than one percent to GDP at current prices in 1980, has grown remarkably since then, its contribution rising to six percent by 1994 (Pinto, 1995).

2.3 An Overview of the Fisheries Sector

Fishing and agriculture have been traditional Omani occupations and major sources of food and employment for the people in Oman. For example, before the discovery of oil in the country, agriculture and fisheries dominated the Omani economy, with around 80 percent of the population depending on these two sectors. Although the structure of the Omani economy has changed since the discovery of oil in the late 1960s, which caused agriculture to lose its position as the main contributor, agriculture and fisheries at present are among the major contributors to the national economy. It is estimated that at present around 50 percent of the population in Oman still depend on these sectors (Oman Daily Newspaper, 10 November 1997 and Ministry of Information, 1997; p. 134). The development of these sectors has the potential to increase the national GDP under the government strategy to diversify the national economy. Besides their contribution to the GDP, the development of these sectors has secured a continuous supply of food and will eventually reduce the dependency on food-producing nations.

The importance of the agriculture and fisheries sectors has attracted the attention of the government, whose investment in these sectors has steadily increased. Government investment in both sectors showed an average growth rate of 13.5 percent per year during the period 1971 - 1995, although this rate was reduced during the Fourth Five-year Plan (1991 - 1995) to an average of 1.5 percent per year (Oman Daily Newspaper, 10 November 1997). Government investment in these sectors has contributed to a noticeable growth in both of them; the average growth rate achieved during the period 1971 - 1995 was 9.9 percent per year, around three times the rate of population growth in Oman, which means that a higher percentage of self sufficiency in food has been achieved.

The agriculture sector's share of the gross national product was 3 percent in 1995, and is expected to rise to 3.1 percent by 2020 (Ministry of Development, 1996; p.

240). Similarly, future Government planning for the Omani economy places major emphasis on the fisheries sector. The sector is expected to grow at an annual average rate of 5.6 percent by the year 2020. The fisheries sector is expected to contribute around 2 percent to the gross national product in 2020 compared to its level of 1.1 percent recorded in 1995 (Ministry of Development, 1996; p. 242).

Oman is one of the most important countries engaged in fishing in the Middle East. The 1,700 km coastline, with a commercial fishing area of 350,000 km^2, has rich fishing grounds, the potential of which has yet to be fully evaluated. A 200 nautical mile exclusive economic zone, extending out toward the sea from the baseline from which the territorial waters are determined, was declared. The climatic conditions induced by the prevailing south-easterly and north-easterly winds contributed to the phenomenon of upwelling which is responsible for the annual recycling of nutrients. The presence of upwelling along the coastline brings to the surface nutrient rich deep-water from the ocean, which is an essential component for the productivity of the phytoplankton, which constitute the start of the marine food chain. The Arabian sea (on the eastern coast of Oman), for, example, is characterised by better circulation to the open ocean and high availability of the nutrient rich deep water which makes it among the most biologically productive seas in the world. There are 930 fish species available in the Omani waters, including 52 inshore species, of which four required new generic names (Randolph, 1995; cited in Sultan, 1996).

Given the high abundance of fish in Omani waters and its importance to the livelihood of thousands of people, the fisheries sector is a significant sector in the Omani economy. There is a strong fishing tradition in Oman, and a large number of small villages scattered along the coast, from which around 26,000 small-scale fishermen operated in 1997.

With the advent of a petroleum-based economy, Oman underwent rapid social and economic changes causing a drift away from fishing communities by young men to the cities where they could earn better wages, leading to a shortage in manpower skills from the traditional occupations. The Government has recognised the effects of its development programmes on traditional occupations and urgent steps have been taken to stem this drift by initiating programmes to develop the traditional fishing sector and help the people to continue with their fishing occupation. With such encouragement, there has been a substantial increase in the number of fishermen, indicating the strong interest of people in fishing as an occupation. The situation has now stabilised with 26,096 fishermen directly employed in the fisheries sector in 1997 compared to only 11,750 recorded in 1985 (Ministry of Agriculture and Fisheries, Annual statistics report for 1997). The sharp increase in the number of fishermen is attributed mainly to the introduction in 1978 of the Fishermen's Encouragement Fund, which encouraged coastal inhabitants to keep to their traditional occupation. The Fund provides financial assistance for the purchase of fibreglass fishing boats, engines and fishing gear. The Agriculture and Fisheries Bank administered the Government's subsidy programme to upgrade the fishermen's socio-economic conditions and make the fisheries profession attractive. For example, during the Second Five-year Fisheries Development Plan (1980 - 1985), the bank processed subsidised loans to small-scale fishermen with a total value of RO 4.073 million ($ 10.61 million[1]) at a two percent interest rate.

The fisheries of Oman are divided into traditional and commercial fisheries, though the traditional sector continues to be the corner stone of the fisheries sector in the country. For example, in 1994 the traditional fishery contributed around 84 percent of the total national landings, the balance being produced by the commercial sector, which is composed of foreign-owned demersal trawlers and longliners. The traditional fishing fleet has been enhanced by increasing the number of units (11,746 in 1997), and replacing the old and inefficient units. By 1993, almost all the traditional fishing vessels had been mechanised by means of the Fishermen's Encouragement Fund. The total Government expenditure during the period 1978 - 1992 to subsidise the traditional fishermen reached RO 6 million, used to help around 16,162 fishermen. During the same period, around 8,462 fibreglass fishing skiffs and 14,106 engines were subsidised.

2.4 The Economic Significance of the Fisheries Sector

The significance of the fisheries sector to the national economy stems from its contributions to: (a) the national GDP; (b) national exports, and hence, foreign exchanger; (c) sources of animal protein and (d) provision of employment opportunities.

(a) Contribution to the national GDP: The fisheries sector's contribution to the Gross Domestic Product (GDP) in market prices has enjoyed modest growth in the period 1980 - 1994, with a sharp increase in 1987 in which the GDP was 68 percent above the 1980 level (Table 2.1). Following 1987, the sector witnessed modest growth

[1] A rate of RO 0.384 to US $ 1 has been used as a rate of exchange in this study.

again until it peaked again in 1995. The year of 1995 witnessed a significant growth, which saw the sector's 1995 GDP 69 percent above that recorded in the previous year, and 209 percent above the 1980 level (Ministry of Development, 1997; pp. 341 - 348).

Although the sector's GDP was on the increase, there have been some sharp reversals. For example, the GDP in 1988 was 10.6 percent below the 1987 level and another sharp decline was recorded again in 1991 when the sector's GDP was 21 percent below the 1990 level. In 1996, the sector's GDP was RO 46.2 million, 11 percent below the 1995 level (Table 2.1). During the period 1980 to 1995, the relative contribution of the fisheries sector to the non-oil GDP at current prices ranged from 0.85 percent to 1.92 percent, averaging of 1.32 percent. As a proportion of the total GDP, the sector's GDP during the same period accounted for between 0.5 percent to 1.0 percent at an average of 0.72 percent. The fisheries sector is expected to contribute around 2 percent to the gross national product in 2020 compared to its level of 0.8 percent recorded in 1996 (Ministry of Development, 1996; p. 240).

Table 2.1 Key Indicators of the Fisheries Sector (1980 - 1996)

Year	Sector GDP (million)[2]	Annual growth (%)	GDP share (%)	Share of non-oil GDP (%)
1980	16.9	-	0.8	1.92
1981	19.7	16.57	0.7	1.76
1982	21	6.60	0.8	1.62
1983	24.8	18.10	0.8	1.68
1984	24.1	-2.82	0.7	1.42
1985	22.1	-8.30	0.6	1.21
1986	21.6	-2.26	0.7	1.12
1987	28.3	31.02	0.9	1.54
1988	25.3	-10.60	0.8	1.26
1989	27.3	7.91	0.8	1.30
1990	28.1	2.93	0.6	1.17
1991	22.1	-21.35	0.5	0.85
1992	26.7	20.81	0.6	0.93
1993	26.9	0.75	0.6	0.88
1994	30.9	14.87	0.6	0.96
1995	52.2	68.93	1	1.55
1996	46.2	-11.1	0.8	1.3
Average	**27.3**	**8.30**	**0.72**	**1.32**

Source: Ministry of Development (1997); pp. 341 - 348.

[2] Current prices

(b) **Contribution to Foreign Exchange Earning:** In terms of foreign exchange earning, fish exports increased steadily between 1981 and 1988, then fluctuated around RO 19 million between 1989 and 1994 (Figure 2.1). The year 1995 witnessed a significant increase in the value of fish exports, reaching RO 41.2 million, which was 117 percent above the 1994 level. Fish exports declined in 1996 to 10.4 percent below the 1995 level. As shown in Figure 2.1 a further 27 percent reduction in the value of fish exports was recorded in 1997. The value of fish exports in 1997 was 34 percent below the 1995 level. Similarly, the quantity of fish exported increased steadily and peaked in 1995 when 59.2 thousand tonnes were exported, which was 33 percent above the 1994 level. After 1995, the quantity of fish exported was on the decline. In 1996 it was 34.9 percent below the 1995 level and a further 5.4 percent reduction was observed in 1997. The 1997 exports were therefore 40.3 percent down on the 1995 level (Figure 2.1).

The reduction in the quantity and value of fish exports was to be expected due to the declining trends of the landings of the traditional sector during the same period. Restrictions imposed by the European Union on fish imports that do not comply with the Union standard are another factor which contributed to reduce the quantity and value of fish exported from the country. At present only one factory (belonging to the Oman Fisheries Company) meets the standards for exporting fish to Europe.

Fish exports are considered to be a significant earner of foreign exchange to the national economy, ranking second after oil exports and first among the non-oil exports.

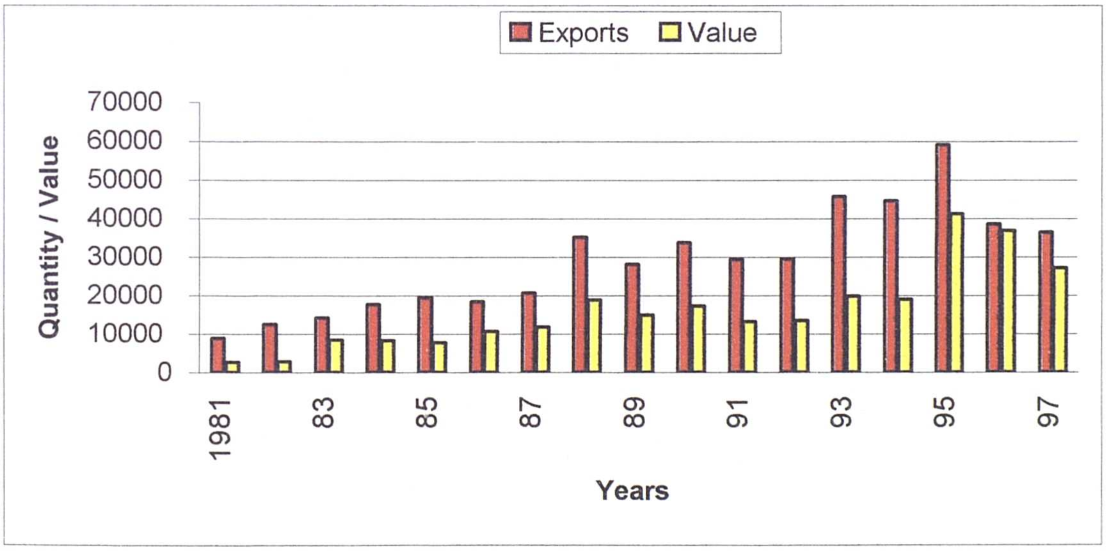

Figure 2.1 Fish Exports in Metric Tonnes and Value in (RO 000s), 1981 - 1997

(c) Contribution to food security: Fish has been an important staple food for the Omani coastal inhabitants for countless centuries, providing a large portion of their protein requirements. Even the interior populations have long depended on fish landed along the coasts of the Arabian Sea and the Gulf of Oman, which were transported by camel and donkeys to the interior in dried or salted forms. At present fish is transported chilled with ice or in refrigerated trucks to the interior over an excellent network of national highways. As stated by Jenkinson (1987) "*fish consumption per capita in Oman is high when compared with other nations in the Arab region*". According to the 1983 FAO Yearbook of Fisheries statistics, per capita fish consumption in Oman was 20.3 kg (ibid.). However, by employing a flesh yield coefficient of 70 percent, the actual per capita consumption of fish was closer to 14.2 kg / year. Table 2.2 provides a rough estimate of the per capita fish consumption in Oman during 1997. As shown in Table 2.2, the per capita fish consumption was 20.3 kg per year. The figure represents the quantity of fish available to each person in Oman during the 1997 after fish exports and losses due to poor handling were deducted and by employing a generic flesh yield coefficient of 70 percent.

Table 2.2 Apparent Consumption of Fish in Oman during 1997.

Total fish landings	119,000 metric tonnes
Exports	- 36,000 metric tonnes
Balance	83,000 metric tonnes
Losses due to poor handling @ 30 %	- 24,900 metric tonnes
Amount available to be consumed by the 2 millions total population	58,100 metric tonnes
Yield coefficient @ 70 % of the 58,100 metric tonnes available in the country	40,670 metric tonnes
Fish consumption per capita	20.3 kilos/ year

The average total fish landings in Oman between 1985 and 1997 were 121, 000 metric tonnes, of which between 70 to 80 percent was consumed locally and the balance exported. This indicates that the country has achieved self-sufficiency in an important source of animal protein. However, current landings must be sustained or more efforts should be directed to the exploitation of the off-shore fishery in order to increase fish landings to off-set the increased demand inside the country as the result of the high population growth rate, which was estimated at 3.5 percent in 1993 (Ministry of Development, 1993).

(d) Contribution to employment opportunities: The other significant role of the fisheries sector is its contribution to employment for the Omani people. The fisheries sector provides thousands of employment opportunities for Omani nationals, especially those inhabiting the coastal villages. The sector provided direct employment for 26,000 traditional fishermen in 1997. Another 4,000 people are engaged in fisheries-related activities, such as fish handling, selling, processing and distribution as well as ancillary industries like workshop mechanics and selling of fishing gears and spare parts. Therefore, the fisheries sector provides direct employment for around 30,000 Omani nationals, or 1.5 percent of the total population. More employment opportunities are to be created in the fisheries-based industry that is planned to be established around the fishing ports currently under construction. There would also be around 3,500 employment opportunities for the Omani people if the commercial fleet were to be fully Omanized. The fisheries sector is expected to employ around 50,000 fishermen in 2020 compared to its level of 26,000 fishermen recorded in 1997 (an interview with Dr. Mohamed Ridha, Director General of the DGFR, Oman Daily Newspaper, 4 July 1998).

2.5 Fish Landings

Although the traditional fishery is still predominantly small-scale, it constitutes the most important sub-sector, accounting for about 86 percent of the total fish landings in 1985. There do not appear to be any statistics available relating to fish landings in the early 70s but Table 2.3 shows the annual fish landing between 1985 and 1997. Two distinct peaks can be noticed from Table 2.3. The total quantity of fish landed rose sharply through the 1980s, peaking first in 1988 when landings rose from 94,900 metric tonnes in 1985 to 166,100 metric tonnes in 1988. This sharp increase in fish landings was attributed to technological development as a result of the fisheries development programme initiated by the Government to upgrade the sector. For several years following that peak, catches decreased (Figure 2.2). Total landings hit a low of 112,300 metric tonnes in 1992 but then generally increased. This was considered as the first sign of overfishing which was caused by excessive pressure on the coastal fisheries resulting from the development programme during the 1980s (Siddeek, 1995; Sultan, 1996).

Table 2.3 Total Fish Landings (000's tonnes) and Value (RO million) between 1985 and 1997

Year / Sector	Traditional		Commercial		Total	
	Landing	Value	Landing	Value	Landing	Value
1985	81.5	22.34	13.4	2.7	94.9	25.04
1986	82.8	21.83	13.6	2.73	96.4	24.56
1987	124.1	30.52	10.9	2.46	135.0	32.98
1988	148.2	27.25	17.9	6.7	166.1	33.95
1989	105.2	27.73	12.3	5.7	117.5	33.43
1990	99.8	27.11	18.8	7.5	118,6	34.61
1991	103.5	22.26	14.2	6.09	117.7	28.35
1992	97.0	26.01	15.3	6.61	112.3	32.62
1993	92.4	24.39	24.0	9.91	116.4	34.3
1994	97.5	28.67	21.0	9.70	118.5	38.4
1995	108.6	47.25	31.3	13.62	139.9	60.87
1996	89.0	39.9	33.0	14.0	122.0	53.90
1997	84.0	45.2	34.50	14.2	119.0	59.40

(Source: Ministry of Agriculture and Fisheries, Annual Statistics Report for 1992, 1993, 1994, 1995, 1996 and 1997)

However, total fish landings started to increase gradually after 1992 reaching second peak in 1995, at about 139,900 tonnes, but declined again since then (Figure 2.2). The total fish landings in 1996 were 122,000 metric tonnes, 13 percent lower than those recorded in 1995. The following year (1997) another 2.5 percent reduction in fish landings was recorded (Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997). The average fish landing during the period 1985 to 1997 amounted to 121,000 metric tonnes.

In 1997, the total fish landings in Oman were 119,000 metric tonnes, representing a small decline of 3,000 tonnes compared to the landings of 1996 which amounted to 122,000 tonnes (ibid.). Out of the total fish landings, the traditional fishermen produced 84,000 tonnes of fish, representing 71 percent of the total fish landings, which was 4,100 tonnes short of that landed in 1996. Despite the decline in fish landings, the value of the landed fish continued to increase, reaching RO 59.4 million in 1997 compared to RO 53.9 million in 1996 (Table 2.3).

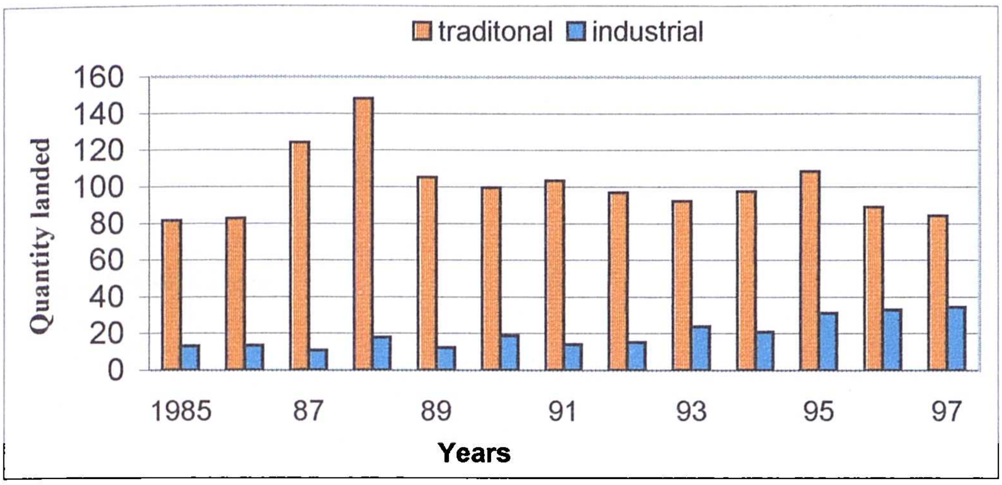

Figure 2.2 Landings Trends in the Sultanate of Oman, 1985 - 1997

It is reasonable to relate the increasing trend in total landings during the 1980s to the progressive expansion of the number and type of fishing vessels. The initial impetus for the expansion of the traditional fishing fleet occurred in 1978 when the government launched the Fishermen's Encouragement Fund. The fund provides financial assistance for the acquisition of fibreglass fishing vessels and engines to replace the native wooden fishing vessels. Statistical figures available for 1985 onwards suggested that the number of fishing vessels (the vast majority of which were motorised fibreglass skiffs) increased by 31 percent from about 9,000 vessels in 1985 to 11,750 vessels in 1997.

Regarding the number of fishermen, this has increased in an exponential manner, from 11,750 in 1985 to 26,095 in 1997, an increase of 121 percent. The sharp increase in the number of fishermen can be attributed to the government programme to encourage local people to stick to their occupation and to the shortage of alternative employment opportunities facing the country since the early 1990s with the advent of low oil prices.

Despite the declining trend of the total fish landings, as well as the traditional ones, figures for the value of landed fish follow an increasing trend as shown in Figure 2.3. As can be observed from Figure 2.3, from 1993 onward, the values of the landed fish continued to increase, but at a higher rate. The value of the landed fish in 1987 was RO 30 million, and had jumped to RO 60 million by 1997; in other words, it doubled during a period of 10 years. This increase in the value of the total landings is ascribed mainly to the increase in the value of the landings produced by the traditional fishermen, which reached its highest level during the last five years as shown in Figure

2.3. The value of the catch landed by traditional fishermen follows a similar trend to the total; it witnessed a sharp increase after 1993, despite the declining trend in the quantity landed. The value of landings produced by the traditional fishermen represented 76 percent of the total value landed in 1997.

Figure 2.3 Value of the Fish Landings in RO Million Between 1985 - 1997.

Although fish landings declined for several years, this improvement in the value of the landed catch can be related to the improvement in the quality of the landings and reduction of waste due to bad handling and storage. This can be ascribed to the newly built landing facilities and cold storage constructed by the Government. During the Fourth Five-year Plan (1991 - 1995), the government planned to build eight large fishing ports and 16 smaller ones along the coast to provide landing facilities in order to improve fish handling and to create fishing based industry around these facilities. In 1994, the government allocated RO 40 million ($104 million) to build 12 fishing ports, five of which are currently in operation (Oman Daily Newspaper, 15 January 1994).

The value of the landings produced by the commercial sector, in comparison, although it has increased for the last six years, has done so at a slower rate (Figure 2.3). In 1997, the value of the catch landed by the commercial sector reached RO 14.2

million, making a small increase of RO 200,000 compared to the corresponding figure for 1996. During the last ten years, the value of the landings of the commercial sector has increased from about RO 2.7 million in 1985 and 1986 to RO 14.2 million in 1997, making an increase of 426 percent. The percentage contribution of the commercial sector to the total value of the landings was 24 percent in 1997, as compared to 10.7 percent in 1985. The increase in the value and landings of the commercial sector can be related to the rapid expansion of the commercial fishing fleet in the Omani waters, especially during the 1990s.

As indicated above, the total fish landings in Oman are made up of landings from the traditional and the commercial sectors. The traditional fishery plays a significant role in the Omani fishery. However, as indicated in Figure 2.2, the landings of the traditional fishery have shown a declining trend for several years since the late 1980s. For example, during the period of 1985 to 1992, the average percentage contribution of the traditional fishery to the total landings was about 88 percent. However, for several years following 1992, this share was on the decrease; the average percentage contribution declined to 77 percent during the period 1993 to 1997 (Figure 2.4).

The contribution of the traditional fishery to the total landings was 71 percent in 1997. It is reasonable to expect that the declining trend in the landings of the traditional fishermen during the last eight years would be correlated with the progressive expansion in the number of fishing vessels and fishermen. It is interesting to see that fishing effort has been on the increase during the same period. Therefore, this gradual decline in the catch of the traditional fishermen can be largely attributed to overfishing in inshore waters.

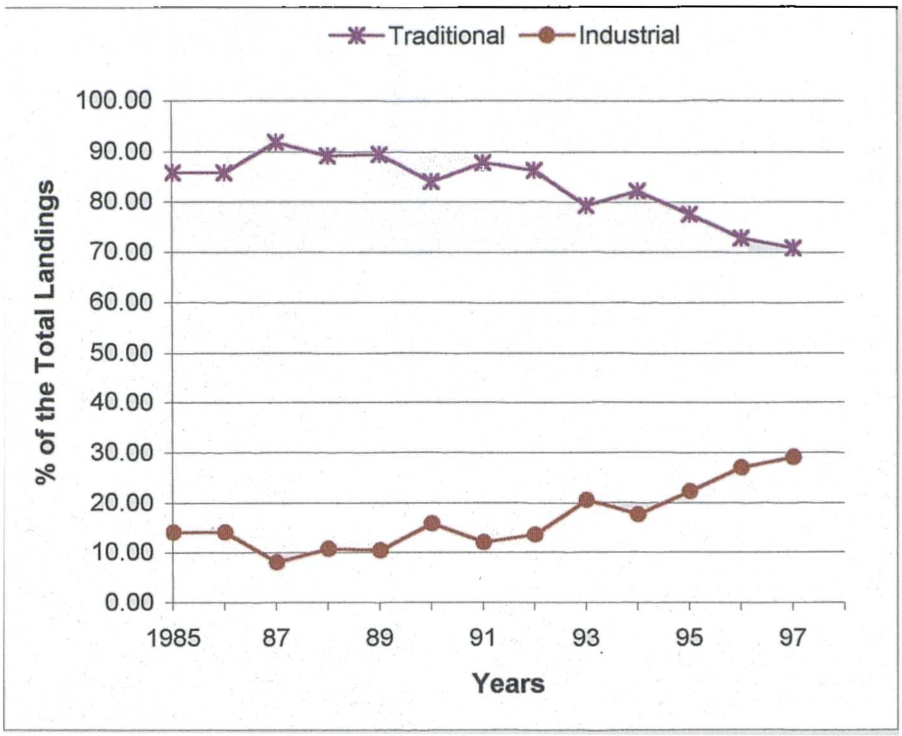

Figure 2.4 Percentage Share of the Traditional and the Commercial Catch of the Total Landings

In contrast to the traditional sector, the landings of the commercial sector have been on the increase, especially during the 1990s as indicated in Figure 2.4. The average percentage contribution of the commercial sector to the total landings has risen from less than 10 percent before 1987 to around 30 percent in 1997 (Figure 2.4). The commercial sector refers to large fishing vessels that either operate trawl nets targeting demersal species or long-lines to catch large pelagics on the high seas. The involvement of foreign fleet in the Omani fishery was first started in 1976 when the Ministry of Agriculture and Fisheries entered into a contract with a Japanese fishing company and later on with a Korean company in 1978, allowing these companies to operate in the Omani waters against a percentage of the catch.

In 1989, the Government decided to give five private Omani companies a production quota. The Oman Fisheries Company is a leading commercial company which was established in 1989. Twenty-four percent of its equity is owned by the Government and the rest is held by thousands of shareholders. Oman Fisheries Company, like other local fishing companies, does not fish on its own account but has been contracting demersal fishing rights to Korean and lately to Chinese trawl operators and large pelagic fishing rights to the Taiwanese. The number of foreign vessels licensed by Omani private companies since 1989 has varied, as has the sharing system employed in exchange for fishing authorisation. The percentage of the catch retained by local companies, for example, has varied from 39 percent in 1988 to its current level of 20 percent. Foreign fleet operators consider such long-term fishing businesses to be profitable, as evidenced by the long period of the contract.

The number of foreign fishing vessels has also varied between 1989 and 1997. There were 9 trawlers operating in Omani waters during 1990 to 1992. The number increased gradually to 25 in 1994 and then dropped to 19 in 1995. The number of trawlers fishing in Omani waters in 1997 was 21. Similarly, the number of longliners varies according the availability of the large pelagics; there were 135 in 1994, 74 in 1995 and 96 in 1997 (Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997).

To protect the traditional fishermen's fishing grounds, foreign fishing vessels are required to operate at about 10 nautical miles from the coastline or 50 metres depth, whichever is farther, in relation to the trawlers and about 20 nautical miles in the case of the longliners. Despite the Ministry's effort to monitor the activities of the foreign fishing fleets, a lot of criticism is directed towards their activities in Omani waters. As stated by Sultan (1996) "*there is a gross under-reporting of the catch to the authorities and the possibility of off-loading on the high seas is often mentioned*". Intrusion into the rich fishing grounds of the traditional fishermen can be added to the above criticisms, as confirmed by regular conflicts with traditional fishermen and court suits for various controversies which reached 541 between 1990 and 1995 (Sultan, 1996).

2.6 The Traditional Fishing Fleet

Although the vast majority of fishing vessels are motorized, the traditional fisheries are still predominantly small-scale fisheries. As shown in Figure 2.5, the traditional fishing fleet is composed of five types of fishing vessels. However, fibreglass vessels (5 to 10 metres long, powered by outboard petrol engines) dominate the fishing fleet. As shown in Figure 2.5, such vessels represent around 79 percent of the traditional fishing fleet. Fishermen also operate Houris (traditional wooden vessels, 8 metres long with an outboard engine), 14 - 16 metre Dhows (traditional wooden vessels with an inboard diesel engine) and Shashas (traditional vessels made of a shell of stripped date palm fronds tied with palm fibre cord and filled with palm frond butts to give buoyancy). The Houris used to be found along the coast in all regions, and dominated the fishing fleet up until late 1970s. The larger wooden vessels (Dhows) are currently operated in big numbers in A'Sharquiyah region, and to a lesser extent in Musandam region, according to the availability of harbours. The Shashas, on the other hand, can only be found on the low, sandy Al-Batinah coast of Northern Oman. Although there are around 965 vessels of the Shasha type in Al-Batinah, these fishing vessels rarely make any landings at the markets of the three towns surveyed by the researcher. This was also confirmed by many studies conducted in the area (Hooker and Parsons, 1995). It is believed that the catch made by these vessels is primarily for subsistence use.

Fishing vessel tenure includes family-owned vessels with family operators and non-family labour, and individually-owned and operated vessels with hired labour (Omezzine, Zaibet and Al-Oufi, 1996). Returns from the family owned vessels are distributed among the family members according to their contribution to the operation of the boat and ownership.

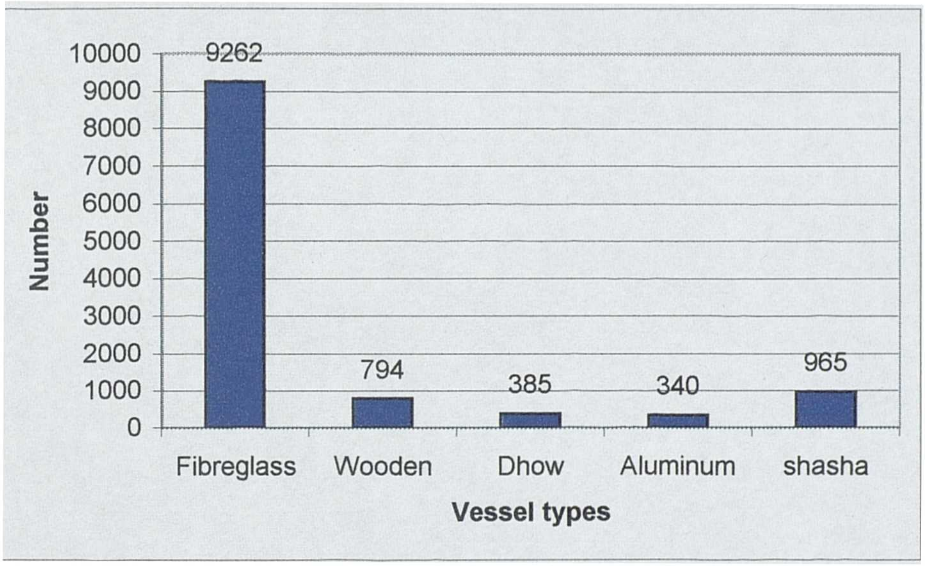

Figure 2.5 The Traditional Fishing Vessels per Type, 1997

Over the last 28 years, there has been a rapid increase in the number of small fibreglass vessels as a result of Government subsidies, accompanied by a rapid decline in the number of wooden Houris. The number of wooden Houris declined from 1684 in 1987 to 794 in 1997 (Hochtief, 1987; Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997). Shashas have also been on the decline during the same period. The number of Shashas declined from 2,866 in 1987 to its lowest level of 965 in 1997. During the same period, the number of fibreglass fishing vessels increased from

2,601 (Hochtief, 1987) to 9262, an increase of 256 percent (Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997).

Fishermen prefer these small fibreglass fishing vessels because they are light, and so much more easily beached than the wooden vessels, which is especially useful in places which lack proper berthing facilities, as do many places along the coast at present. The tendency of these vessels to dominate the traditional fleet poses a number of problems. Because of their small size, these vessels are vulnerable to sea conditions. As a consequence, their fishing operation is restricted to the inshore areas, which results in intensified pressure on coastal stocks. Moreover, the small size of these vessels prevents fishermen from taking ice on their fishing voyages to preserve the quality of the catch, thus restricting their sea time capability significantly.

Very low entry costs (vessels are cheap and available secondhand), have contributed to raising the number of individually-owned and operated fibreglass vessels. Crew (boatless workers with fishing skills) aboard the larger wooden Dhows find it more profitable to operate their own fishing vessels instead of working as crew. As the number of owner-operators of these small fibreglass boats increased, the situation created a shortage of hired fishing labour in coastal communities to work as crew aboard the larger fishing boats. As a consequence, the number of the larger wooden Dhows has declined gradually. The Dhows are regarded as more productive, can undertake longer voyages, and have more space for storage, than the fibreglass vessels; thus, they are more able to fish in the off-shore waters.

2.7 Resource Surveys by Research Vessels

Estimation of the annual yield is based on researches and observations conducted by various consultant teams during the past 20 years. In general it is recognised that the Omani water contains abundant resources which are not exploited by the Omani fishermen. Three research surveys have been undertaken in the Omani exclusive economic zone, (EEZ), over the recent years, by using trawl nets and acoustic integration techniques, to evaluate the availability of demersal and pelagic resources. The FAO survey (1990), the first extensive and major survey, provides the first adequate information base to develop an appropriate and scientific management of the fish resources. A total of 156 demersal species belonging to more than 30 families were documented during this survey. Of these, only 99 species from 15 families were considered of commercial interest (Al-Abdissalam, 1991).

On the basis of the results of the survey conducted aboard the vessel Rastrelliger, in 1990, the total biomass of small pelagic species amounted to 252,000 metric tonnes and the potential yield of this resource was estimated at around 59,000 metric tonnes. This was less 80 per cent than the previous estimates by the vessel Fridtjof Nansen in 1983. The report indicated a 36 per cent increase in the biomass of the demersal resource.

The estimated total biomass of demersal resources was 564,000 metric tonnes (Al-Abdissalam, 1991). The total potential annual yield of demersal species is estimated at 126,000 metric tonnes, of which 67,000 metric tonnes is the potential yield for commercial fish species. The total landing of demersal species during the period 1987 - 1992 averaged only 25,000 metric tonnes, and an additional 7,200 metric tonnes annually is discarded by the commercial trawl fleet. Thus, there is scope for expansion of the demersal fishery, considering that only 32,000 metric tonnes is harvested out of a possible 67,000 metric tonnes per year. However, the bulk of the demersal fish stocks is distributed along the eastern coast of the country. The survey carried out in 1990 indicated that in areas with major traditional fishing grounds, especially in Muscat, Dhofar and Al-Batinah, the demersal fish stocks were limited (Al-Abdissalam, 1991). Given this fact, the Ministry of Agriculture and Fisheries should consider limiting further expansions of the traditional demersal fishery, especially in Al-Batinah, to avoid overfishing.

The results of the survey indicate that the biomass was highest on the East Coast of the country (the Arabian Sea). The total biomass found in the area was 314,820 metric tonnes, constituting 76 percent of the overall biomass (Al-Abdissalam, 1991). By comparison, the Salalah region, Halanyat bay and Al-Batinah coast with 1.4 percent, 5.7 percent and 6.4 percent of biomass respectively were the least productive (Al-Abdissalam, 1991). The highest catch rates were recorded in areas along the Arabian sea (Muscat to Sauqarah bay) and the lowest catch rates were found in Salalah region and Al-Batinah region.

2.8 Fisheries Management in Oman

From the foregoing, it is obvious that the development of both the traditional and the commercial sectors of the Omani fisheries has exerted excessive pressure on fish stocks. Unfortunately, most of the development efforts have been and still are directed toward the accumulation of fishing efforts in coastal waters. Consequently, for reasons that appear to be complex but clearly point to the problem of overfishing, the landings of the traditional fishermen have now been on the decline for several years (see section 2.5). Stocks of many high value species of fish and shelfish in the Omani waters are seriously depleted, and their fisheries appear to be heading towards collapse (Moore and Dorr, 1994). In particular, kingfish, tuna, sardine, abalone, shrimp and lobster are among the species that have been considerably affected. There is much apprehension that the viability of the fishermen's future is in jeopardy and that their livelihoods are being threatened.

The fishery of Oman is managed by a Directorate-General within the Ministry of Agriculture and Fisheries. A system of licensing small fishing vessels and fishermen is in place, but remains unenforced. This is generally attributed to the fact that fishermen in Oman are spread throughout the country in numerous villages, both small and large, scattered along the 1,700 kilometres coastline. Lack of financial resources can be added, as the Ministry has to spend a substantial amount of money to enforce its licensing programme. The costs associated with the use of a licensing programme include not only hiring of staff, but also the purchase of monitoring equipment, development of an effective monitoring infrastructure, the ability to sanction rule violators and many others. This considerable expenditure cannot be met by the Ministry in Oman, as is the case in many developing countries. The licensing programme in its current form is, therefore, only used for statistical purposes and in fact it does little to regulate the activities of the fishermen. Furthermore, regulations of this type are imposed from outside the village (external) and do not recognize the informal rules crafted by the users themselves, the very fact that limits the effectiveness of state run resource management institutions (Alessi, 1998; p. 30; Ostrom 1990; p. 23 and Baland and Platteau, 1996; p. 281).

Obtaining a licence was not a problem for those who wanted to enter the fishery, until 1992 when the Ministry discontinued issuing new licences after it concluded that the number of fishermen was too high compared to the capacity of the resources to support them. However, after three years the Ministry discovered that there were 4,500 fishing vessels and 7,000 fishermen fishing without a licence. In April 1997, the Ministry changed its original policy to restrict the number of fishermen when it decided to register those unauthorized fishermen, an action which officials claimed to be in consistence with the Ministry's policy to increase the number of fishermen to 50 thousands in the year 2020 according to the recommendations of the Vision for the Oman Economy 2020 (an interview with Dr. Mohamed Ridha, Director General of the DGFR, Oman Daily Newspaper, 22 August 1998).

2.9 Overfishing in Coastal Waters

The economic theory of an open access or common property fishery was developed by Gordon (1954). However, as argued by many scholars, there is confusion over the use of the term open access to denote common property fisheries and vice versa. For example, Ciriacy-Wantrup and Bishop, (1975) argued that the notion of property implies the exclusion of non-owners. The same authors argued that open access (*res nullius*) is free for all, while common property (*res communes*) represents a well defined set of institutional arrangements to determine who should utilize the resource and the rules governing the activities of the users. Historically, common property has been regarded as "nobody's property"; the economic rent from the resource is to be gained by the first comer (Gerritsen, 1987). In the Omani fishery this attitude was reflected in uncontrolled access of thousands of fishermen to the fishery. The results were, first, that resources, especially the high commercial value species, were depleted at an inefficiently high cost, and secondly, that the landing levels declined below what could be produced if less effort had been applied to the fishery. The results of the development programme are quite impressive, since the number of fibreglass fishing vessels has increased from 2,601 in 1987 (Hochtief, 1987) to 9,262 in 1997, an increase of 256 percent (Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997). Nevertheless, for reasons which appear to be rather complex but clearly point to problems of overfishing, total landings (in metric tonnes) did not really increase between 1987 and 1997, but on the contrary, declined. It can argued here that the Government has actually subsidised over-fishing by providing grants for procuring better boats and fishing gears.

It has been widely accepted that when common property fishery resource is open access, fishermen will not exploit the fishery in a rational manner where the long-term sustainability of the resource is considered (Hardin, 1968). For reasons which appear to be rather complex but clearly point to the fact that there exists no restraint on fishermen's activities, nor can they see the negative consequences they create for others and for the future productivity of the fishery, depletion is the ultimate result. In this case, rent from the fishery is said to be completely dissipated. Based on these grounds and in order to rectify the uncontrolled use of the fishery, government intervention was seen as justifiable. In 1975, the Directorate General of Fisheries within the Ministry of Agriculture and Fisheries claimed sole responsibility for the development and management of the countries' fish resources, undermining the laws and social norms of the informal local institutions (Senat Al-Bahar) that were used to coordinate the use of the fishery by constraining the behaviour of individuals.

The fishery of Oman is therefore more likely to be an open access model than a common property model, with a few exceptions which are found in three shellfish fisheries, namely: the shrimp fishery in Mahut Island, the Abalone fishery in Salalah and the Lobster fishery in the Al-Wusta region. The three fisheries represent the highest valued species in the country. Since they are fished by fishermen inhabiting remote communities exclusion of outsiders is possible. In these three fisheries, the users themselves exclude outsiders and a system of closed seasons was implemented for the three fisheries after they almost collapsed. Some success has been achieved in this regard; although the stocks have not fully recovered to their level before 1990, at least landings levels have for several years been stable, except the for lobster fishery, which continues to decline.

To summarize how rent from fishing will eventually be completely dissipated under open access, let us consider a simple graphical representation of an open access model as shown in Figure 2.6. This model provides a rough illustration of why decisions were made by individuals which seemed rational from the individual point of view but proved to be irrational collectively. There are two models resource managers can choose from when formulating a management plan. The regulatory practices may be dominated by restrictions designed to preserve the biomass supply in the long run; an approach which relies on the use of the biological concept of Maximum Sustainable Yield (MSY). MSY is defined as the maximum quantity, which may be taken from the stock without adversely affecting future reproduction and recruitment (King, 1995; p. 198). However, Gordan (1954) argues that fisheries managers should aim to maximize the economic yield (MEY) from the fishery. MEY is defined as the maximum difference between the value of the catch and the cost incurred in catching it. This point on the yield curve is achieved by equating the marginal revenue to the marginal cost of fishing.

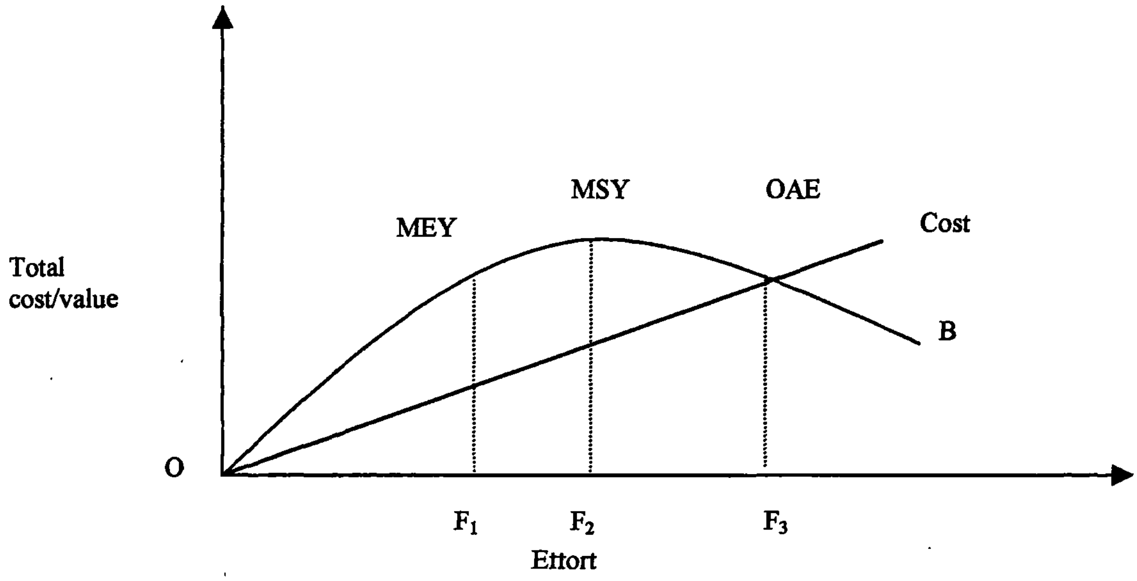

Figure 2.6 The Open Access Fishery

As fishing begins at point "o", the profit, represented here by the space above OC and below OB, accelerates sharply initially (Figure 2.6). The high profit gained by those who are actually in the fishery as fishing starts attracts new fishermen. As fishing efforts are added into the fishery, the MEY (Maximum Economic Yield) will soon be reached. Economists consider the MEY as the point where the maximum return from the fishery is obtained with the lowest possible effort (F_1). However, maintaining an optimal level of effort is extremely difficult. The high profits will attract more fishermen into the fishery and the effort level will tend to gravitate towards F_2, especially in fisheries which are not controlled or are under-controlled. Soon the maximum sustainable yield (MSY) will be reached at an effort level of F_2. At the MSY, although the catch is at its highest level, the marginal cost of fishing (for the fishery as a whole) is higher than the marginal revenue. Thus, the fishery is said to be economically overfished. As there is no information about the size of the stocks, new entrants are not discouraged because of their expectations of high profits, despite the declining profits at the MSY. The situation will eventually reach the equilibrium point OAE, which represents the open access equilibrium. At this point the cost of fishing equals the value of the catch. The same catch produced at the OAE point can be efficiently produced at a considerably lower level of effort. However, even when the open access equilibrium is reached, new fishermen may still enter the fishery because profitability varies depending on individual skill and technology endowments (Gerritsen, 1987; p. 393). Therefore, eventually, the OAE point will be surpassed and the fishermen will start to make negative returns. The situation leads in many cases to the collapse of fish stocks. The kingfish fishery of Oman, which is reported to be in a state of collapse, is an example (Hooker and Parsons, 1995 and Marine Science and Fisheries Center, 1995).

However, if the level of fishing effort exerted on a fish stock produces a catch in access of the maximum sustainable yield a fishery can sustain, the ultimate result will be overfishing. Biological overfishing can take two forms: first, growth overfishing which results when the young recruits entering the fishery are caught before they grow to a marketable size; second, recruitment overfishing which results when the adult stock is reduced to the extent that insufficient offspring are produced to maintain the population (Pauly, 1984; p. 39 and King, 1995; p. 198).

It is believed that the coastal fisheries of Oman are exploited beyond the MSY level or at the OAE level. This is indicated by an escalation of fishing effort in the coastal fisheries during the last 20 years and the fact that landings of many commercial species have been on the decline during the same period. There is no indication of entry into the fishery being restricted by the Ministry, nor are there policies to encourage fishermen to exploit the off-shore fisheries. In fact, the traditional management system for the common fishery (including usage pattern, enforcement, sanctions and conservation issues) has practically disappeared. This is a side effect of the development projects initiated by the Government since the 1970s, where CPRs have been converted into an open access resource and the tragedy of the commons of fish resources in coastal areas is the result. Furthermore, as was observed by Platteau, most developing countries have given preference to the industrial development of fisheries while to a large extent letting the small-scale sector fend for itself (Platteau, 1989a; p. 589). Fisheries development, in the official view, should be ensured through radical modernization which implies the importation of industrial techniques from developed countries rather than through gradual upgrading of the traditional sector. For example, an American consultancy consortium which was commissioned to assess the potential development of fisheries sector in Oman in the early 1970s advised the government to ignore the traditional small-scale fishery and to replace it with modern, high technology fishing and fish marketing (Donaldson, 1980; p. 491)

Traditional conventions and informal social sanctions relating to the use of fish resources have been replaced by unenforceable legal and administrative measures. This has marginalized the fishermen's initiatives to coordinate their usage pattern and to exclude outsiders from entering their communities.

2.10 Fishing Activities in Al-Batinah Region

The Batinah coast runs for a distance of some 270 kilometres from the frontier with the United Arab Emirates to the town of Sib, 40 kilometres from Muscat. The entire length of this coast is characterised by a medium width continental shelf extending up to 30 nautical miles toward the sea (Mundt, 1980). The substrate is generally sandy. The coast itself is marked by a thin strip, seldom wider than three kilometres, of dense vegetation composed primarily of date palm trees (Ministry of Information, 1995; p. 30).

Al-Batinah, with its 12,500 square kilomtres area representing 4 percent of the total area of Oman and its 623,708 inhabitants (representing more than one third of the total Omani population in 1997), is one of the most populous areas in Oman where there are around 50 people per square kilometre. The main towns are Barka, Masn'a, Suwaiq, Khaboura, Saham, Sohar, Liwa and Shinas.

Traditional fishermen are distributed continuously along the Batinah coast in numerous villages, both small and large, scattered along the 270 kilometres coastline. In 1997 there were 9,027 fishermen representing 35 percent of the total fishermen in the country operating 4,158 fishing vessels which constitute 35 percent of the total traditional fishing fleet (Ministry of Agriculture and Fisheries, Annual Statistics Report for 1997). The fishing fleet in Al-Batinah is composed of different types of fishing vessels, but dominated mainly by fibreglass fishing vessels, accounting for around 3000 vessels (1997) which represent 70 percent of the total fishing fleet in the region. The numbers of fishermen and fishing vessels have been on the increase since the 1980s. In 1987 there were 4,060 fishermen operating 1,203 fibreglass fishing skiffs along the

Batinah coast. Therefore, the number of fibreglass fishing vessels has grown by 150 percent between 1987 and 1997.

Fishermen along the Al-Batinah coast use a variety of gear types including drift gill nets, fixed gill nets, fish traps, cast nets, beach seine, handlines, longlines, and encircling nets. Given the high population, number of fishermen and fishing vessels, intense fishing activity has been observed along this coast compared to other regions in the country.

In 1997 the total fish landings in Al-Batinah was 23,000 metric tonnes representing 28 percent of the total traditional fishermen landings in Oman, making a decline of 10 percent below the 1996 level. The value of the catch for the same year was RO 12.5 million compared to RO 13 million recorded in 1996. The decline in the catch was largely attributed to the decline of tuna and sardine.

Figure 2.7 shows the annual fish landings and number of fishermen in Al-Batinah between 1985 and 1997. A distinct peak in the quantity landed can be noticed from Figure 2.7. The total quantity of fish landed increased steadily between 1985 and 1990 but rose sharply to peak in 1991 when landings rose from 32,000 metric tonnes in 1990 to 41,900 metric tonnes in 1991.

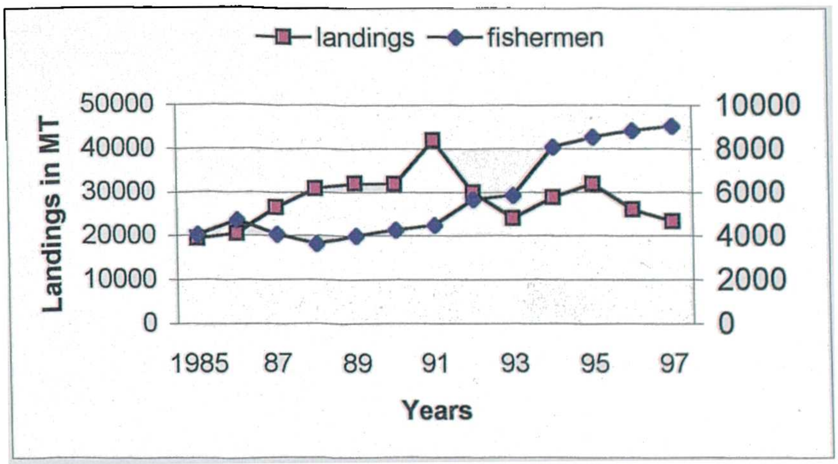

Figure 2.7 Total Fish Landings (Metric Tonnes) and Number of Fishermen in Al-Batinah between 1985 to 1997

For several years following that peak, catches have been on the decline, despite a slight increase in landings recorded in 1994 and 1995 (Figure 2.7). Total landings hit a low of 23,392 metric tonnes in 1997, which was 44 percent below the 1991 level. In comparison, the number of fishermen has been increasing steadily between 1985 and 1991. After 1991, the number of fishermen increased sharply and since then it has been on the increase. The number of fishermen is therefore has grown by 122 percent between 1985 and 1997. On the other hand, the number of fibreglass fishing vessels has grown by 150 percent during the same period.

The declining trends of the fish landings was considered as the first sign of overfishing which was caused by excessive pressure on the narrow continental shelf of the Al-Batinah coast as the result of the development programme during the 1980s which increased the number of fishermen by 122 percent and the number of vessels by 150 percent between 1987 and 1997 (Siddeek, 1995; Sultan, 1996).

2.11 Conclusion

In this chapter, an overview of the fisheries sector was presented. The fisheries sector, particularly the traditional sector, is a significant sector in the Omani economy. As indicated in the chapter, the sector is important for the livelihood of thousands of people in the country. It provides substantial employment opportunities for coastal inhabitance besides its contribution to the national GDP, foreign exchange and the provision of an important source of animal protein.

Although the traditional fishery is still predominantly small-scale, it constitute the most important sub-sector, accounting for around 80 percent of the total fish landings during the last twenty years. However, as indicated in the present chapter, the landings of the traditional fishery showed declining trends for several years since 1980s. The decline in the landings of this sub-sector was largely attributed to overfishing in inshore waters.

The Ministry of Agriculture and Fisheries manages the traditional fishery. Many fisheries management plans have been implemented to address the problem of overfishing in coastal waters, but remain unenforced due to the lack of financial resource. Furthermore, these management plans do not recognize the informal rules crafted by the fishermen themselves, which limit the effectiveness of the regulations designed by the Ministry.

Given the failures of the current state management institution to address the problem of overfishing and to protect the livelihood of thousands of fishermen, it is important to search for an alternative solution. Cooperation among resource users to manage their resources has been regarded as an alternative to the expensive and often inappropriate state management. Therefore, it is essential at this stage to examine the factors that influence fishermen's decisions to participate in collective action. Chapter Three provides an overview of the collective action approach to fisheries management.

CHAPTER THREE

LITERATURE REVIEW OF THE EMERGENCE OF COLLECTIVE RESPONSIBILITY OVER LOCAL COMMONS

3.1 Introduction

This study focuses on the possibility of collective responsibility among resource users to resolve dilemmas facing them in their use of the resource. Previous studies (experimental and field research) have explored the topic, but each with a distinct focus. This study, however, will use the combined findings of previous research as the bases for exploring the use of coastal fish resources among the fishermen in South Al-Batinah, Oman.

The purpose of this chapter is to present a literature review of the theoretical and empirical background of the study. The review uses concepts from collective action, common property resources, public goods and game theory, as they pertain to the study of small-scale traditional fishermen, to create the rationale for this study. In this chapter common property resources are defined and distinguished from open access. The chapter will also compare common property resources to public goods, to demonstrate their susceptibility to the problem of free riding and other problems usually associated with public goods. The use of game theory to explore fishermen's behaviour in social dilemmas is also discussed. The final section of this chapter presents how state regulation of local commons my not guarantee efficient exploitation of the resource.

Fish resources are considered as renewable natural resources, which are regenerative but at the same are in danger of exhaustion from excessive use (Dasgupta and Maler, 1994; p. 320). In developed countries the problem of the commons is often related to global warming, acid rain and depletion of ozone layer, whilst in developing countries the daily livelihood of the poor depends more substantially and directly on the local commons: irrigation, forestry, grazing, coastal fisheries and so on (Bardhan, 1993b; p. 87). The importance of common property resources for human well-being has been stressed by Dasgupta (1996). The extent of common property resources as a proportion of total assets in a community varies considerably across ecological zones. In

India, for example, they appear to be most prominent in arid regions, mountain regions and unirrigated area and are less prominent in humid regions and river valleys. (Dasgupta, 1996; p. 404). For example, Jodha used data from eighty villages in six dry tropical states in India to estimate that, among poor families, the proportion of income based directly on local commons is in the range 15 to 25 percent (Jodha, 1986).

3.2 Common Property Resources

Of fundamental relevance to the study of collective action is the distinction between Common Property Resources (CPRs) and Open Access Resources (OARs). A CPR is distinguished from an OAR by the fact that the former is governed by a property regime while the later is not (Shanmugaratnam, 1996; p. 165). CPRs are defined as a natural or man made resources in which (a) exclusion is nontrivial (but not necessary impossible) and (b) yield subtractive (Hackett *et al.*, 1994; p. 99). Similarly Berkes *et al.* (1989; cited in Feeny *et al.*, 1996; p. 187) defines CPRs as a class of resources for which exclusion is difficult and joint use involves subtractability. OAR resources are defined as those resources, which belongs to no one and where no rules of exclusion operate (Ciriacy-Wantrup and Bishop, 1975; p. 714; Feeny *et al.*, 1996; p. 187). In the words of Tietenberg, property rights on CPRs are a bundle of entitlements defining the owner's rights, privileges and limitations for use of the resource (Tietenberg, 1992; p. 45).

Therefore, in the context of coastal fisheries, CPRs are those resources which have clear physical boundaries and the rights to use the resource are assigned to an identified group of individuals by virtue of their membership of the group in accordance with its rules and norms of appropriation and management and where non-members are denied access to derive benefits from the resource. Most coastal fisheries appropriated as CPRs fit this definition. This type of property rights regime was common among traditional artisanal fishing communities and is often in a number of contemporary coastal fisheries throughout the world (Feeny *et al.*, 1996; p. 188). The property rights governing the use of the resource affect how users behave and relate to one another. By examining the entitlements of the users and the way these entitlements affect human behaviour, we will have a better understanding of how resource problems arise. OARs and unregulated CPRs are likely to be exploited in an inefficient way. As expressed by Baland and Platteau, *"the core problem is that open access and unregulated CPRs do* *not give individuals the proper incentives to act in a socially efficient way*" (Baland and Platteau, 1996; p. 36). As Runge (1986) noted, natural resources such as fish stocks are more used in common rather than used in private; thus, without exclusive rights, individual users would exploit the resource until profit is zero.

As illustrated by the above definitions, OAR is not governed by an enforceable regime; thus, there is no restriction on entry of appropriators nor are there any restrictions on their use of it. As the matter of the fact, in developing countries, more often than not, state property resources have become *de facto* private or open access resources due to the state's failure to enforce property rights because of high transaction costs, corruption of enforcement agencies, and / or political reasons (Shanmugaratnam, 1996; p. 166). There are many examples of CPRs, which became OARs when their management institutions broke down and disintegrated due to the effects of factors like nationalisation, partial privatisation and social and demographical changes. The fact that coastal marine resources have often been under a regime of free access has contributed to fleet overcapacity, resulting in too many fishermen and vessels racing after too few fish. The use of inappropriate economic assistance measures, which can provide the incentives for increased participation in the fisheries sector, has aggravated the problem (OECD, 1997; p. 9). Such situations lead to uncertainty caused by lack of assurance mechanisms which in turn hamper the capacity or motivation of resource users to participate in collective action[1].

To look at Hardin's example of a pasture open to all, one of the problems associated with inefficiency is lack of property rights. The pasture is an open access resource to which herdsman can bring any number of cattle to graze. After some time, the amount of food available will be reduced as more cattle are added into the pasture, thus reducing the benefits herdsmen receive. Inefficiency results because there are no limits placed on the rights to graze, which leads each herdsman to take only his own benefits and costs into account and ignore the effect his actions have on others. Therefore, if property rights are well defined concerning the use of the pasture, sustainability can be maintained. If the villagers are dependent on healthy animals from

[1] In this thesis the term collective action refers to the process and consequences of individual decisions to voluntarily coordinate behaviour (White and Rung, 1995). The term collective action regime refers to the set of institutional arrangements governing a collectively managed activity or resources (White, 1997, p. 68).

the pasture land for their survival (economic dependence), they are likely to ensure that grazing rights are limited and enforced through some form of collective decisionmaking body to form rules and monitor use (Hanna *et al.*, 1995; p. 16). Therefore, property rights regimes are a necessary but not sufficient condition for the efficient use of environmental resources (ibid., p. 24). For property rights to be efficient, sufficient property rules must be enforced.

Another issue of fundamental relevance to the study of collective action is the distinction between the attributes of CPRs and pure public goods. It is important to note that the common property that concern us here (coastal fisheries) are renewable common-pool resources which are distinguished from pure public goods by their property of subtractability (Ostrom, 1990). Unlike the consumption patterns of pure public goods, in the case of a fishery each user reduces its total availability to others by the quantity harvested by him, less the amount that is replenished through biological regeneration at a given time. If one fisherman catches more fish less remains for the others. In this context, when the rate of harvest exceeds the rate of replenishment, the fishery can be exhausted. To distinguish it from CPRs, pure public goods can be defined as those goods which exhibit consumption indivisibility and, in additionally, are fully accessible to all (Tietenberg, 1994; p. 39). Indivisibility in consumption refers to the pattern of consumption when one person's consumption of a good does not diminish, in the slightest, the amount available for others (Tietenberg, 1994 and Cornes and Sandler, 1996). Fish stocks often share the nonexcludability attribute of public goods in their use. Exclusion occurs when it is possible to exclude potential users from deriving benefits from the goods unless they meet certain criteria. Because fish stocks (marine fisheries) require a large territory it is difficult (if not impossible) to exclude potential users.

Many common environmental resources are regarded as public goods, such as clean air, clean water and biological diversity. Other examples of public goods include fireworks displays, strategic weapons, and pollution-control devices. Public goods, such as pollution-control devices for example, are similar to reductions in fishing effort in that it is difficult to exclude potential users from deriving the benefits of the good once it is provided. Therefore, fish stocks are a common-pool resources, they can be used jointly, because of the high cost of excluding potential fishermen within a community;

and their consumption are subtractive when a particular fish is caught by one fisherman is not anymore available to the others.

As illustrated above, fish stocks are usually characterised by three features: nonexcludability, subtractability and replenshability. The nonexcludability and subtractability of fish stocks pose a major challenge for organising assurance mechanisms that ensure a fair distribution of the resource without impairing its sustainability. In the context of a coastal fishery, the challenge facing its users (or owners) is how to organize for the provision of institution or rules (the public good) to coordinate their activities.

The attributes of public goods give an individual user an opportunity to derive benefits from the resource without paying the full cost. This can be clearly seen in an OARs and unregulated CPRs which are likely to be exploited in an inefficient way. These inefficiencies result as an individual user exploiting these resources becomes a free rider on the contribution of others. This action tends to diminish incentives to contribute toward a sustainable exploitation of the fish stocks. The cumulative effect of this action by multiple users can create harms (negative externalities) on the stocks and the users that will eventually affect the well-being of both. In the case of the fishery, these externalities include stock depletion, gear destruction and congestion. Negative externalities imposed on the stocks and their users and the subsequent loss of benefits are regarded as the tragedy of the commons (Hardin, 1968).

Individuals jointly using a CPR are assumed to face a social dilemma often caused by factors which appears to be complex but point to the protracted absence of an institutional environment or failure of existing ones to provide the interested individuals the opportunity to negotiate courses of actions. In such a situation, individual rational actions ignore the external harm they impose on each other, leading to outcomes that are not rational from the perspective of the whole.

Cooperation in the case of an overexploited fishery is required to restrain resource use and to provide institutions for coordinating individual action. In such a situation, fishermen have many options to coordinate their use. They can choose one or more of the following: limits on their boat size and power; limits on the number and size of nets; limits on their fishing time; limits on individual total catches and minimum landing sizes. However, collective action may take place in cases where the balance between the gains from cooperative effort reduction and the transaction costs involved in initiating it is positive. In Lipton's view, the positive balance is the "temptation of goodness": the incentive for each individual in the common dilemma to make a social optimum choice and the negative balance is the "temptation for badness" (Lipton, 1985; cited in Morton, 1996; p. 66).

It seems unlikely that individuals will initiate collective action if their patterns of usage of the resource are not organized through an institution[2]. Institutions for managing the fishery can be regarded as a public good where they are provided jointly by the users (or the state), and produce nonexcludable benefits for all participants (e.g., stock enhancement, restrained fishing, reduction of gear damage and conflicts resolution mechanisms), but the benefits obtained are not indivisible, which makes them similar to private goods. To illustrate this, let us take a small fishing village in which stocks are overfished and fishermen finally agreed to establish an institution to restrain their take from the fishery. For simplicity, assume that there is full compliance with rules and the fishery recovers after a period of time. In this context, the institution is jointly provided by all participants, the benefits are nonexcludable to any member of the village and further, the benefits are rivalrous in the sense that one fisherman's catch is another's loss.

A major problem in relation to the supply public good is "free riding". In an overexploited fishery, rent dissipation occurs because each fisherman becomes a free rider[3] on the others' contribution to restrain the take from the fishery. Because of the nonexcludability property of fish stocks, free rider fishermen receive the benefits of any reduction of fishing effort contributed by other fishermen. Those who free ride on the common pool fishery obtain benefits (without paying the cost) from the adherence of other fishermen to the rules of such institutions.

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[2] According to North: "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social, or economic. Institutional change shapes the way societies evolve through time and hence is the key to understanding historical change" (North, 1990; cited in Hanna and Munasinghe, 1995).

[3] A free rider is someone who derives benefits from a commodity without contributing to its supply (Tietenberg, 1994; P. 41).

The losses resulting from an overexploited fishery may provide incentives for fishermen to engage in collective action to set restrictions on entry and on the amount of fish harvested. These losses are perceived by an individual as equivalent to the potential gain from collective action. Capturing a portion of aggregate resource rent that is saved motivates individuals to bargain for institutional change (Libecap, 1994; p. 566). The private expected gain from institutional change as compared to the *status quo* will determine the strength of the bargain over benefits distribution by interested parties. Libecap (1994) argues that the intensity of debate over distribution and likelihood of collective action are influenced by: (1) the size and the aggregate expected gains; (2) the number and heterogeneity of the bargaining parties; and (3) information availability. The larger the potential benefits over the cost incurred in initiating the collective action, the more likely the emergence of collective institutions to coordinate resource use (Baland and Platteau, 1996; Cornes and Sandler, 1996; Gardner and Ostrom, 1991; Libecap, 1994; Sandler, 1992; Wade, 1988 and White and Runge, 1995). Large potential benefits will make individuals better off as compared to the *status quo.* It can be expected, therefore, that influential individuals will aim to provide institutional change to coordinate resource uses.

The size and heterogeneity of resource users are commonly reported by scholars as potential problems facing the emergence of collective action. Olson (1965), for example, argues that provision of public goods depends on the size of the group: a small "privileged" group[4] will provide itself with public goods, whereas in large and intermediate groups the public goods will not be provided. Olson (1965) has also attributed failure in the provision of the public goods to group heterogeneity. Baland and Platteau (1996; p. 302) provide three sources of heterogeneity which hamper the capacity or motivation of resource users to participate in collective action. First, heterogeneity may result from ethnic, race, or other kinds of cultural divisions. Second, it may arise from differences in the nature of interests various individuals may have in a particular collective action. Third, it may originate in inter-individual variations in some critical endowments, that are reflected in varying intensities of interest. Baland and

[4] A privileged group, as defined by Sandler, contains at least one individual or coalition whose benefits from collective action exceed the associated costs, even if these costs are solely borne by the individual or coalition (Sandler, 1992; p. 9).

Platteau (1996; p. 302) further assert that while the first two are considered as causing a strong obstruction to collective action, the same cannot be said of the third case.

Regarding the first source of heterogeneity, ethnic, social and other cultural differences may have a negative impact on the ability of resource users to form collective action. This happens as these differences leave room for different interpretations of the rules of the game being played, for different views about who should enforce them, and for different perceptions of social conventions and norms supporting cooperation (Baland and Platteau, 1996; p. 302). However, this should not be generalized to assert every collective failure to these differences. For example, Salim (1996) in his study of the coastal trawl fishery of Malaysia found that Chinese, Muslims and Malay fishermen have organized collective action to reduce overfishing in their fishery. Thus, their ethnic differences were no impediment to collective action.

The second source of heterogeneity (heterogeneity of interests or objectives) is a strong impediment to collective action as argued by Baland and Platteau (1996). In the context of coastal fisheries, for example, collective action is threatened when some fishermen have alternative income-earning opportunities. Resources management is undermined by the existence of different interests, most notably between full-time and part-time fishermen and, more seriously still, between small-scale traditional fishermen and industrial fishing. In the case of fishing status, part-time fishermen, having secured another source of income, may feel much less concerned about conservation of fish resources, than full time fishermen for whom subsistence crucially depends upon the state of these resources owing to lack of alternative income opportunities. The same can be said about industrial fishing owning many exit possibilities, because they can move their fleets to other fishing grounds (Platteau, 1989b; p. 645). Many cases of this type are found in developing countries, where industrial fishing have been given concessions to exploit fish resources (see Lim *et al.* (1995) for an example from San Miguel Bay, Philippine). In the Sultanate of Oman, for example, it was observed that the Korean fleet operating off the east coast of the country is causing severe damage to the demersal fish stock through violation of the rules by entering the coastal zones previously allocated to the traditional fishermen and by discarding substantial quantities of valuable fish species which do not fit the local markets in Korea (Hare, 1989).

In the context of the third cause of heterogeneity (differences in skills, assets, income and access to credit markets), changes in property institutions involve the risk of being made worse off for some group members, especially those who are usually profited under the *status quo* (Libecap, 1994). This is because different sharing rules may produce different distributions of earnings for resource users. In his well-known book, The Logic of Collective Action, Olson (1965) has argued that agents with high stakes in a public good are more willing to bear large share of the costs of its production (see also Guttman, 1978; p. 254). Some evidence from CPRs supported Olson's argument where the costs of regulation are often born by the economic elite (Wade, 1988; p. 190 and Ostrom and Gardner, 1993; p. 105). In an example provided by Baland and Platteau, (1997a; p. 461), it was found also that rural cooperatives in the Netherlands were often created by better-off farmers who took the initiative to start the cooperatives and contribute the bulk of initial share capital.

Another successful example was the case of Saudi Arabia which for many years produced less than its quota of oil to subsidize OPEC in its effort to reduce excess production by other members (Heckathorn, 1993, cited in Baland and Platteau, 1997b; p. 3). This pattern conforms well to the exploitation hypothesis advanced by Olson (1965) that the large is exploited by the small.

However, as argued by Baland and Platteau, (1997a; p. 461 and 1997b; p. 3), the above consideration should not be taken to mean that if the distribution of wealth is more equal, individual contributions will fall. It just happens that the wealth of Saudi Arabia has been overwhelmingly more than other members in OPEC and it attaches a higher value to any improvement in oil prices, which make it rich enough to bear a greater share of the reduction of excess production. Further, Cornes and Sandler (1985; p. 113) argue that the optimal provision of public goods in a community of a given size is independent of income distribution (see also Cornes, 1993; p. 265). In communities where wealth is made more equal, the cost of initiating regulatory tasks is shared more equally among agents, whereas greater inequality makes some agents big enough to bear a greater share of the costs on a voluntary basis, while others are too small or attach too little value to their resource endowments (Baland and Platteau, 1997b; p. 3).

In many instances, wealth is associated with better availability of outside economic opportunities. Thus large elites, even though they attach greater value to their resource endowment, may still choose to sacrifice conservation effort in order to derive quick gains in the present. In the context of coastal fisheries, for example, conservation effort may be seriously undermined by the presence of more endowed members. As their assets increase, they start to acquire bigger vessels and stronger engines, which allow them to exploit new fishing grounds away from their base village. Owing to this exit opportunity, they feel less concerned about conservation of local fish resources. It has been suggested that heterogeneity of preferences amounts to transaction costs, and thereby impedes cooperation as cooperation requires shared values (Dasgupta, 1996; p. 403). Therefore, more inequality does not necessary lead to more efficient use of natural resources (Baland and Platteau, 1996; chap.12; 1997a; p. 461 and 1997b; p. 3). Thus Olson's (1965) conjecture (the equilibrium in public-goods game often has small members free-riding more than large members) might not hold true in the case of CPRs.

Information problems can also delay the emergence of collective action. The function of institutions that make available to the fishermen the opportunity to negotiate mutually advantageous collective choices is hampered by the lack of information. According to Dasgupta, "*the functioning of institutions is linked closely to the structure of property rights (that is, who controls what and who owns what) and also the structure of information that people possess and have access to*" (Dasgupta, 1996; p. 393). Similarly, Baland and Platteau, (1996) argued that information asymmetries make the bargaining process inefficient. This is because parties often have an incentive to give false information so as to manipulate the outcome of the new arrangement. Further, it can be difficult to evaluate individual wealth under the *status quo* and proposed changes, in the presence of serious information asymmetries (Libecap, 1994). It is difficult for fishermen using a common fishery to achieve agreement if they lack information regarding the value of the individual's share of the resources under current use and of potential losses resulting from institutional change. Limited information on the impact of the new arrangement rules on fish stock and individuals' returns makes collective action less preferred by fishermen.

As pointed out in the previous section, lack of information tends to diminish contributions toward the initiation of collective action. However, Teoh (1997; p. 401) argues that a policy of nondisclosure or nongeneration of information (good or bad) can sometime benefit teams. For example, when a cooperative is in a state of collapse, generating information about its status would make members more reluctant to contribute to the cooperative. The same can be said about resources management institutions (formal or informal), where rosy forecasts are likely to motivate greater contributions.

3.3 Externalities and Common Property Resources

Externalities are responsible for many general problems in a capture fishery. An externality occurs whenever an action taken by some economic unit has a direct impact on the welfare or productivity of some other economic unit (Dorfman, 1974; p. 5). It occurs when someone is not held accountable for his actions. The obvious case of negative externality is producer to producer, when one fisherman's behaviour can affect the welfare and productivity of other fishermen in a particular fishery. An externality can be either positive (if the effect is favourable) or negative (if the effect is unfavourable). A negative externality exists when a fisherman uses fishing traps to harvest demersal species, but catches other non-targeted species in the process (for example, killing female lobster during breading season). There is no feedback to the trap fisherman in terms of fines to curtail the non-target mortality. There may be a longer term effect on the lobster fishery if catching female lobster reduces its stocks. Therefore, activities of misuse of CPRs are an instance of negative externality. A positive externality exists when a trap fisherman decides to change his fishing gear (change to handline, for example) to minimize the bycatch of lobster during the closed season. This action does not benefit the trap fisherman, but does benefit a lobster fisherman. There is no feedback that enables the trap fisherman to capture the benefits of protecting lobster during the closed season other than the personal satisfaction of avoiding non-target mortality.

There are two types of externality, pecuniary and technological (Tietenberg, 1992). Pecuniary externality affects the input and output prices of firms but does not directly enter into the production decisions (Sarch, 1996; p. 306). Therefore, overfishing is not a pecuniary externality because the effect is not transmitted through prices. The other class of externality is technological externality, which occurs when the negative effect produced by an economic unit directly enters in the production function of another economic unit[5]. If we think of common fishing grounds, the yield on any day displays diminishing returns to the total fishing effort. In this case the activity of an individual fisherman depletes the flow of services available for other fishermen thereby imposing a negative externality. Fishermen have to fish longer and incur higher fishing costs. Consequently, there are short and long term effects on the fishery since excessive fishing on any day raises the cost of the catch on subsequent days, and excessive effort in one season may impair the productivity of the fishery in the future. The mode of damage to common property resources is the removal of something of value from it (Dorfman, 1974). It is obvious that depletability is not the only mode of damage to CPRs, because in congested fishing spots (in the case of the beach seine fishery for example) fishermen do also reduce its accessibility to other beach seiners.

Stock externalities occur as the cumulative effect of catching fish from the standing stock at a rate which exceeds the rate of replenishment, leading to a diminished quality and quantity of fish (MacDonald, 1993). Congestion, on the other hand, is a class of technological externalities, which occurs when fishing gears become entangled or when the setting of a fisherman's gear affects the catchability of another fisherman's gear. The assignment problem is the outcome of the situation where there are more fishermen competing for a limited number of good fishing spots or when industrial fleets enter inshore fishing grounds previously allocated to traditional fishermen. All these will ultimately result in conflict among fishermen, resulting in many cases in gear being stolen or cut loose, and boats damaged. There have even been cases of gunfire exchange resulting in injuries and death (see: Gardner and Ostrom, 1991; Ostrom, 1990; McGoodwin, 1994 and Begossi, 1998). As shown above, negative externalities in a fishery may take different forms: stock externality, technological externality, congestion, and assignment problems. All these lead to a rise in fishing costs and diminish returns from the fishery, hence increasing rent dissipation.

3.4 Public Goods and Collective Action

A good is nonrival or indivisible when a unit of the good can be consumed by one individual without detracting, in the slightest, from the consumption opportunities still available to others from the same unit (Cornes and Sandler, 1996; p. 8). Examples

[5] Johnston termed this type of externality a real externality (Johnston, 1992; cited in Sarch, 1996).

of indivisible goods are pollution-control devices, lighthouses and street lighting. If lighthouse services are provided, the use of this service by one boat does not reduce its availability for the others, therefore, its benefits are nonrival. At the other extreme, private goods (such as food) are regarded as rival. Consumption of one unit of the private good eliminates consumption opportunities available for other consumers. Therefore, the benefits of private good are fully rivalrous and excludable, whereas the benefits of pure public goods are nonrival and nonexcludable (Cornes and Sandler, 1996). Another attribute of public goods is non-excludability. If the benefits of a good are available to all, once it is provided, then the benefits are said to be non-excludable (Sandler, 1992). The benefits of a lighthouse are non-excludable since once the service is provided, all boats can use the service regardless of whether they contributed to the cost or not. Pollution removal is another example. Where pollution is removed it will be impossible to exclude any one from enjoying a clean air, even those who do not contribute to the cost of removal. In the case of private goods (such as food, cloth) the benefits can be withheld costlessly by the owner, therefore they are excludable (Table 3.1).

However, unlike the consumption of public goods, consumption of common property resources is rivalrous in the sense that it is possible for an individual to increase his consumption at the expense of others (Dasgupta, 1996; p. 399). Therefore, the reduction of fishing effort as a collective good is public-like, by its nonexcludability and jointness of provision and resembles private goods as the benefits are subtractive (rivalrous) in nature. In the context of an overexploited fishery, if all fishermen agree to restrain their take to ensure sustainability they will all benefit. If few fishermen choose not to reduce their catch, they will continue to harvest at the previous rate allowing others to bear the cost of restraint, thus they are free riding on the groups' effort. However, motivation for free riding is often affected by cultural norms, ideology and value systems (Feeny *et al.*, 1996; p. 190 and Dasgupta, 1996; p. 422).

Table 3.1 Goods Types and their Attributes

Type of goods	example	Excludability	Rivalrousness
• pure public goods	• Pollution-control devices	Difficult	Absent
• impure public goods	• Club goods (swimming pool)		
• private goods	• Foods and cloths	Easy	High

Sugden, (1984) argues that public goods can be produced through three mechanisms: (i) Charging consumers (those who consume must pay); (ii) Raising taxes (equal taxes are paid by those who consume and those who do not consume); (iii) Voluntary contribution (consumers decided for themselves whether to contribute or not). As stated above, the problem with the voluntarily contribution of public goods is characterized by nonexcludability; once the goods are provided, their benefits are allocated among consumers. It will be costly and difficult (if not impossible) to exclude those who do not contribute time and money toward the provision of the public goods (Cornes and Sandler, 1996). Cornes and Sandler (1996) claim that the nonexcludability attributes of public goods are the crucial factor determining the level of provision. As it is costly to exclude non-contributors, this gives individuals incentives to take a free ride on the provision of others.

Free rider problems result from the incentive that individuals have to defect from the rules of institutions they belong to. This defection behaviour (Olson, 1965) seems to be logical from the point of view of narrow self-interest. This behaviour leads to an outcome in which the group as a whole is made worse off (Runge, 1986). The tragedy of stock over-exploitation results from the individual fisherman's incentive to free ride regardless of the expected actions of the others. Even when fishermen agree to refrain from further fishing, the dominance of the free riding strategy makes such a contract unstable, which will result in an inferior Nash[6] equilibrium.

[6] Nash equilibrium results when an agent chooses his or her best or optimizing choice for one (or more) variables, given that the other players have chosen their optimizing or best responses for this (or these) variables. However, it should be noted here that when the public good is impure (exclusion is possible for example as in club goods), Nash behaviour need not imply sub-optimality (Sandler, 1992; p. 16).

The reduction of fishing effort and solving conflicts in the fishery can be conceived of as public goods characterised by jointness of supply and consumed by a well-defined group. The nonexcludable nature of the benefits derived from effort reduction creates incentives for individuals to undersupply it. Runge (1984; p. 156) states that these consumption decisions are troubling both in theory and practice because they create incentives to free ride at the group expence. How can a reduction in fishing effort be achieved when fishermen can benefit by catching more fish and passing the cost of overfished stocks to the whole society? The answer to this question was advanced in a pessimistic conclusion by Olson (1965; p. 2): *"rational self interested individuals will not achieve their common or group interest"*. However, there are many counterexamples. For example in many real world situations there are substantial voluntary contributions to the provision of public goods without outside enforcement.

In the context of coastal fisheries, many fishermen in different regions are able to organize allowing scope for viable collective action to avoid the tragedy. The case of the fishermen of Alanya-Turkey (Ostrom, 1990 and Berkes, 1986) is an example; the informal lobster territories in Maine (Acheson, 1989) is another example; many successful cases are also presented by Baland and Platteau, (1996). Furthermore, from their experimental research, Marwell and Ames (1981) provide little support for Olson's perspective. They found individuals contribute to public goods at an average rate between 40 and 60 percent. They question the validity of the dominant free riding hypothesis, however, they observed the existence of some "weak" free riding[7], but they found that individuals often contribute resources voluntarily to public goods. Their investigation does not support the "strong" free riding hypothesis, which concludes that those who contribute to provision of public good voluntarily are simply irrational. Feeny *et al.* (1996; p. 190) reached the same conclusion: *"complete free riding appears to be uncommon; on the other hand the complete absence of free riding is as well"*. In the same vein Hirshleifer (1983; p. 384) argues that: *"in normal times people behave in a conventionally cooperative way because individually they find it profitable to do so:*

[7] The "Weak" free rider hypothesis suggests that individuals often contribute resources to public goods voluntarily, whereas, the "strong" free rider hypothesis concludes that there will be no contributions made by individuals. Weak free riding leads to some form of provision (sub-optimal provision) of the public goods, whereas strong free riding is demonstrated by contribution close to zero. (Runge, 1984; p.156; Marwell and Ames, 1981).

while there is some slippage around the edges, on the whole the social control mechanisms deter evildoing".

3.5 The Tragedy of the Commons

In an overexploited fishery, collective action is required to maintain the sustainable exploitation of fish resources. If resource users succeed in solving their collective problems, the outcome will be collective goods in the form of healthy stocks and mechanisms for solving conflicts between users. To achieve this outcome, voluntarily provisions by all fishermen are necessary, as state control and private ownership schemes to manage fish resources, as discussed in the following sections, do not produce optimal social outcomes (Ostrom, 1990; Baland and Platteau, 1996; Dasgupta and Maler, 1994 and Dasgupta, 1996).

The starting point for any analysis of common-pool resources is Garrett Hardin's 'tragedy of the commons' which has become the standard frame for so much of the common-pool resources management (Blair, 1996). Hardin (1968) assumes that resource users are individualistic and unable to co-operate in their collective interest. He concludes that to prevent the tragedy of the commons, resources must be either privatized or controlled by the state, in other words, by an authority external to those directly effected by the commons. This idea has been adopted by many third world countries which have failed to stop over-exploitation and in many cases may have contributed to even more rapid degradation of resources and increased inequality where the distribution of wealth is already unequal (Runge, 1986). However, there is much empirical evidence challenging the use of Hardin's model and its sweeping pessimism about collective action in general or some kinds of common-pool resources management in particular. Co-operative means to manage common-pool resources have achieved successful results in many parts of the world (see: Baland and Platteau, 1996; Blair, 1996; Berkes, 1989; Feeny *et al.*, 1996; Jentoft and Mikalsen 1994; McCay and Acheson, 1987; OECD, 1997; Ostrom, 1990; Pinkerton, 1994; Salim, 1996 and Townsend and Pooley, 1995). Similarly, Dasgupta reached the same conclusion: *"members of local communities have often cooperated in protecting their commons from excessive use"* (Dasgupta, 1996; p. 400). In Benin, for example, the lagoon fishermen still observe the simple rules for conservation of fish resources that their ancestors had established some three centuries earlier (FAO, Fisheries Department, 1999; p. 42). Based on taboos, these customary rules forbade all capture of fingerlings or juveniles. They also designated rest days when no one was allowed to fish for fear of incurring the wrath of the gods. The area is guarded by the dabbo hounon, the chief of the region, who inflicts heavy fines on offenders (ibid.).

Therefore, in thinking about communities and the fishery, the "tragedy of the commons" thinking that motivated some management strategies needs to be reconsidered, and a clear distinction must be drawn between open access and "commons" fisheries. The widespread use of "tragedy of the commons" thinking among resource managers and policy makers is not restricted to developing countries, but even in developed countries the role as well as the interest of the local people has been ignored (Ommer, 1998; p. 5).

Although Hardin does not use the Prisoner's Dilemma (PD) in his argument, it can be represented formally as a PD game. The Prisoner's Dilemma has exercised a continuing fascination to many scholars because it appears to provide a solid basis for the conclusion that rational people cannot achieve rational collective outcomes (Wade, 1988). In this game, each individual will try to cheat, regardless of what he expects others to do. In such a situation the only solutions, as stated above in Hardins' conclusion, are either coercion from outside the group to force people to reach and maintain the social optimum, or a change in the rules from outside the group to a private property regime which, as will be shown later, does not provide a social optimum in the long run (see section, 3.8).

Although the short term dominant strategy of Hardin's approach was presented as a single-period Prisoner's Dilemma game, this does not apply in a natural field setting for three reasons. First, the problem is a multi-period one; the game has an indeterminate end. As is the case of any community exploiting a common resource, interaction among the users occur over the years. Second, in the context of a community exploiting a common resource, individuals are interacting in their daily activities, thus they are communicating, unlike in the PD game. Thirdly, the PD scenario does not apply if the resource users value working together and care about their reputation in the wider community. Therefore, in the context of a natural field setting the game is played repeatedly by participants who can communicate, negotiate and care for their reputation, allowing scope for collective action to avoid the tragedy of the commons

(Bardhan, 1993a; 1993b; Ostrom, 1990; Seabright, 1993; Hackett *et al.*, 1994). In a fishing village, for example, a fisherman who is seen to defect would find it very difficult to attract the future cooperation of others.

3.6 The Logic of Collective Action

Mancur Olson (1965) in his book, "The Logic of Collective Action", argues, "*unless the number of the individual in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self interested individuals will not achieve their common or group interest*" (Olson, 1965; p. 2). When a public good is provided, the rational course of action, for a self-interested individual, is to take a free ride to enjoy the benefits of the collective goods without contributing to the cost (Udehn, 1996). Olson states that provision of the public good depends largely on group size. He divides groups into "small", "intermediate" and "large". As the size of the group increases, free riding becomes a dominant strategy. This is found in "large" and "intermediate" groups where the contributions of individuals to collective goods are not significant and the share of the benefits as stated by Olson (1965) is also negligible. "Intermediate" groups differ from large groups in that the contributions of a single individual are noticeable to others. Thus, the "intermediate" group is not large enough to let a free rider remain anonymous (Udehn, 1996). In a "small" privileged group, free riding is less of a problem. In such a group, at least one individual has the incentive to provide the public goods, irrespective of the others' contributions.

Olson defined "privileged" in this way. If "Ci" is costs and gross benefits are "Vi" to the individual and net benefits are "Ai", then individual benefits may be defined: Ai = Vi - Ci. He argued that if Ai is greater than zero for some i then the group is privileged and may form. If one member in the group finds that the benefits he will obtain by having the good outweigh the cost of providing the good by himself, then the group is privileged and the good will be provided even though other members will consume the good without contributing toward its provision. In this case the total gain is so large in relation to the total cost, and that an individual's share would be more that the total cost of provision. However, if Ai is less than zero for all i then the group is "latent" and will fail unless selective incentives (noncollective goods) are introduced to force individual to contribute (Olson, 1965; pp. 23, 49 - 51). Olson (1965) concludes that small groups are more likely to be privileged, whereas large groups are generally "latent". Against this claim, Barry and Hardin (1982) argue that in an instance of the smallest of all possible latent groups in the PD game, the group fails if the net benefit is less than the costs for both members (Barry, and Hardin, 1982; p. 26). They add that even if a thousand players, who value the collective goods higher, are added to the PD game, there are many players for whom the benefit is greater than the cost, so the group is privileged.

As has been shown by Olson's conjecture above, the likelihood of voluntary collective action (without selective punishments or inducements) is high for small groups, low for large ones, and indeterminate for intermediate ones. However, as Barry and Hardin (1982) argue, Olson's logic can only discriminate between privileged or latent groups, not whether they are large or small. Because Olson gives little guidance on how to distinguish the three types of groups, it seems that his conjecture regarding group size does not fit the study of collective action of the fishing communities undertaken by this thesis, as it is very difficult to assess if the fishing communities in South Al-Batinah are "small", "large" or "intermediate".

Sandler (1992) provides a more rigorous analysis of collective action. His analysis shows that important exceptions exist to the themes proposed by Olson. For example, the extent of suboptimality may be independent of group size (Cornes and Sandler, 1985; p. 114). Large, homogenous groups may be privileged, and their provision levels may increase with group expansion (Sandler, 1992; p. 19). The provision of a public good depend largely on the notion of privilege. A privileged group will form when at least one individual derives sufficient net benefits from the collective action to go it alone. The conditions for a privileged group may depend on the technology of publicness and its relationship to the underling game structure (Sandler,1992). In Chamberlin's view, the relationship between group size and the provision of collective goods is more complex than Olson asserts and that, in many cases, it is the opposite of that suggested by Olson (Chamberlin, 1974; p. 707). In the same vein, Baland and Platteau, (1996; p. 300) reached the following conclusion: "....... *there is some sense in saying that large groups are made more like small groups when their members share common norms possibly enforced by a well-recognized authority".*

3.7 Game Theory and Common Pool Resources

A collective action problem exists when rational individual action can lead to an inefficient or Pareto-inferior outcome (Taylor and Singleston, 1993; p. 196; Sandler, 1992; p. 22). Therefore, the fishermen's problem in an overexploited fishery is to move away from this Pareto-inferior outcome to a Pareto-optimal or a Pareto-superior outcome [8]. As argued by Taylor and Singleston, (1993; p. 196), "*moving to a Pareto-superior outcome would make at least one actor better off without making anyone worse off and may make every one better off*". However, institutions that may solve the collective action problem (i.e., to move to a Pareto-optimal or a Pareto[9]-superior outcome) may not exist, simply because the costs of negotiation (transaction costs) are too high (Dasgupta, 1996; p. 393; Taylor and Singleston, 1993; p. 196). These transaction costs include searching cost (identify possibilities for cooperation), bargaining cost (agreeing in one scheme to solve their collective problems), and enforcement cost (ensuring that all individuals' behaviours are monitored). Communities that devise solutions to the common problems are those whose members have sufficient resources to meet the transaction costs (Taylor and Singleston, 1993 and Hanna, 1995).

Collective problems facing the individual in a common pool resource can be analysed using game theory. This is because collective action problems are typically characterised by interdependence among fishermen. In such a situation the contribution or effort of one fisherman will influence the contribution or effort of other fisherman. Therefore, because of the interdependent nature of fishermen's activities in a real world setting, game theory has been proved to be a relevant tool to illustrate many failures and success of collective action. An individual is said to be trapped in a social dilemma when he receives a higher pay-off for a defecting strategy than for a cooperative strategy, but all are better off if all cooperate. In a common fishery, cooperation by fishermen is required to reduce fishing effort and provide institutions to coordinate resource use. To establish an institution to manage a resource and to maintain it over an

[8] Among the Pareto-superior outcomes, there are some Pareto-optimal from which no Pareto-superior moves can be made.

[9] Pareto efficiency is defined as an acts occurs when there does not exist another feasible vector of acts that is preferred by at least one agent and which is judged not inferior by any agent (Dasgupta and Heal, 1979; p. 55).

extended period of time, it is necessary for all users to comply with its rules, norms and strategies.

Game theory can be used to represent individual rational action. Individual and collective behaviour can be represented by a variety of models or games, of which the Prisoner's Dilemma (PD) has been the most common tool used by scholars to predict individual rational behaviour. The Prisoner's Dilemma appears to provide a solid basis for the conclusion that rational people cannot achieve rational collective outcome (Wade, 1988). The dominate strategy of the Prisoner's Dilemma game is similar to Hardin's conclusion: rational people cannot achieve rational collective outcome (Hardin, 1968). In the two persons Prisoner's Dilemma (Figure 3.1), the individual gets a higher pay-off by defecting if the other cooperates. If both actors defect, the outcome will be worse for both of them. Although mutual cooperation yields the highest aggregate pay-off, the structure of this game gives individuals incentives to defect. This is because the defection strategy of this game always makes the individual better-off, regardless of the other's strategy.

Player 2

Player 1

Strategy	Cooperate	Defect
Cooperate	3, 3	-1, 4
Defect	4, -1	0, 0

Figure 3.1 Prisoner's Dilemma Payoff Matrix

To take a cooperative strategy is to risk being a "sucker" and receive the lowest pay-off if the other defects. Therefore, the dominant strategy of the PD is defection, yet it is a Pareto-inferior outcome because both actors would be better off under the mutual cooperation strategy (Ostrom, 1990).

Now consider a fishing community with n fishermen, who must catch fish from a fixed common fishery. Each fisherman has one of two options. The first option is to cooperate by applying fishing effort at a level which is advantageous to the whole group, thus protecting his well-being. Alternatively the individual fisherman may use a defection strategy (free riding) by applying a fishing effort which, while advantageous to him, harms the whole group of fishermen by causing overfishing.

If fishermen devise a new institution to coordinate their use of their common fishery, then they might obtain better returns from the fishery. However, if the PD logic illustrates the incentives facing the community, no one will have an incentive to cooperate and they will all fish at a sub-optimal level, leading to a situation in which all are made worse off. In the PD model of a common fishery, each fisherman has an incentive to free ride and fish heavily to increase his immediate gains, overexploiting the fishery. An individual fisherman in such situations believes that he will receive a higher payoff if he defects rather than if he cooperates.

To illustrate the rational action of individuals in the commons, assume for simplicity that there are only two fishermen in the above community. As shown in Figure 3.2, the first payoff in any box is that of fisherman 1, while the second payoff is that of fisherman 2. Further assume that each unit of reduction of fishing effort contributed by either fisherman gives a benefit of four units to both fishermen: the contributor and non-contributor, at a cost of five units to the provider. Looking at the matrix of this game it appears that the pay-off structure encourages defection, because one is always better off (with a gain of 4 or 0) defecting, regardless of the other's behaviour. Both fishermen are unable to communicate. The only information they have is that one gets a higher payoff by defecting if the other cooperates. Although if both cooperate, the highest aggregate pay-off is achieved, there is always a risk of the cooperative fishermen receiving the lowest payoff (-1) (being a "sucker") if the other defects.

Fisherman 2

Fisherman 1

Strategy	Cooperate	Defect
Cooperate	3, 3	-1, 4
Defect	4, -1	0, 0

Figure 3.2 Payoffs Matrix for Fishermen's PD Game

Fisherman 1 is better off choosing the defection row, as his payoffs in this row (4 + 0 = 4) exceed the corresponding payoffs in the cooperating row (3 + -1 = 2). Analogously, fisherman 2 is better off choosing the defection column as the payoffs of this column exceed the payoffs of the other column. The resulting payoffs in Figure 3.2, constitute the Prisoner's Dilemma, as the dominant strategy is to defect and, therefore, the group is latent and will fail (Sandler, 1992). The outcome of this game is "Pareto-inferior" because both would be better off with the outcome of mutual cooperation (Ostrom, 1990). To avoid this Pareto-inferior outcome, incentives to cooperate from within the group must emerge or outside intervention (Olson, 1965 and Hardin, 1968) must be applied. In contrast, a Pareto-optimal outcome is achieved when it is not possible to improve the well-being of one individual without harming at least one other (Sandler, 1992). In a non cooperative game such as a PD game, both players choose a dominant strategy, and they produce an equilibrium that is the third best result for both. This equilibrium is called the "Nash equilibrium", in which neither player has an incentive to change his strategy (Sandler, 1992).

To model the above situation as a PD, however, two key assumptions must hold: anonymity in decision-making, and that the game is played only once (Feeny *et al.*, 1996 and Wade, 1987). The two assumptions clearly fit the core parable of the Prisoner's Dilemma, where the two prisoners are interrogated separately (communication is forbidden, no future interaction). Both prisoners know that if each uses the cooperative strategy and neither confesses, they will receive suspended sentences, yet if one defects (confesses) he will be released, and the other will receive a long term prison sentence and will not be able to choose another strategy (confess) again in the future. If both defect (confess), each gets a reduced sentence. To protect himself, each has sufficient incentive to defect, regardless of the other's decision. The same assumptions may also make a useful approximation to the situation of the two fishermen game. It is difficult to monitor compliance with a rule of restrained fishing. Therefore, either of the two would use more effort when he can see that his defection will not be detected. Analogously the other will use the same strategy and both end up using more fishing effort.

In contrast to the Prisoner's Dilemma game, when taking the case of a common fishery, the simple PD model does not exactly capture individual rational action because fishermen jointly using a common do interact among themselves, repeatedly, over the years. Fishermen play the above game repeatedly and non-anonymously. Each fisherman accumulates experience of the behaviour of his opponent as he meets him personally on the fishing ground. If both fishermen know that each will have more opportunities in the future to alter his decision, there is a chance that one will cooperate today, hoping that the other will do the same. The rational individual can, after all, perhaps achieve a rational collective outcome (Wade, 1987). Sandler, in his analysis of collective action problems, supports this argument: "*collective action problems need not imply a Prisoner's Dilemma*" (Sandler, 1992; p. 44). If a fisherman sees that others will contribute to reduce fishing efforts, he will have an incentive to contribute as well.

The dominant strategy of the two-persons PD game can be altered by changing the game structure (Sandler, 1992). In the above example of the two fishermen, it is assumed that individual cost exceeds individual benefits, and summation technology applies (benefits are summed over the units provided); the group is latent. However, if individual benefit exceeds individual costs and summation technology applies, it can be shown that the group is fully privileged (Sandler, 1992). For example, suppose that each unit of reduction in fishing effort contributed by individual fishermen gives a benefit of five units to each and every individual, at a cost of four units. The payoff structure is shown in Figure 3.3. If both fishermen use a cooperative strategy, each will receive a net gain of six units ((5x2)-4). If one cooperates and the other defects, the cooperator will receive one unit, while the other fisherman will get five units. The dominant strategy in this case is full cooperation. The payoff structure encourages both fishermen to cooperate. Therefore, the group is fully privileged. As stated by Sandler, the number of players would have no effect on whether the good is provided or not-group size is irrelevant (Sandler, 1992; p. 40).

Fisherman 2

	Strategy	Cooperate	Defect
Fisherman 1	Cooperate	6, 6	1, 5
	Defect	5, 1	0, 0

Figure 3.3 Payoffs Matrix for Privileged Group

Another important game form is the game of Chicken[10]. The Chicken game can be used to represent a situation where everybody agrees that something is to be done but the problem is who will actually do it. Many real world situations in marine fisheries such as provision problems (assigning fishing rights) and appropriation problems

[10]The storyline behind the name of this game can be found in Sandler, 1992, p.40.

(reducing the take from the fishery) may correspond to this game form. In the context of a fishing community in which its fishing grounds stand threatened by the invasion of an industrial trawler, a number of fishermen (maybe half of them) can either lobby the authority or challenge the trawler in the fishing ground. In such a situation, everybody in the community agrees that something needs to be done to protect the fishing ground and hence their livelihood. It could be that a number of fishermen decide to avoid the collective bad voluntarily (lobby the authority or challenge the trawler). This may happen when the total gain resulting from the avoidance of collective bad (trawler invasion a traditional fishing ground) is so large in relation to the total cost that an individual's share of the aggregated gain would exceed the total cost (Baland and Platteau, 1996; p. 79).

Similarly, reducing the problem of overfishing correspond to this game form. In an overexploited fishery, if all fishermen continue to increase their fishing efforts, the overfishing problem will become severe; and they will incur more losses. If only half of the fishermen reduce their fishing efforts, then the fishery would recover slightly and everybody will generate additional revenue (provided that others do not increase their fishing efforts). Off course, the non-contributors will gain more as they incur no costs, whereas those who reduce their fishing efforts will receive less benefits as they have to deduct the cost of provision of the collective goods.

Fisherman 2

	Strategy	Cooperate	Defect
Fisherman 1	Cooperate	8,8	6, 10
	Defect	10, 6	2, 2

Figure 3.4 Payoffs Matrix for Chicken Game Group

For simplicity, the Chicken game is illustrated in Figure 3.4 as a game between two fishermen whose fishing ground is threatened by the invasion of an industrial trawler. From Figure 3.4, it is seen that neither fisherman has a dominant strategy in this game. What each decides to do depends on what he expects the other to do. The payoff structure (income to each fisherman) reveals that each fisherman prefers that the other undertakes the avoidance of the collective bad while he refrains from doing so, as he will get the maximum possible income (10 units). However, unlike PD situations, each fisherman cooperates if the other refuses to cooperate as the consequences of nobody avoiding the collective bad are so disastrous (it is better to be a "sucker" and get 6 units of income than not to be a "sucker" and get only 2 units. Therefore, there are two pure strategy Nash equlibria in which one fisherman take the full responsibility to get the trawler out of the fishing grounds (cooperates) while the other receives the benefits with out any cost (defects)[11].

In a natural world setting, at least some collective goods might be provided with some form of coordination among participants. The institutional setting in place plays a crucial role in avoiding the worst outcome.

In some natural world settings, participation of a few players will not lead to the provision of the collective good. Thus, efforts of everyone are needed for any benefits to be obtained. For example, the use of dynamite is a technical option, which is available for fishermen to receive an immediate gain. This technique is used to harvest fish in coastal waters but killing of immature fish takes place in the process. In such a situation, if only a few fishermen abstain, their impact on the status of the fishery is likely to be insignificant (Figure, 3.5). All fishermen need to avoid the collective bad in order to protect their fishery. It has been a general view that the situation of common property resources can be represented by an assurance game (Baland and Platteau, 1996; p. 90 and Runge, 1986; p. 628).

Fisherman 2

Fisherman 1

Strategy	Cooperate	Defect
Cooperate	4, 4	-3, 0
Defect	0, -3	0, 0

Figure 3.5 Payoffs Matrix for an Assurance Game Group

The payoff structure of the assurance game presented in Figure 3.5 represents different strategies facing individual fishermen in a fishery in which the use of dynamite as a fishing technique is widespread. As seen from Figure 3.5, if dynamite is eliminated

[11] There are actually three Nash equlibria: not only (C, D) and (D, C), but also a randomized Nash equilibrium known as "mixed strategy". A mixed strategy equilibrium is found by allowing each player to

completely from the fishery (mutual cooperation), net income will return to its previous level of 4 units each. If only one fisherman abstains, his impact on the fishery is likely to be insignificant and the status quo landings prevail. In this case, the cooperative fisherman will bear the cost of his contribution to avoid the collective bad (his payoff is - 3 units), while the free rider receives no improvement in his income (no provision cost). If neither of them abstain, the status quo will remain (Figure 3.5).

As argued by Runge "*the coordination game described by the Assurance Problem (AP) suggests that there are incentives to develop and maintain institutions characterized by rules which make voluntary contribution to public goods a utility-maximizing strategy*" (Runge, 1984; p. 155). When institutions exist to facilitate the coordination of behaviours by providing information regarding the expectations of others, they provide assurance, which makes cooperation with the group's action more attractive than free riding (see Chapter Four for an illustration of the role of institutions in achieving optimality).

Sandler (1992) states that institutional rules, the technology of public supply and the payoff structure are the main factors predicting the success or failure of collective action. As compared to the PD, in the assurance game, both players must contribute if either is to benefit from their actions. There is no dominant strategy in this game, but there are two pure Nash equilibrium strategies: either all cooperate or all defect and the former Pareto dominates the latter (Sandler, 1992; Runge, 1984). If one fisherman reduces fishing effort to cooperate, the contract is self-enforcing, since the other fisherman has a strong incentive to reduce his level of fishing effort.

The question of how agreement is implemented into a contract in the case of a local commons has been clearly answered in a fascinating article by Dasgupta (1996). According to Dasgupta, there are three mechanisms by which such agreements are implemented. In the first mechanism, the agreement is translated into a contract, and is enforced by an established structure of power and authority. This may be the national government, but it need not be. The power of authority is often vested in tribal elders and sheikhs in rural communities. For example, within the nomadic tribes in sub-Saharan Africa the authority is in the hands of tribal elders and sheikhs (Baland and

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choose his probability based on the best probability choice of the other player (Sandler, 1992, p. 41; Baland and Platteau, 1996; p. 81).

Platteau, 1996 and Dasgupta, 1996). Similarly, in the context of the coastal fisheries in Oman, the authority is vested in the hands of the master (or chief) of the local institution (Senat Al-Bahar) who is elected by the users to settle disputes, enforce contracts, communicate with the authority and so on. What makes such a structure of authority accepted by people is that general acceptance itself is a self-enforcing behaviour (Dasgupta, 1996; p. 419). For example, in the context of a fishing village, when all fishermen accept the structure of authority to coordinate the use of the fishery, each fisherman has an incentive to accept it. General acceptance is a Nash equilibrium (Dasgupta, 1996; p. 420).

The second mechanism, according to Dasgupta (1996), consists in the development of a disposition to abide by agreements, a disposition formed through the process of communal living and the experience of rewards and punishments. When an individual internalizes social norms[12] (paying his dues, keeping agreements, returning a favour and so on), continuing that norm becomes the mainspring of his action. That person feels shame or guilt in violating a norm, and this is what often prevents him from doing so. If a majority in the community shares the same norm, the individual is subject to criticism and social frowning for violating that. It has been found that in communities where social norms are highly internalized, transaction costs[13] are minimized considerably.

The third mechanism for the implementation of agreements in local commons may occur in situation of repeated encounter among the resource users in similar situations (Dasgupta, 1996). This can take place in situations where far-sighted individuals (people applying a low subjective discount rate to the future costs and benefits) know each other and the environment, where they expect to interact repeatedly under the same conditions. In the context of a small fishing village, for example, if all fishermen are far-sighted, a credible threat by others that they will impose sanctions on those who broke the rules would be sufficient to achieve compliance. Tit-for-Tat (where a player cooperates unless another defect) appears to be a robust strategy which resists

[12] A social norm is a rule of behaviour that is commonly obeyed by all. The rule is sustained by the feelings of embarrassment, anxiety, guilt and shame that a person suffers at the prospect of violating it (Elster, 1989; p. 100).

[13] Transaction costs are those costs incurred in process of initiating collective action.

challenge from other strategies. However, the trouble with Tit-for-Tat is that in the real world the first defection often leads to breakdown (Child and Faulkner, 1998; p. 29). Ridley, (1996; cited in Child and Faulkner, 1998) suggests two alternative strategies that have been found to be more effective than Tit-for-Tat. They are Pavlov and Firm-but-Fair. In Pavlov, players stick to their strategy if they win on that strategy and if they lose, try another strategy. Ridley claims this to be the basis of both dog-training and child-rearing. In this context, individuals are trained to do things that are rewarded and stop doing things that are punished. Child and Faulkner (1998) argue that Pavlov is also powerless against continual defectors. The strategy of Firm-but-Fair seems more effective than Tit-for-Tat and Pavlov. According to Child and Falukner (1998; p. 29), "*in the firm-but fair, players act successively and can communicate (unlike the PD game) which leads them to cooperate with cooperators, return to cooperation after mutual defection, and punish defectors by further defection, but assumes that they continue to cooperate after being a sucker in the previous round*".

3.8 Fisheries Management by the State

To handle the tragedy of the commons, Hardin (1968) suggests mutual coercion where a strong state control must establish order in the commons. One way to improve things is to impose regulations on resource users, for example restricting membership to a community of resource users, and enforce strict sanctions on those who violate its rules or establish quotas on the quantity of fish harvested. Another is to introduce a system of taxes (Pigovian taxes) (Dasgupta, 1996; p. 395). However, many scholars have argued that the capacity of the state to stop the tragedy is questionable (Baland and Platteau, 1996; Dasgupta and Maler, 1994; Dasgupta, 1996; Dyer and Leard, 1994; Ostrom, 1990 and Williams, 1997). Social change and the advent of modern institutions have eroded the effectiveness of the traditional management systems and introduced fisheries management approaches have generally failed to prevent resource overexploitation (Doulman, 1993; p. 108 and Williams, 1997; p. 59). Furthermore, lack of a coherent or a consistent set of operating principles is a problem associated with state failures to bring order to the commons. Even placing the commons under state control cannot guarantee exclusion.

There is a potential conflict between the interest of communities and the state in managing fishery resources (Kuperan and Abdullah, 1994; p. 307). The interest of the community may be to use the fish resources for securing a subsistence living, whereas the state has its development plans to maximize revenue through export, tourism and so on. In most cases, the state interest to maintain commons institutions may not coincide with what resource users expect from the commons.

The threat of the tragedy of the commons, especially in developing countries, comes from development projects carried out by the state (Subir, 1996). Major advances in the efficiency of fishing gear and vessels and an increase in the demand for fish over the past twenty to thirty years has contributed to the tragedy in many fisheries. Accumulation of capital in the fishery by subsidizing the purchase of engines, boats and fishing gear is observed in many fisheries. Opening new markets and opportunities for fish export is another example, causing intense pressure on coastal fisheries. Dyer and Leard, (1994) see the destruction of traditional use patterns by the state and the ignorance of the resource users knowledge, perceptions, and experiences as other major contributors to the fisheries' crises. As argued by Dasgupta and Maler (1994; p. 335) "*environmental damages at the local level have often been inflicted upon such communities (possibly unwittingly) by outside agencies-very often by their own government*". However, this is not to suggest that rural development is to be avoided. According to Dasgupta, "*Resource allocation mechanisms that do not take advantage of dispersed information, that are insensitive to hidden economic and ecological interactions, that do not take the long view, and that do not give a sufficiently large weight to the claims of the poorest within rural population are going to prove environmentally disastrous*" (Dasgupta, 1996; pp. 406 - 407).

Organizing collective management by local users may not be appreciated by government officials. Government officials, scientist and policy makers may view collective management initiative as quaint since they do not fit the development and management strategies devised to avert the tragedy of the coastal commons (Kurien, 1995).

Fish resources are diminishing, and some fisheries are collapsing due to population growth, fishing pressure, technological changes, overcapitalization, over-regulation, pollution and habitat loss (Dyer and Leard, 1994; Jodha, 1990; Lim *et al.*, 1995 and Richards, 1997). These factors individually or jointly contribute to the decline and in some cases depletion of coastal fisheries. The decline in productivity and sustainability of coastal fisheries has been a part of the commons scenario in most developing countries, where these resources continue to be important in providing employment and food for a large section of the population. Modern management by the state has so far addressed such problems inadequately because of a lack of flexibility in administrative protocol and organization, because of conflicts among agencies and various special interest groups in fisheries and because of different world views between managers and users (Dyer and Leard, 1994 and Subir, 1996).

It appears that Hardin's (1968) conclusion was applied since it first appeared to persuade governments to impose a centralized management to set order into the commons problems and many countries have adopted such policies, particularly developing countries. Development and management of the fisheries in Oman has been the responsibility of the government since 1970. The government has frequently undermined the capability of customary institutions and organizations to manage the fish resources by transferring authority to government agencies and by imposing controls that conflict with traditional use patterns. This intervention is viewed as legitimate, and even necessary, to prevent overexploitation of the fishery if fishermen were left to their own devices. Thus, as has been the case in many developing countries, in Oman laws are established to redefine local users' rights and duties with respect to the pattern of use of the coastal fisheries. However, this intervention often arises from an insufficient understanding of the capability of traditional institutions. With this action, government's interventions have frequently resulted in unintended, but disastrous outcomes (Williams, 1997; p. 60)

For example, coastal fisheries in Oman have been regulated by a licensing programme for the last two decades. However, instead of restricting the newcomers from entering the fishery, the government policy has contributed to increasing the number of fishermen substantially, thus exacerbating resource degradation. There are three reasons for this. First, this intervention destroyed the basis of the social and institutional structure that previously regulated access to the fishery. Second, due to the limited employment opportunities in other sectors of the economy in Oman and in other Gulf states, more people were attracted to the fishery. Thirdly, the subsidies provided by the Fisherman's Encouragement Funds (FEF). Individuals holding a fishing licence can benefit from the programme (FEF) initiated by the Government to develop the fishery.

The Government programme of mechanization of the fishing crafts and purchasing of efficient fishing gears has led to over-exploitation of fish resources.

3.9 Conclusion

The literature review presented in this chapter provides some insight into the social dilemmas individuals may face in their use of a local commons. These dilemmas occur in situations where individual rationality to produce private interest are in fact in conflict with the collective rationality, thus creating undesirable consequences for themselves and for others. We are fortunate to have the opportunity to use game theory as a tool to study many environmental problems, but it is completely unrealistic to jump to the immediate conclusion that the incentive facing individuals in such a situation is similar to the Prisoner's Dilemma model. There is confusion in the literature concerning the term "common property". The term has been repeatedly used to refer to property owned by a government, a community or by no one (open access) (Schlager and Ostrom, 1992; p. 249). This usage leads to confusion in scientific study and this is what made Hardin (1968) advance the "tragedy of the commons" model which has been the basis for natural resource management plans around the world. Contrary to Hardin's recommendation, game theory has clearly demonstrated that in the context of a natural field setting, the game is played repeatedly by participants who can communicate, negotiate and care for their reputation, allowing scope for collective action to avoid the tragedy of the commons (Bardhan, 1993a; 1993b; Ostrom, 1990; Seabright, 1993 and Hackett *et al.*, 1994;). The role of centralized government to manage coastal fish resources is questionable, as it may not remedy the situation because the effort may be impeded by conflicting political interests or lack of enforcement.

The results of previous field research of many local commons indicates that fishermen as decision-makers can play a significant role in preventing the tragedy of the commons through collective action. Examples of resource users successfully managing their resources are noted above. These examples strengthen the case of this study that individuals using a local common can in fact initiate collective action to further their well-being.

CHAPTER FOUR

THE ROLE OF INSTITUTIONAL ARRANGEMENTS IN AVOIDANCE OF THE TRAGEDY OF THE COMMONS

4.1 Introduction

The aim of this chapter is to determine how different institutional arrangements used to exploit a common fishery can provide the necessary discouragement of the user's activities that generate negative externalities. In fact, examples of situations in which communities have evolved institutional structures to exploit resource as a common property are legion (see Ostrom, 1990). Although most of these institutions rely very much on informal laws and convention, it often appears that they are effective in avoiding the tragic outcome associated with open access (Ostrom, 1990; Baland and Platteau, 1996; Cornes and Sandler, 1996).

In this chapter, two institutional arrangements used to exploit a fish resource will be compared. The first section of this chapter considers an open access fishery where the proportional sharing rule is implemented. The Nash equilibrium fishing effort resulting from such an arrangement is compared to that obtained under the Pareto efficient utilisation of the fishery. The second section looks more closely at another institution in which the fishery is exploited as common property, where fishermen agreed to pool the catch (equal sharing rule) at the end of the fishing day and then divide it among all participants on that particular day. The total level of fishing effort at the Nash equilibrium under the equal sharing rule is compared to that found under the proportional sharing rule arrangement. Examples from real world settings are included to give more support to the analysis.

4.2 Proportional Sharing Rule

An open access situation can be shown to be formally equivalent to an n-person PD game (defined in Chapter Three). The equilibrium observed in an n-person PD game is universal defection, yet it is a Pareto-inferior outcome because all actors would be better off under a mutual cooperation strategy. Similarly, the open access equilibrium as a failure of collective action leads to an inefficient allocation in which all rents are dissipated, and fishermen's profits gravitate toward zero. To show this, a static analysis is presented below. It is adapted from similar analyses in Cornes and Sandler (1996), Baland and Platteau (1996) and Gibbons (1992).

Consider a fishery in which all fishermen have a right to fish and there are a large number of fishermen. Since there are no well-defined property rights all fishermen will enter the fishery as long as the average product of fishing exceeds the price of entry (the rental price of a vessel, for example).

Let the total amount of catch and number of vessels be denoted by Y and R respectively and let the total amount of catch depend on the number of fishing vessels.

The production function for this fishery is therefore: $Y = F(R)$. For simplicity, assume that $Y = F(R)$ can be approximated by the following functional form: $Y = aR - bR^2$ which is increasing and strictly concave[1] (i.e., $F'(R) > 0$ and $F''(R) < 0.$).

It is assumed that unity and c denote the price of fish and the cost of renting a vessel[2] respectively. The individual fisherman's catch and number of vessels are denoted by y and r respectively. A proportional sharing rule is implemented here, meaning that the individual fisherman's share of the total catch equals his share of the total fishing effort in the fishery. It is assumed also that the fish are evenly distributed throughout the fishing grounds, so that each fisherman catches the same amount. This assumption allows us to represent the individual fisherman's catch to equal his share of the total effort multiplied by the total catch. Therefore, the payoff or the production function of each fisherman can be represented as follows:

$$y = \frac{r}{R}(aR - bR^2) \tag{1.1}$$

The efficient solution in this fishery is obtained by choosing the number of vessels that will maximize the total profit (π) generated from the fishery. The maximand is

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1 The equation $Y = aR\text{-}bR^2$ is Schaefer's model which suggests that yield is related to fishing effort by an asymmetrical parabola. The values a (the intercept) and b (the slope) can be found from the graphed catch per unit of effort against fishing effort and then substituted in the production function ($Y = aR\text{-}bR^2$) to construct the yield curve (King, 1995). This type of model is the typical production technology assumed in common property analysis (Cornes and Sandler, 1996 and Baland and Platteau, 1996).

2 Assume that all other costs are negligible.

$$\pi(R) = (aR - bR^2) - cR \tag{1.2}$$

The optimal value, R^*, is uniquely determined by the first-order condition which is when the fleet's marginal product is equated to the variable input's price (vessel rental price, c). This is when:

$$\frac{d\pi}{dR} = (a - 2bR) - c \Rightarrow \; a - c = 2bR$$

$$R^* = \frac{a-c}{2b}$$

Therefore, R^*, or the number of vessels at the social equilibrium, is $R^* = \frac{a-c}{2b}$. This amount of effort is required to satisfy the first order condition obtained from equation (1.2). This allocation would result from competitive exploitation when the property rights are well defined.

However, maintaining an optimal level of effort is extremely difficult. High profits will attract more fishermen into the fishery and the effort level will tend to gravitate towards a higher effort level, especially in fisheries which are not controlled or are under-controlled. In the Nash equilibrium the individual fisherman will maximize his profit and treat the rest of the fishing vessels operating in the fishery as exogenous. The fisherman's problem is:

$$\text{maximize}_{(r)} \{\frac{r}{R}(aR - bR^2) - cr\} \tag{1.3}$$

Using the chain rule to find the derivative, the first order condition of (1.3) is obtained as follows:

$$\frac{R * r(a - 2bR) + R(aR - bR^2) - r * (aR - bR^2)}{R^2} - c = 0 \tag{1.4}$$

$$\frac{r(a-2bR)}{R} + \frac{(R-r)(aR - bR^2)}{R^2} - c = 0 \tag{1.5}$$

$$c = \frac{r}{R}(a - 2bR) + \frac{R-r}{R^2}(aR - bR^2) \tag{1.6}$$

Equation (1.6) can be written as:

$$c = \frac{r}{R}(a - 2bR) + \frac{R-r}{R}\frac{(aR - bR^2)}{R} \qquad (1.7)$$

where $(R-r)$ represents the rest of the fishermen's vessels.

It is clearly shown in equation (1.7) that the price of renting a fishing vessel is equated to a weighted sum of its marginal $(\frac{r}{R}(a-2bR))$ and average $(\frac{R-r}{R}\frac{(aR-bR^2)}{R})$ product. At a symmetric equilibrium where there are n fishermen in the fishery, $\frac{r}{R} = \frac{1}{n}$ and $\frac{R-r}{R} = \frac{(n-1)}{n}$, hence, (1.7) can be expressed as;

$$c = \frac{1}{n}(a - 2bR) + \frac{(n-1)}{n}\frac{(aR - bR^2)}{R} \qquad (1.8)$$

In the case of a single fisherman (the fishery is efficiently managed), n = 1, it can be seen from (1.8) that the price of renting a fishing vessel equals to marginal product and the Nash equilibrium and Pareto optimality are identical.

$$n = 1 \qquad c = (a - 2bR) \Rightarrow a - c = 2bR$$

The number of vessels at this allocation can be obtained:

$$R^* = \frac{a-c}{2b} \qquad (1.9)$$

As the number of fishermen exploiting the fishery grows large (n tends to infinity) the price of renting a fishing vessel converges to average product and profit approaches zero.

$$n \to \infty \qquad c = \frac{(aR - bR^2)}{R} \Rightarrow c = a - bR$$

The number of vessels operating at this allocation can be written as:

$$R^n = \frac{a-c}{b}. \qquad (1.10)$$

or there are R^n number of vessels under the open access arrangement.

Comparing (1.9) and (1.10) shows that $R^n > R^*$: too many vessels are in the Nash equilibrium compared to the social optimum. As a matter of fact, $R^n = 2R^*$ in this example. In other words, the impact of open access is to double the number of vessels operating in the fishery, thereby leading to the complete dissipation of the total rent (Baland and Platteau, 1996; p. 27). As the number of fishermen increases, the ratio of equilibrium to the optimum (R^n/R^*) of vessels increases. In this sense, overexploitation is exacerbated by an increase in the number of fishermen (Cornes and Sandler, 1996; p. 279). The degree of inefficiency resulting from common ownership depends on the number of agents operating in the commons (Baland and Platteau, 1996; p. 31). As is illustrated by equations (1.9) and (1.10), the lower the number of fishermen, the greater the extent to which they can consider the negative externality of their action on the productivity of the fishery. For example, when there is only one fisherman in the fishery[3] (n = 1 as in equation 1.9) he operates $R^* = \frac{a-c}{2b}$ which is half of the number of vessels that would be operated under the open access equilibrium (equation 1.10). In this case the single fisherman takes into account the fall in his income (the negative consequences of his actions on the productivity of the fishery) if he has to add one more vessel into the fishery. This implies that group size, as argued by Olson (1965) is, in part, a root cause of collective failures in this model. However, this might not be the case as argued by Sandler (1992; p. 35); Cornes and Sandler, (1996) and as will be illustrated in Section (4.3). Sandler (1992) argues that the conditions for an efficient exploitation of the commons hinge on the institutional rules implemented. Although in an open access fishery the systematic tendency is toward defection as implied by the model of the Prisoner's Dilemma, the fact is that institutions can be designed to eliminate defection as a dominant strategy and to create an underlying game structure that fosters cooperation.

The first order condition (1.7) reflects the incentives faced by a fisherman who is already operating one vessel but considering adding one more. The value of adding one vessel is $\frac{R-r}{R}\frac{(aR-bR^2)}{R}$ and its cost is c. The harm to the fisherman's existing vessel is $\frac{r}{R}(a-2bR)$ and its cost is c. The fishery is overexploited because each fisherman considers only his incentives, not the effects of his actions on other fishermen. The inefficient outcome obtains because even in the zone where total income is falling, an

[3] The fishery was efficiently managed so as to maximize profits.

increase in individual fishing effort may cause the fisherman's individual share of income to rise (Baland and Platteau, 1997a). This effect is shown in equation (1.7) by the positive sign of the second term (the average product) $\frac{R-r}{R}\frac{(aR-bR^2)}{R}$. This explains clearly why decisions which were made at an individual level seem rational from the individual point of view but prove to be irrational collectively.

As shown by the above analysis, an open access arrangement leads to the full tragedy of the commons (Hardin, 1968). A collective failure is clearly shown by the above analysis when fishermen fail to restrain their fishing effort. The total level of effort at the Nash equilibrium (equation 1.10) is in excess of the social optimum which requires total effort to be such that its marginal productivity is equal to zero. Individual fishermen adopt a defecting strategy by operating more vessels; hence, they overexploit the fishery. A cooperative strategy where R^* vessels are operated achieving the Pareto efficient outcome would make all fishermen better off.

When the fishery is open to all (open access), individuals have to decide whether they should enter the fishery or engage in other economic activities (farming for example). To start exploiting the fishery, individuals have to compare the price of entry that they have to bear and the benefits they expect to get. As long as the net benefit is greater than the price of entry, they decide to enter and exploit the resource. The problem is that their private evaluation of the expected benefits does not take into account the fall in the others' incomes which is caused by their entry: by their action they impose a negative externality on other agents (Baland and Platteau, 1996; p. 26).

4.3 Sharing Output

As was shown above, fishermen who enjoy unrestricted access to fishing grounds seek to maximise their profits in the short run. Initially, the catches of those who start fishing increase, but as the number of newcomers rises, per vessel catches decline and overfishing take place, ruining the well-being of all fishermen. Ginkle (1995) described this situation as a zero-sum game in which one fisherman's gains is another's loss. This condition was modelled in equation (1.8), the interesting feature of which is that under an open access arrangement individual fisherman equate the average product of fishing

$\frac{R-r}{R}\frac{(aR-bR^2)}{R}$ to the variable input price of entry, instead of equating the marginal product of fishing $\frac{r}{R}(a-2bR)$ to the price of entry. Consequently, the resource is overfished in the economic sense.

A growing body of literature has emphasised the importance of self-governance institutions to solve a wide range of common property resource problems that neither the state nor the market can effectively tackle alone. These problems can include, for example, the over-exploitation of resources, the internalization of externalities and problems associated with conflicts between resource users (Ostrom, 1990). There are many examples of efficient exploitation of resources in which communities have evolved self-governing institutions based on formal or informal agreed custom and convention. A commonly cited example can be found in the case of the Alanya fishery in Turkey, where fishermen have agreed on a system of rotating access to the fishing sites in an equitable manner (Berkes, 1986; Ostrom, 1990 and Baland and Platteau, 1996). This informal institution has been designed to change the incentive structure facing individual fishermen in Alanya.

The indigenous institution of Alanya will be described here to show how the incentive structure was changed in order to encourage fishermen to maintain the institution. The fishermen of Alanya faced a declining fishery during the 1970s caused by unrestrained use of the resource and competition between fishermen for better fishing sites. The former had led to declined stock and the latter had increased fishing costs. The pay-off structure of this game is similar to that found in the Prisoner's Dilemma game; universal defection was the outcome in this case. To avoid this tragedy, all fishermen in Alanya negotiated a new institution to coordinate their use of the fishery. The institution was designed to allocate fishing sites to local fishermen in an equitable manner. After a decade of trial and error, Alanya's fishermen established their institution which is based on a rotating system of equal access for all fishermen to the fishing sites. The system can be summarised in three steps. First, all fishing sites within the area normally fished by Alanya's fishermen are named and listed. Second, all those who have the right to fish in Alanya are listed as well. Third, in September of each year, all fishermen gather to participate in the lottery to draw their lots from the list of fishing sites, and the allocation of the named fishing sites is in effect from September to May (Berkes, 1986).

In the above system, consideration is made to allow for spaces between fishing sites so that nets set in one fishing site will not block fish from being available to the adjacent sites. Seasonal migration of fish is also considered. This is achieved by allowing individual fishermen to move east to the next site during September to January and then to move west after January. This arrangement gives all fishermen equal opportunities to be in the best fishing sites.

The interesting feature of the above institution is that the enforcement of the system is carried out by the fishermen themselves as a by-product of the incentive created by the rotation system. When a fisherman is assigned a better fishing site, he is motivated to use his rotating turn to the fullest extent. Shirking on the system can be detected at a low cost by those who most want to deter the cheater at that particular time and location. Fishermen assigned a good fishing site will punish rule breakers by destroying their gears if necessary. The others will obey the rules as they do not want their rights to be violated when they are assigned a good fishing site. The fishermen in Alanya have, therefore, broken out of the trap inherent in the commons dilemma by making a binding contract to commit themselves to a co-operative strategy. The incentive structure of the Prisoner's Dilemma game of the above case was transformed to a privileged game in which all fishermen have an interest in maintaining a universal cooperative strategy.

The solution brought up by the Alanya's fishermen is not the only way to solve a commons dilemma. It is merely one way (Ostrom, 1990; p. 16). Cornes and Sandler (1996) stated that "*one way of managing a common property resource is simply to change the sharing rule in such a way as to change the incentive structure facing individual exploiters*". If fishermen change the incentive structure, commons dilemmas can be avoided. To demonstrate this, consider a fishing village in which all fishermen reach an agreement to change the present proportional sharing rules to an equal shares rule in which each takes home the fraction 1/n of the catch. It can be shown below that this alteration in the sharing rule will lead to efficient exploitation. This is similar to changing the rule of the game in which the Prisoner's Dilemma is transformed into a fully privileged game by changing the way the game is played (see Sandler, 1992). To demonstrate how the incentive structure can be changed, in the following section the outcome of the equal shares rule will be compared to the results obtained in Section 4.2 (proportional sharing rule). The static model presented here is based on the analysis of Cornes and Sandler (1996) and Baland and Platteau (1996).

Under the proportional sharing rule, the amount of effort applied at the Nash equilibrium is double that of the social optimum exploitation (see the result obtain from the first order condition (1.8). However, as is demonstrated below, the inefficiency associated with the tragedy of the commons can be reversed if resource users agree to adopt an alternative institutional arrangement (equal shares rule). An example of sharing the final output may include fishermen splitting their catch from a jointly owned fishery or a cattle herd owned collectively by a tribe grazing on reservation land. For example, sharing output was found to be the dominant method for allocating hunting grounds among aboriginal cultures (Bailey, 1992; cited in Lueck, 1994).

Suppose that a fishing community enforces a system in which all fishermen's catches are pooled and landed at one place so that individual fishermen get the fraction 1/n of the total income at the end of the day. To show this, consider the example of the fishery presented in Section 4.2, where the total amount of catch and number of vessels is denoted by Y and R respectively. It is assumed that the price of fish and the cost of renting a vessel are denoted by unity and c respectively. Let, the total amount of catch depend on the number of fishing vessels and the individual fisherman's catch and number of vessels is denoted by y and r respectively. In Section 4.2 where the proportional sharing rule is adopted the individual fisherman's share of total catch equals his share of the total fishing effort in the fishery. However, in this section the investigation will focus on the outcome of equal shares rule where the individual fishermen's share of the total catch equals the fraction 1/n times the total catch. The production function for individual fishermen can be written as:

$$y = \frac{1}{n}(aR - bR^2) \tag{2.1}$$

where R is the total fishing effort in this fishery which is denoted by: $R = R^{\circ} + r$, in which R° represent the other fishermen's vessels in the fishery. The efficient solution in this fishery is obtained by choosing the number of vessels that will maximize the total profit (π) generated from the fishery. The maximand for one fisherman is

$$\pi(R) = \frac{1}{n}(aR - bR^2) - cr \tag{2.2}$$

To establish the first order profit maximization condition with respect to r, the partial derivative with respect to r is derived and set equal to zero.

$$\frac{\partial \pi(R)}{\partial r} = \frac{1}{n}(a - 2bR) - c \tag{2.3}$$

Therefore, the first-order condition implies that:

$$\frac{a - 2bR}{n} = c \tag{2.4}$$

In the previous section (assuming the proportional sharing rule) it was shown that the price of renting a fishing vessel is equated to a weighted sum of its marginal and average product, a classic open access dissipation of rents. Equation (2.4) gives different results. The price of renting a fishing vessel is equated to the marginal productivity. This implies that the Nash equilibrium and Pareto optimality are identical, an interesting feature of this first order condition at the Nash equilibrium (when n = 1). The intuition behind this theoretical result is that the new institution plays an important role in forcing some of the cost of externality back on the fishermen. The efficient exploitation of the commons is then achieved as individual fishermen have no incentive to increase their effort beyond that required for the social optimum.

The equal sharing rule implies that the externality generated by each fisherman is forced back on its perpetrator. Under this model it does this to such an extent that the effort induced falls below the economic optimum when n is greater than 1.

The total level at the Nash equilibrium effort is in fact lower in this case, as will be shown below, than the social optimum which requires total effort to be such that its marginal productivity is equal to zero. Individual fishermen will increase their effort until the first order condition of equation (2.3) is satisfied.

From equation (2.4) the following result is obtained:

$$R = \frac{a - cn}{2b} \tag{2.5}$$

Equation (2.5) represents a common (R) value at equilibrium for any (n). At the symmetric Pareto optimum (n = 1), where the marginal product equals the price of renting a fishing vessel, the optimum number of vessels (R^*) can be obtained directly from equation (2.5).

$$R^* = \frac{a-c}{2b}. \tag{2.6}$$

On the other hand, the Nash fleet, R^n, for this fishery can be obtained from equation (2.5) (i.e., when n tends to ∞). It is clearly shown that R^n cannot rise beyond $R^* = \frac{a-c}{2b}$, because as (n) increases R falls. Furthermore, as seen in Figure 4.1, the production function will cross the x-axis when profit is zero before R reaching (∞). Therefore, the above results confirm that $R^n < R^*$ when the equal shares rule is implemented.

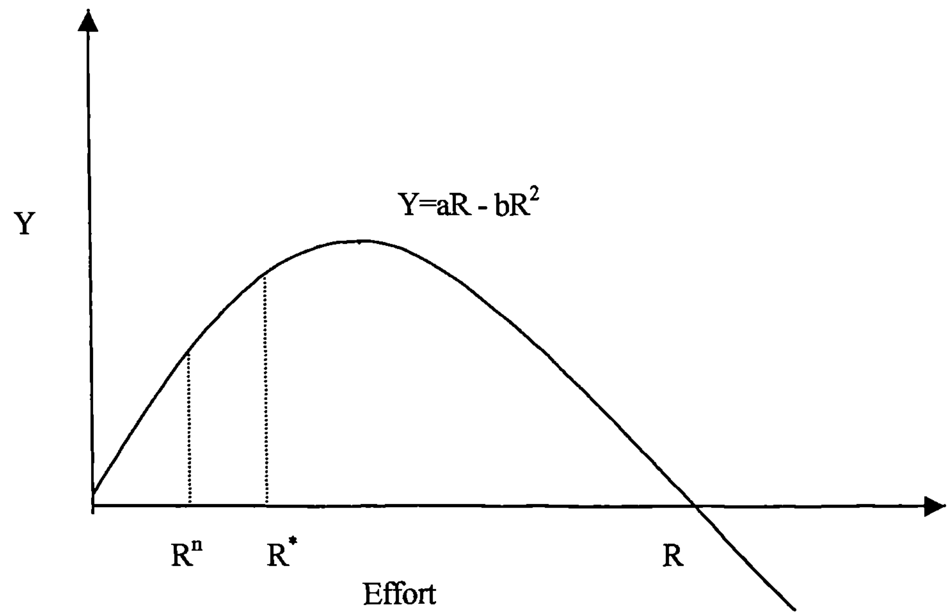

Figure 4.1 A Typical Production Function for a Fishery

Comparing this allocation of effort to that obtained with the proportional sharing rule, it can be concluded that the proportional sharing rule leads to higher effort, which is higher than the level required for efficient exploitation of the commons (Cornes and Sandler, 1996). Since $R^n < R^*$, the results obtained from equal shares rule reverse the overexploitation of the fishery commonly found under the open access situations. Therefore, different institutional frameworks imply different outcomes. This result is consistent with those achieved by Cornes and Sandler (1996), Sandler (1992) and Lueck (1994).

In fact, as shown in Table 4.1, it was confirmed here that fishing effort applied to a fishery under the equal sharing rule is lower than that required for the social optimum allocation ($R^* = \frac{a-c}{2b}$). This is because when an individual fisherman considers adding more effort to fishing, he counts only the fraction $\frac{1}{n}$ of any extra benefit to himself. In this sense, individual fishermen impose a positive, not a negative, externality on others (Cornes and Sandler, 1996; p. 287). When communities design institutions to coordinate their use of the commons, the dominant strategy of defection is eliminated and the situation creates an underlying game structure that fosters cooperation.

Table 4.1 Fishing Efforts Under Two Catch-Sharing Systems

Proportional sharing rule		Equal sharing rule	
Nash fleet	**Pareto**	**Nash fleet**	**Pareto**
$R^n = \frac{a-c}{b}$	$R^* = \frac{a-c}{2b}$	$R^n < R^*$	$R^* = \frac{a-c}{2b}$

To take a real world application of the equal shares rule, the informal lobster territories in Maine (Acheson, 1989) will be highlighted. The lobster resource in Maine is owned by private groups known as harbour gangs. Gang members harvest lobster and exclude outsiders from their territories. Gang members also agree to limit the number of traps each fisherman may use. The individual lobsterman owns his vessel, traps and ultimately the catch in his traps. The lobster resource in Maine is, therefore, managed as a common property by the resource owners. It is apparent that group member are homogeneous and that cultural norms (all come from the local town), technological constraints (limited number of traps), and limited membership (outsiders excluded) strengthen this homogeneity. One of the interesting features of the Maine lobster case is that gang members have instituted an equal sharing rule by limiting the number of traps individual fishermen may use. The outcome achieved by this sharing rule is a more efficient exploitation of the lobster resource in Maine.

Another example of the use of equal shares rule in the fisheries sector is given by Lopez (1984, cited in Baland and Platteau, 1997b; p. 12) in his study of fisheries in Batanes Islands, Philippines. The number of vessels that go fishing in Batanes Islands is determined on the basis of a scout's report of the day's potential catch, but the catch is divided equally among all households, regardless of the number of vessels operating (ibid., p. 13)

4.4 Conclusion

The above analysis lead us to conclude that small changes brought about by institutions can change the incentive structure facing individual fishermen. The dominant strategy of individual fishermen under the proportional sharing rule is universal defection. This non-cooperative game is changed by modifying the sharing rule into a game in which the dominant strategy of all fishermen is to cooperate.

This section shows that the equal shares rule can produce an outcome opposite to that characterized by Hardin (1968) as the tragedy of the commons. However, care should be taken when considering the above analysis as it can only be relevant in cases of homogeneous groups in which similar technology is used.

CHAPTER FIVE

CONCEPTUAL FRAMEWORK

5. 1 Introduction

To satisfy the general aim of this study, which is to investigate the factors that contribute to the emergence and evolution of collective action in fishermen's communities to manage their coastal fish resources, a conceptual framework is needed to clarify the predicted nature of the relationships among the different factors covered by the study. The conceptual framework developed in this section is very useful to guide the selection of variables for testing of hypotheses and to check their relevance in order to verify the empirical results achieved. More specifically, the framework proposed here will try to reach a systematic answer to the basic question raised in this study: what are the factors that influence the individual fishermen's decision-making to participate in collective action to manage their fishery? This framework, is therefore, a representation of reality; it delineates those aspects of the real world which are considered to be relevant to our investigation; it makes explicit the significant relationships among those aspects, and it enables the formulation of empirically testable propositions regarding the nature of these relationships (Nachmias and Nachmias, 1996; p. 44).

The study focuses on understanding why fishermen choose to participate (or not participate) in local collective action to manage fish resources. Figure 5.1 shows a framework for assessing the factors that contribute to the emergence and evolution of collective action in fishermen's communities. The collective action consists of fishermen obeying the group rules and participating in collective effort to manage the coastal fish resources in South Al-Batinah. The degree to which the following variables influences each other and fishermen's willingness to participate in collective action can provide some useful information. This framework can also be used to verify the results of testing the hypotheses and assumptions proposed by this study. The structure of the framework, as well as the relationships among its variables, is then tested using the empirical results of the data collected from the field.

Before examining the central question of which factors are likely to influence fishermen's decision to participate in collective action, we first need to understand how collective action emerges. Following White and Runge's suggestions, what happens in the cases of collective action in a fishery can be understood to occur in three phases: (1) a challenge to the status quo and proposal for collective action; (2) choices by individuals between participating and not participating in the collective action and (3) the emergence of the collective action (White and Runge, 1995; p. 1685). In a real world setting, phase (1) occurs when individuals face a commons dilemma or externalities which render the use of the resource inefficient and which establish the rationale to change the current situation. For example, fishermen facing a depleted fishery and hence declining revenues may be motivated to look for ways to mitigate the problem. The losses resulting from an overexploited fishery may provide incentives for fishermen to engage in collective action to set restrictions on entry and on the amount harvested.

In situations where the status quo needs to be changed, the demand for new rules or the establishment of an institution to coordinate the use of the fishery always arises. However, the demand for changes in the existing rules might face great difficulties. As argued by Ostrom (1990; p. 202), the status quo operational rules always protect some individuals and expose others. Thus, changes in property institutions involve the risk of being worse off for some individuals, especially those who are usually profited by the status quo (Libecap, 1994; p. 567). Therefore, for the current rules to be changed, the support of a set of individuals large enough (critical mass in Wade's (1986) words) to have them changed is required. When there are enough fishermen to support the change, the rules are changed either by the users themselves, in cases of informal management institutions, or by the authority, in cases where the state has some control over the resource. However, even when fishermen are facing a declining incomes, collective action may not emerge directly due to the higher transaction coasts involved (Taylor and Singleston, 1993; p. 196) and because of imperfect information concerning the impacts of resource use and the expectations regarding the behaviour of other fishermen in the group (Baland and Platteau, 1996; p. 290). Therefore, the process may take quite a long time, as was observed in Alanya, Turkey, in which an agreement between fishermen to manage their fishery was reached after ten years of trial and error (Ostrom, 1990).

In the second phase, fishermen choose either to cooperate or to defect. As proposed by Ostrom (1990), it is essential, therefore, to analyse the collective choice from the perspective of the individual fishermen. The outcome of this phase depend on a number of factors. For example, the individual decision is determined by the configuration of variables relating to the physical world, the institution rules in use and the attributes of the individual involved in the situation (Ostrom, 1990; pp. 192 - 206). The three variables are denoted as situational variables according to Ostrom (1990). However, not all situational variables advanced by Ostrom (1990) have a deterministic effect on the success or failure of collective action and the data for many are not readily available because of the difficulty in their operationalization and measurement. The choices made in phase (2) (individual participation choice) are determined and explained by the factors listed in the boxes shown at the bottom of Figure 5.1 and discussed in sections 5.2.1 to 5.2.8.

In the third phase, the final decision taken by fishermen in phase two determines the collective outcome of phase (3) (outputs). In this phase the "outputs" are differentiated into decision and action. Even when the individual fisherman supports the proposed change of existing rules, he might not be able to execute his decision into action unilaterally. As argued by White and Runge (1995; p. 1685) individual choice will be contingent on the expected behaviour of the other participants and the probability attached to certain outcomes. Whether or not a change in status quo will be accomplished depends on the level of support for the change. Thus, the sum of individual fishermen's decisions to cooperate might result in a change in the status quo. Therefore, when the majority (critical mass) of those involved in collective action agree on certain procedures to change the current situation, collective action is likely to emerge. As shown in Figure 5.1, the three phases are interrelated, with "feedback" performing the functions of continuity or change. This study tries to explain how individual fishermen in Oman react to "input", how the factors listed in Figure 5.1 influence decisions and how outputs, through "feedback" change or preserve the nature of inputs (the status quo).

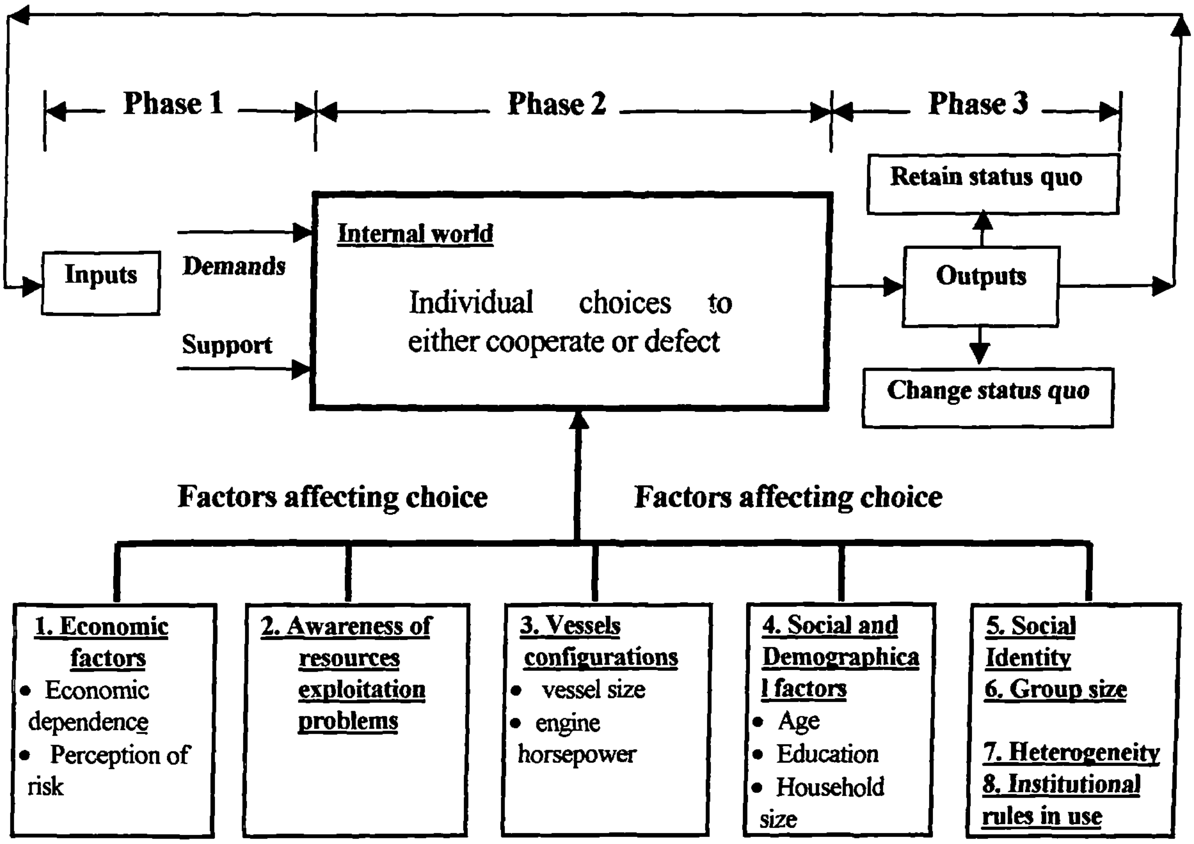

Figure 5.1 Conceptual Framework: Assessing the Emergence of Collective Action

As discussed above, not all the factors advanced by Ostrom (1990) have a deterministic effect on the final collective outcomes. Therefore, the study focuses only on a number of factors for which operationalization and measurements proved possible and accurate information could be obtained. These factors are derived from the assumptions outlined in the statement of the hypotheses presented at the end of this chapter. The proposed framework shown in Figure 5.1 is derived from these assumptions.

5. 2 Factors Affecting Individual Choice

We have seen in Figure 5.1 that when fishermen engage in collective choice decisions, their action can be explained and determined by a number of factors. As will be seen later, some of these factors influence fishermen's decisions directly, others may influence each other, thus creating indirect relationships. In the following sections, the factors selected for the present study and their operationalization are discussed in turn.

5. 2.1 Economic factors

5.2.1.1 Economic dependence on the fishery

The notion that economic dependence on a common pool natural resource as a source of livelihood promotes the emergence of collective action has received considerable support in the literature. The more the user group depends on the resource as a source of livelihood, the more likely its members will achieve endogenous solutions to the commons problems (Baland and Platteau, 1996; Jodha, 1990; Runge, 1986; Shanmugaratnam, 1996 and Wade, 1987). Therefore, it is expected here that economic dependence on the fishery will have a positive influence on the collective outcome.

Consequently, economic dependence on fishing is hypothesised to have a positive influence on cooperation (Table 5.1). The independent variable "economic dependence" was operationalised as the relative importance of respondent's income from fishing to the overall household income. For the purpose of this study, only net income earned directly from fish sales by individual vessel owners was counted as fishing income. Therefore, "household dependence on respondent's fishing income" (RED) was calculated as the respondent's annual income from fishing divided by total household income (fishing and non-fishing income earned by the respondent and other members of the household).

$$\text{RED} = \frac{\text{respondent's annual income from fishing}}{\text{total household income}}$$

Another factor, which is hypothesised to be inversely related to fishermen's decision to cooperate in the commons, is the respondent's economic dependence on non-fishing income. This situation is illustrated by the following account from a study of rangelands which were used as common property resources in Western Rajasthan, India: "*Households with large and irrigated private holdings, being highly independent of the gochar for biomass, are not likely to be motivated to commit themselves to collective action for managing the commons*" (Shanmugaratnam, 1996; p. 183). The study anticipated that those who are less dependent on their fishery would show less indication to cooperate. Therefore, the concept "economic independence" was operationalised as the relative importance of respondent's non-fishing income to the overall household income. The variable "respondent's economic independence" (REI) was therefore calculated as the respondent's annual non-fishing income divided by total household income (fishing and non-fishing income earned by the respondent and other members of the household) as shown in the following equation.

$$REI = \frac{\text{respondent's non-fishing income}}{\text{total household income}}$$

Table 5.1 Operationalization and Measurement of Association for Economic Dependence with Attitude toward Cooperation.

Dependent variable (Interval variable)	Independent variables		Test
	Indicators	Type	
Cooperation	RED	Ratio	Pearson's r
	REI	Ratio	Pearson's r

5.2.1.2 Perception of risk

Economic factors such as income, debt levels as well as future discount rates and risk preferences, are potentially important determinants of a fisherman's willingness to manage fish resources (Ostrom, 1990; Baland and Plateau, 1996; Fernandez-Cornejo *et al.*, 1994 and Kalaitzandonakes and Monson, 1994). For example high debt and low income levels could prevent the fisherman from investing in conservation practices (changing his gill net to a lager mesh size to avoid catching juvenile fish). This is because the productivity gains due to resource conservation are usually not immediate. Similarly, situations of high risk and uncertainty play a crucial role in fishermen's decisions to take a particular strategy.

Fernandez-Cornejo *et al.* (1994; p. 161) in their study of the factors that influence the adoption of Integrated Pest Management (IPM) technique argue that the perception of increased risk inhibits adoption among farmers. Their empirical results support the hypothesis that the perception of risk has a negative influence on IPM adoption (adopters are less risk-averse than non-adopters). However, Kalaitzandonakes and Monson (1994; p. 202) state that risk aversion is expected to be positively related to conservation effort. They state that risk-averse farmers are likely to expend greater conservation effort in order to avoid future losses. Robison and Barry (1987) support this view, finding that farmers with a large debt to asset ratio (less risk-averse) may also want to reduce their business risk, which will make them less inclined to cooperate (cited from Fernandez-Cornejo *et al.*, 1994).

Therefore, risk aversion can be both positively and negatively associated with conservation efforts and the final outcome depends on the certainty of the productivity benefits resulting from the conservation effort. For example, when the potential benefits from collective action are considered certain, more risk-averse individuals may be likely to expend greater conservation efforts in order to avoid losses in the productivity of the resource (Kalaitzandonakes and Monson, 1994; p. 201). In this study, risk aversion is expected to be positively associated with higher willingness to participate in collective action.

To operationalize the concept of risk perceptions using fishermen's attributes obtained from the questionnaire, the study considers two factors generally associated with fishermen's risk attitudes. The first is debt to asset ratio (D/A) which measures financial risk (Fernandez-Cornejo *et al.*, 1994; p. 161). Fishermen with a high D/A ratio are likely to be less risk averse (or they have a greater willingness to accept some risk). Therefore, fishermen with a large D/A ratio may be willing to accept greater business risks, and therefore they may be less willing to cooperate in managing their fishery. This is because the productivity gains due to resource conservation are usually not immediate. Furthermore, they are not assured that many others in the group would share their efforts to conserve the resource. Assets included here are those that represent mainly fishing assets such as fishing vessels, engines, fishing gears and other fishing accessories.

The second indicator used to measure perception of risk is the total number of fishing gear types owned by vessel owners[1]. This indicator is used as a proxy for a fisherman's willingness to assume risk. When fishermen own many types of fishing gears, they are willing to accept some risk because they have invested more. Thus, the more types of fishing gears a fisherman owns, the less a risk-averse he is and the less likely to show a high level of cooperation in the commons.

5.2.2 Social identity

In her analysis of Japanese villages' managing of local-level common property resources, McKean argues that one of the factors behind the success of collective action was the very strong community identity and a sense of mutual interdependence (McKean,

[1]Number of fishing gear types: discrete variable equal to the total number of fishing gear types owned by each vessel owners. The most six popular types of fishing gears used in the area are included in the index. These are: drift net for tunas, drift net for kingfish, drift net for mackerel, traps, encircling net for mackerel and encircling net for sardine. The index ranges from one (high risk-averse) to six (low risk-averse).

1986; cited in Baland and Platteau, 1996; p. 288). In this study it is expected that the stronger the individual's social identity as a fisherman, the higher will be his willingness to adopt a cooperative strategy. Therefore, it is expected here that strong social identity will enhance fishermen's ability to reach a cooperative arrangement to solve some of the dilemmas they are facing. The assumption made here is that when people from outside the fishing village enter the fishery (outsiders are not excluded as is the case in the open access situation) they will not be ready to comply with the rules devised by the local fishermen. As the number of outsiders increases, the function of the local institution is weakened. This eventually makes local collective efforts to conserve the fishery difficult to achieve. This is because fishermen inherited fishing rules and fishing knowledge from their fathers and grandfathers; thus, they tend to have strong awareness of the activities that might harm their fishery compared to newcomers.

Three indicators: fisherman's family involvement in fishing, his principal work, and his experience in fishing were devised to measure social identity of individual fisherman (Table 5.2). The first indicator of social identity was operationalized in terms of family involvement in fishing. It is assumed here that fishermen with more family involvement in fishing have a strong social identity as fishermen. To measure this variable, a value of one was given for each kin relation involved in fishing. The measure ranges from weak social identity, with a value of zero where no other member of the respondent's family is involved in fishing, to strong social identity, with a value of five, where his father, brothers, sons, uncles and cousins were identified as fishermen. Cousins and uncles were included in the index because of the extended family characteristics in the Omani culture.

The second indicator of social identity is operationalized as the number of years the respondent spent working as a fisherman (fishing experience)[2] (Caffey *et al.*, 1994; p. 268). The more years the respondent has spent in fishing the stronger is his social identity. The researcher anticipated a positive relationship between the number of years the respondent has spent in fishing and his willingness to cooperate.

The third indicator of social identity was the respondents' fishing status. A value of one is given to a fisherman citing only fishing as the main occupation and identified here as

[2] Childhood fishing (the first 14 years of adult life) was excluded because it was found that respondents included their childhood fishing in their reponces. In the study area, it was observed that children at the age of ten go fishing with their fathers.

a full-time fisherman. Part-time fishermen, on the other hand, are those who are engaged in fixed employment such as working in government offices or the non-fishing private sector. These were given a value of zero, based on the assumption that a fisherman having a secure employment besides fishing (part-time fishermen) has a lower social identity as a fisherman.

Table 5.2 Operationalization and measurement of association for social identity with attitude toward cooperation.

Dependent variable	Independent variables		Test
(Interval variable)	Indicators	type	
	Social identity		
Cooperation	**a.** Family involvement	Interval	Pearson's r
	b. Experience	Interval	Pearson's r
	c. principal work	Nominal	t-test

5.2.3 Awareness of resource exploitation problems

A third essential condition for collective success is that fishermen must be aware of the status of their fishery and the potential benefit from participation in collective efforts to manage the resources. For example, when fish resources are abundant, fishermen are unlikely to participate in collective effort reduction, as the future benefits gained might be insignificant while the cost incurred is high. It is expected, therefore, that resource scarcity may give an incentive for cooperation. Sharing similar awareness and perception about harvesting activities by some may create the necessary consensus for resource users to adopt cooperative behaviour. Possession of information about the status of the resource is important for the emergence of collective action, as this will reduce the transaction cost allowing agreements of cooperative behaviour to take place (Ostrom, 1990). As argued by Baland and Platteau, "*one of the conditions for successful collective action is that resource users are well informed about the status of the resources and the possible impact of use behaviour on its stocks*" (Baland and Platteau, 1996; p. 290). It is expected in this study that the more the fishermen are aware of resource exploitation problems and the potential benefits from collective action, the more is their willingness to cooperate.

Using the concept of rational action, the individual fisherman is expected to select strategies whose expected benefits exceed the expected costs. (Ostrom, 1990; p. 193). The individual fisherman's evaluations of his expected benefits and cost is based on the information available to him concerning the potential benefits (or harm) he is likely to gain from an alternative set of rules as compared with the benefits (or harm) he is likely to gain from maintaining the status quo rules (ibid.).

Four indicators are used to measure fishermen's awareness of their resource exploitation problems[3]. The first indicator is "awareness of resource status". For this indicator the researcher used a scale containing a number of statements designed to assess different aspects of resource status. The second indicator of fishermen's awareness of resource exploitation problems is operationalized in terms of their awareness of the factors that cause overfishing. A multi-item scale was designed in order to determine the factors that are responsible for the depletion of the fishery. The third indicator is the fishermen's perception of the consequences of overfishing. To test their perception, a multi-item scale containing a number of statements was administered to the fishermen. The fourth indicator is operationalized as their perception of the externalities in coastal fisheries. Similarly, a multi-item scale was used to measure this variable.

5.2.4 Demographic variables

Although demographic variables may not have a crucial deterministic effect on the success or failure of collective action, some of these variables such as age, education and household size are expected to have some influence on fishermen's decision to participate in collective action. Due to the long-run nature of productivity benefits from resource conservation, long planning horizons are expected to positively influence fishermen's decision to participate in managing their resources (Kalaitzandonakes and Monson, 1994; p. 202). Younger fishermen are thus more likely to participate in collective effort than older fishermen. Similarly, fishermen with higher education might be expected to be willing to participate more in fishery conservation. This is because higher education is associated with greater information on the productivity implications of overfishing and the benefits of various collective conservation efforts. The effects of these social and demographic attributes may not influence fishermen's decisions directly. However, it is expected that

[3] The process of designing these scales is discussed in greater detail in Chapter Six.

some of these variables may have an indirect influence on the final outcome by influencing other variables. For example, household size raises the economic dependence of the fishermen on the resources and hence may improve the fishermen's participation in conservation efforts. The rational action for a fisherman with many dependants is to avoid his livelihood being jeopardised. Thus, he has great interest in participating in collective action. Therefore, although household size might not have a direct influence on fishermen's decision, it directly influences economic dependence, which in turn is positively associated with greater conservation efforts.

5.2.5 Vessel configuration

Differences in vessel configuration are thought to be an important determinant of fishermen's decision to participate in collective action. It is a widely accepted view that the larger the vessel and the more powerful its engine, the higher is its ability to catch fish. Thus, large difference in vessel configuration across individuals will lead to different catch rates. This makes collective decision to restrain the take from the fishery difficult to achieve. The emergence of collective action is seriously hampered by the existence of different interests, notably between users of different technology. Fishermen with bigger vessels have the opportunity to exploit new fishing grounds away from the coast. Therefore, they might not be interested in joining local collective effort to reduce the take from the fishery, especially if they expect that their vessel productivity needs to be reduced. In such cases, collective failure is likely to occur as seen by Johnson and Libecap (1982) when they found that fishermen's willingness to organise with others is made more difficult because they are equipped with different fishing techniques.

5.2.6 Group size

One of the conditions for successful collective action that has received considerable attention in the empirical literature is group size. For many scholars, a small group is a prerequisite for successful collective action (Olson, 1965). In Olson's view the provision of public goods is reduced as the size of the group increases. However, there are others who disagree with Olson's view with respect to the relationship between group size and provision level (Barry and Hardin, 1982; Baland and Platteau, 1996; Chamberlin, 1974; Sandler, 1992 and Wade, 1988). The effect of group size on individual ability to participate in collective action has been dealt with in greater detail in Chapter Three; thus no further discussion is needed in this section. Based on the findings of Barry and Hardin (1982);

Baland and Platteau (1996); Chamberlin (1974); Sandler (1992) and Wade (1988), it is hypothesised in this study that group size has no effect on the resource users' level of participation on collective action.

5.2.7 Group heterogeneity

Of fundamental relevance to the study of collective action is the relationship between group heterogeneity and the success of collective action. Based on the literature review, three sources of heterogeneity that hamper the capacity of resource users to participate in collective action were identified. These sources originate from the following: ethnic, racial, or other kinds of cultural divisions; differences in the nature of interests various individuals may have in a particular collective action and inter-individual variations in some critical endowments, that are reflected in varying intensities of interest (Baland and Plateau 1996; p. 302). Baland and Platteau (1996; 1997a and 1997b) further asserted that while the first two are considered as causing a strong obstruction to collective action, the same can not be said of the third case. Operationalization and measurement of the three sources of heterogeneity will be dealt with in greater detail in Chapter Nine (Section 9.4.8).

5.2.8 Institutional rules in use

Among other variables discussed, institutional rules in use are by far the most important factor for the success of collective action. It is a widely accepted view among scholars that different institutional arrangements used to exploit a common fishery can provide the necessary discouragement of users' activities that generate negative externalities (Sandler, 1992; Ostrom, 1990; Baland and Platteau, 1996). In fact examples of situations in which communities have evolved rules to exploit resources as a common property are legion (see Ostrom, 1990). It often appears that these institutional rules are effective in avoiding the tragic outcome associated with open access (Ostrom, 1990; Baland and Plateau, 1996; Cornes and Sandler, 1996).

As argued by Sandler (1992) and Cornes and Sandler (1996), small changes brought about by institutions can change the incentive structure facing individual fishermen. As was proved mathematically in Chapter Four, the dominant strategy of individual fishermen under the proportional sharing rule is universal defection. This non-cooperative game has been changed by modifying the sharing rule into a game of equal shares in which the dominant strategy of all fishermen is to cooperate. Institutional rules in use provide the enforcement mechanism needed to organize a change in fishermen's behaviour.

5.3 Measurement of the Dependent Variable

The attitude toward cooperation is the dependent variable for this study, measured as an index. Cooperation is operationalised as fishermen's obeying the group rules and participating in collective efforts to manage the resource. Ideally, cooperation should be measured as fishermen's self restraint in harvesting the resource when it is depleted, but measuring such a concept, either directly or indirectly, proved difficult. Therefore, the researcher measured fishermen's willingness to cooperate from different dimensions. Although the index contains items describing activities not related explicitly to harvesting behaviour (or resource use), these items could be viewed as a demonstration of cooperation to manage the fishery and to support the local management institution (Senat Al-Bahar). Therefore, attitudes and beliefs towards issues such as returning under-sized fish, observing the distance rule, participation in conflict resolution, renewing the fishing licence, persuading others to follow fishing rules and many other issues are related to the fundamental values that form the individual's cooperation attitude. Hence, beliefs on such issues can be used to elicit the individual's fishermen's cooperation attitude. The construction of this index is discussed in greater detail in Chapter Six and its results are presented in Chapter Nine.

5.4 Statements of the Hypotheses

Based on the above assumptions, a number of hypotheses are proposed in this section to examine factors that may be influential in fishermen's decisions to adopt a cooperative behaviour. The dependent variable for the analysis is fishermen's willingness to cooperate in managing their fishery, which will be tested against a number of factors which was discussed above and presented in Figure 5.1. Therefore, the hypotheses (null hypotheses) advanced for the purpose of this study are as follows:

Hypothesis one: There is no significant correlation between fishermen's economic dependence on the fishery and their attitude toward cooperation.

Hypothesis two: There is no significant correlation between respondents' social identity as fishermen and their attitude toward cooperation to manage their fishery.

Hypothesis three: There is no significant correlation between the attitude toward cooperation and fishermen's perception of the status of the resource.

Hypothesis four: There is no significant correlation between fishermen's awareness of the causes of overfishing and attitudes toward cooperation.

Hypothesis five: There is no significant correlation between fishermen's awareness of the consequence of overfishing and attitude toward cooperation.

Hypothesis six: There is no significant correlation between fishermen's awareness of externalities in coastal fisheries and attitude toward cooperation.

Hypothesis seven: There is no significant[4] correlation between fishermen's willingness to cooperate in the commons and their personal profiles.

Hypothesis eight: There is no significant correlation between attitude toward cooperation and vessel characteristics.

Hypothesis nine: There is no significant relationship between attitude toward cooperation and risk aversion

Hypothesis ten: There is no significant relationship between group size and fishermen's willingness to cooperate in managing their fishery.

Hypothesis eleven: There is no significant difference in willingness to cooperation between fishermen with different objectives concerning the use of the fishery.

Hypothesis twelve: There is no significant relationship between income inequality and individual fishermen's willingness to cooperate.

The results of testing the above hypotheses will provide some insight into the factors that influence the emergence of collective action to manage coastal fisheries. The results of testing the above hypotheses are presented in Chapter Nine.

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[4] This means statistically significant at the five-percent significance level.

CHAPTER SIX

THE RESEARCH METHODOLOGY

6.1 Introduction

This chapter aims to give a description of the procedures that were followed in this research in order to collect the data related to the issue of this study. Research designs provide many functions: they provide the researcher with a blueprint for studying social questions; dictate boundaries of research activity and enable the investigator to channel his energies in specific directions; and they enable the researcher to anticipate potential problems during the implementation stage (Black and Champion, 1976). The chapter begins by setting the rationale for the selection of the data collection methods. Then the chapter focuses on the survey population and the procedures implemented to select the study sample. The chapter also describes the techniques used to collect the baseline data including the design of Likert scales and their validity and reliability. An explanation is then given of the implementation of the data collection process. The final section is devoted to a description of the statistical techniques used in the analysis of the data.

6.2 Selection of the Methodology

The choice of a design setting for any research project is generally an important concern to the researcher, who seeks to determine the validity of a hypothesis and how best to discover evidence to either accept or reject it (Miller, 1991; p. 21). The rationale for the selection of the method depends on the research questions and the setting of the study area. As the purpose of this study is to assess the collective choice in coastal communities in South Al-Batinah, individual vessel owners' strategies must be investigated. Thus, individual vessel owners are selected as the unit of analysis in this study. Babbie (1975) defined the unit of analysis as the people or things whose individual characteristics are aggregated for purpose of describing some large group.

A cross sectional survey study is used to carry out the investigation of this study. Survey research has been defined as "*specifications of procedures for gathering* *information about a large number of people by collecting information from a few of them*" (Black and Champion, 1976; p. 85). The data gathered in the survey through different data collection techniques enable the researcher to test certain assumptions and hypotheses and to describe several dimensions of group behaviour. Furthermore, surveys are very flexible as they permit the use of multi-methods of data collection techniques (Black and Champion, 1976). For example, observation, questionnaire and in-depth interviews can be used in a survey method to collect information about the target population. Survey methods are more appropriate in cases where quantitative data are required and when the information sought is specific and familiar to respondents (Bulmer and Warwick, 1983).

The past three decades have seen a growing recognition of the need for multiple-sources research methodology. The weaknesses of individual methods can be overcome or reduced by merging two or more methods of data collection together to produce accurate results. In general the advantage of adding information from separate data sources depends entirely on the purpose of the research and the feasibility of obtaining the additional information sought (Warwick, 1983).

To carry out this study, a questionnaire was employed as the main method of data collection. The researcher, however, felt that a questionnaire alone would not fulfil the purpose of this study, so a decision was made to supplement the questionnaire by (a) semi-structured interviews of key-informants and (b) observations of the fishing operations and activities of fishermen in their villages. The three methods offer different types of data, which fit well together. In this case the researcher has more confidence concerning his conclusions than he would have if he had employed a single method (Whyte and Alberti, 1983).

6.3 Designing Sample

The way in which a researcher designs a sample depends on his research objectives. As argued by Arber, "*some researchers select samples in order to provide the maximum theoretical understanding, while others are primarily concerned to obtain a representative sample so that they can make inferences about the whole population*" (Arber, 1993; p. 86). The concern of this study is to obtain a representative sample of fishermen so that inferences can be made about the whole fishermen population in Al-

Batinah. To carry out this study, it would be ideal to interview all fishermen in the area rather than just a sample taken from that population. However, to study the whole population would not be possible, given the time and resources available for the study. Furthermore, researching a sample can yield more accurate results than using the complete population (Arber, 1993; p. 69). When fewer people are interviewed, more resources and time can be spent on each interview, permitting the employment of trained interviewers.

There are many sampling techniques available, and the choice of a particular technique is determined by the purpose and the design of the study and by the time and resources available. The most popular sampling procedure is probability sampling. Here, the sample is drawn in such a way that each member of the population has an equal probability of being included in the sample (Weisberg and Bowen, 1977). The sample of our study must be representative of the whole population from which it is selected if it is to provide useful estimates about the characteristics of that population. For instance, there should be same proportion of fishermen from each village in Al-Batinah in both the sample and the population. A sample will be representative of the population from which it is drawn if all elements of the population have a specific non-zero probability of being included in the sample (Oppenheim, 1992). Babbie (1975; p. 140) argues that samples need not be representative in all respects; representativeness is limited to those characteristics that are relevant to the substantive interests of the study.

The ultimate purpose of survey sampling is to select a set of members from a population so that a description of those members accurately describes the whole population from which they are drawn. Probability sampling provides a method to meet such criteria. Babbie (1975; p. 145) argues that "*random selection offers the researcher access to the body of probability theory, which provides the basis for his estimates of population parameters and estimates of errors*".

The main purpose of this study, which is to describe accurately the strategic choices of individual fishermen, raises the need for probability sampling. As argued by Arber (1993), a probability sample is most appropriate for analytic studies, which involves testing empirical hypotheses. There are many random sampling techniques used to ensure that the sample selected represent the characteristics of the population studied. Simple random sampling is the most direct method that gives an unbiased sample without much difficulty. However, although unbiased selection can be avoided, the sample may not represent the population at large, especially when the population is not homogenous. This is particularly true for this study because the fishery of Al-Batinah is divided into small villages scattered along the coast. Fishing activities carried out in one village might not be found in other villages. A simple random sample from these villages might produce a high sampling error[1]. Suppose we want to study the collective choice of fishermen in Al-Batinah coast and have sufficient resources to interview 250 fishermen. With simple random sampling, it would be possible to draw a sample which under-represents fishermen from some villages and over-represents others. Collective choices are likely to be closely linked to the behaviour of fishermen in each village, so it is desirable that the sample should have the correct representation of the fishermen's villages. Therefore, care must be taken when drawing the sample to avoid over-representation of some villages and/or under-representation of others.

To cope with these differences, a stratified random sampling technique seems to be more appropriate to achieve the objectives of this study. A stratified random sample is one in which the population is divided into groups or "strata" and a random sample is then selected from each subgroup (Babbie, 1975; Black and Champion, 1976 and Fink, 1995). The ultimate function of stratification is then to organise the population into homogenous subsets and to select the appropriate number of elements from each (Babbie, 1975; p. 156). This method of sampling gives a greater degree of representation and decreases the probable sampling error that would occur with a sample of the same size.

Before the sample was drawn, all fishermen included in the study were listed in the sampling frame according to their villages. A sampling frame is a list of the survey population from which a sample can be drawn (Babbie, 1975; Hoinville and Jowell, 1978). As well as listing all elements, the sampling frame provides some identification of those elements (address, location, etc.), so that each element can be easily identified in the field. If the sampling frame is to fulfil its purpose it must meet a number of criteria. It must be accurate, free from omissions and duplications and up to date (Murthy and Roy, 1983).

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[1] Sampling error is the difference between a sample estimate and the population value that would have been found by a 100 % census conducted with identical procedures (Bulmer, 1983).

Most survey methods text books were written with developed countries in mind, such as those written about North America and western Europe (see for example: Babbie, 1975; Black and Champion, 1976; Hoinville and Jowell, 1978; Miller, 1991; Oppenheim, 1992, etc.) and they take for granted the availability of an adequate sampling frame. The case of developing countries is different from those stated above. As argued by Bulmer (1983; p. 93), "*In developing countries, such extensive information is either not available at all, or where it is available is subject to a considerable degree of error*". Therefore, it is very important to determine the accuracy of the sampling frame as the exclusion of fishermen in the population from the sampling frame will lead to bias in the sample which is a source of non-sampling error. Earlier in this section, it was noted that care were taken to minimize sampling error by choosing a stratified sampling method which yields a representative sample with less sampling error. Nevertheless, reducing sampling error will be inadequate to reduce total error. Reduction in error requires attention to both sampling and non-sampling errors (Bulmer, 1983; p. 97). Therefore, non-sampling errors that occur from an inaccurate sampling frame, untrained field staff, literacy, lack of cooperation from respondents and other factors must be minimized as far as possible.

To survey the fishermen population in Al-Batinah, fishing vessel registration record of the Ministry of Agriculture and Fisheries could have been used to prepare the sampling frame. The researcher felt, however, that such a record would probably be inaccurate and not up to date. Fishing vessels registered during the eighties, for example, might not be in operation during the survey, which would lead to difficulties in the field. In addition, the fishing registration record does not classify fishing vessels according to the type of fishing gear used, nor does it give the location of the owner of the vessel.

The Ministry of Agriculture and Fisheries carried out an extensive census of fishing vessels in Oman in 1995. The results of this census are available in a data base format, which gives information such as the name of the owner, his address, age, type of vessel, and other information. The results of the census classify fishing vessels and the type of fishing gears operated in each village. The researcher was very fortunate to gain access to the Ministry of Agriculture and Fisheries computer system. A list of fishing vessels and their owners, obtained from the 1995 fishing vessel census, was used as a sampling frame. The census gives essential information for this study as it gives detailed information about the target population, which is useful for stratifying groups of fishermen by their fishing villages.

There is no clear-cut answer in the literature on the appropriate sample size. However, some advice was found in Upton (1973) and Cohen and Manion (1980). They suggested that a sample size of thirty in each stratum is sufficient if the researcher plans some forms of statistical analysis of his data. A large sample size, however, is not sufficient to guarantee the accuracy of the results. It is true that in some designs, an increase in sample size will increase the precision of the results, but it will not reduce bias caused by an inaccurate sampling frame. Therefore, the size of the sample is not in itself enough to guarantee that all will be well (Moser and Kalton, 1971; p. 79).

The fishermen population was stratified in relation to geographical location. Prior to sample selection, the sampling frame was divided into towns (strata). Within each fishing town, the vessel population was further stratified according to their respective fishing villages (Table 6.1). Systematic selection from a list ordered by one or more stratification factors automatically forces the sample to be representative on these factors (Arber, 1995; p. 88). The vessel owners' population consisted of 962 fishing vessels in South Al-Batinah. The researcher aimed to interview 201 vessel owners' for this study using a proportional stratified sample in which each stratum is represented exactly in proportion to its size in the population from which the sample was drawn.

Theories of collective action consider group size as an important factor that effects the emergence of successful collective action (as described in Chapters Three and Five). Fishermen in the study area are scattered along the coast in villages of different sizes. Therefore, fishing villages in each town are separated into two strata: small and large. A decision was made to consider villages with more than 40 vessels as large and those with less than 40 as small. Therefore, small villages were grouped together to form a stratum and a systematic sample was then drawn from this stratum and care was taken to make the sample proportionate to its size in the population from which the sample was drawn. The same thing was done for large villages in each town. All villages with more than 40 vessels were grouped together.

Table 6.1 Sampling Frame for South Al-Batinah[2].

Town	Village size	Village	Total population	Target sample	Actual sample	% of population[4]	% of target sample[3]
	Large	Al-Swadi	160	31	31	11.7	100
		Al-Haradi	105				
Barka	Small	Al-Maragh	32				
		Al-Shamal	10				
		Al-Marisi	20	30	30	38.5	100
		Al-Hufri	16				
Sub-total			**343**	**61**	**61**	**17.8**	**100**
	Large	Wadam	59				
		Aweed	43	30	30	20	100
		Masanhgnoz	42				
Masn'a	Small	Abuabali radah	19				
		Abuabali sahil	16				
		Al-Greem	17				
		Al-Shurus	14	30	30	33	100
		Allbreak	10				
		Masanhfager	16				
Sub-total			**236**	**60**	**60**	**25**	**100**
	Large	Al-Jaleel	97				
		Al-Quarha	65	50	43	19	88
		Badewooh	57				
		Hagerah	40				
Suwaiq	Small	Dayaan	25				
		Rhadah	11				
		Khadrasaad	12				
		Aweedat	15				
		Khadrarasheed	14	30	30	22	100
		Albatha	22				
		Almatamur	13				
		Halatswooq	12				
Sub-total			**383**	**80**	**73**	**20**	**93**
Total			962	201	194	20	97

The three towns that represent South Al-Batinah and were selected for this study are: Barka, Masn'a and Suwaiq. These three towns represent the first stratification of the whole fishermen population. Further stratification was carried out for each town. For example, fishermen in Barka were stratified into two groups: those who came from large villages and those who came from small villages. As shown in Table 6.1 there are

[2] Proportional stratified sample, i.e., each stratum is represented exactly in proportion to its size in the population from which the sample was drawn.

[3] Actual sample as a percentage of target sample.

[4] Target sample as a percentage of total population.

six villages in Barka, two large villages, Al-Sawadi (160 fishermen) and Al-Haradi (105 fishermen) and four small villages, Al-Maragh (32 fishermen), Al-Marisi (20 fishermen), Al-Hufri (16 fishermen), and Al-Shamal (10 fishermen). The two large villages form a stratum where a sample of 31 fishermen was selected. Another 30 fishermen were selected from the other stratum (small villages). Hence, a total of 61 fishermen from Barka were selected to be in the sample for this study. The target samples for Masn'a and Suwaiq were 60 and 80 respectively. This facilitates our comparison of the dependent variable "willingness to cooperate" of fishermen from small and large villages. This helps determine the effect of group size on collective activities in coastal communities.

6.4 The Questionnaires

To operationalize the general concepts of this study, the researcher employed a questionnaire as the main research method of data collection. Babbie defined operationalization as the process through which the researcher devises procedures and operations that will result in observations relevant to general concepts he is interested in studying (Babbie, 1975; p. 105). The questionnaire is a very popular tool of operationalization in which concepts are operationalized in the form of questions, which are then put to the people under study. The questionnaire was administered to the fishermen and the researcher himself recorded their responses. The researcher preferred this method because it was already known that most of the fishermen in the study area were illiterate. An administered questionnaire would also enhance the completion rate, reduce the number of unanswered questions, and enable probing and controlled clarification (Babbie, 1975; p. 275).

To achieve high accuracy in obtaining the data, the questionnaire schedule is divided into several sections and used a mixture of closed questions, open questions and attitudinal scales.

The first section of the questionnaire concerns general information, such as fisherman's name, village, Walayah (town) and the serial number given. This information was obtained from the sampling frame prior to the fieldwork to facilitate the work of the researcher. The second section concerns fishing assets owned by the respondent. It is divided into fishing vessels owned, number and horsepower of engines used, fishing gear, and fishing accessories and other assets owned. The section provides background information about the respondent which is needed for testing research hypotheses. The third section is on fishing activities and fish marketing. Under this section there are a number of questions used to elicit information about the pattern of fishing activities and the way fish is marketed.

The fourth section concerns the current status of fish resources. The section aims to elicit fishermen's perception of the status of their resources. Four attitudinal scales are included in this section to measure fishermen's attitude. These scales were developed originally by Salim (1996) to collect data on fishermen's attitude towards collective action in fishing in West Johor (Malaysia). The developer of the questionnaire administered them to 144 fishermen in West Johor where high internal reliability was achieved. Cronbach's alpha for the four scales was between 0.84 to 0.92 (Salim, 1996). Despite the cultural differences between Malaysia where the four scales were developed and administered, and Oman where it was applied in this research, the researcher felt that the scales are appropriate, although differences in responses were to be expected in this case. To cope with cultural differences and to make the questionnaire suitable for this particular research, some modifications were made.

The fifth section is on collective activities in fishing communities. The sixth section asks questions about the influence of group size, fishing technology constraints, institutional factors, economic dependence on fishing and the social identity on collective activities. The seventh section is on the attitude toward investment in fishing. The eighth section is on the establishment of clubs. Fishermen were asked to give their views about establishing fish producers' associations. The last section contains an index to measure fishermen's attitudes towards cooperation.

The questionnaire set contains two categories of questions. The first type is factual questions which are designed to obtain objective information from the respondents regarding their backgrounds and their habits. Questions regarding respondent age, education, income, degree of wealth and the like are grouped under "factual questions" described above. The second category of questions concerns the fishermen's attitudes towards the status of the fishery in which they are operating. Attitudes are defined as general orientations that can incline a person to act or react in a certain manner when he confronted with certain stimuli (Nachmias and Nachmias, 1996; p. 252). Attitude is normally measured by more than one question, because unlike factual questions, respondents may not have an attitude toward the concept and because many attitudes have numerous aspects; the respondent may agree with one aspect and disagree with another. As argued by Nachmias and Nachmias (1996), "*by using several attitude statements, a researcher can more accurately ascertain both the strength of a respondent's attitude and the conditions under which his or her attitude may change*".

Fishermen's attitude toward Resource Status, Overfishing, Consequences of Overfishing and Externalities are measured using attitude scales consisting of five or more attitude statements, to which respondents were asked to indicate their degree of agreement or disagreement. This approach to measurement is called a summated scale, which was devised by Likert (1932), and it is the most widely used approach to measurement in the social sciences today[5]. Most Likert-type scales use a 5-point response composed of (1) strongly agree, (2) agree, (3) undecided, (4) disagree, and (5) strongly disagree. Adams and Schvaneveldt (1991; p. 160) state that fewer or more response categories have been used. Considering the respondents' level of illiteracy, the researcher felt that using five response categories in the scale would confuse fishermen and possibly produce biased results. This is because it is difficult for an uneducated fisherman to differentiate between "strongly agree" and "agree". This was confirmed during the pilot study when the researcher observed that a five point scale made fishermen confused and the researcher found it difficult to record accurately fishermen's reaction to the items of the scale. A decision was made at this stage to reduce the scale response categories from five points to three points, namely, (3) agree, (2) indifferent, (1) disagree.

As mentioned above, to meet the aims and objective of this research, four scales were devised to measure Fishermen's Perception of their Resources, the Cause of Overfishing, the Consequences of Overfishing and the Externality in Coastal Fishing. An index was also constructed to measure fishermen's cooperation. In the following sections, the processes of modification of these scales and construction of the index will be highlighted.

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[5] Another method of scaling is the Guttman scaling technique developed in early 1940s by Louis Guttman. A Guttman scale is unidimensional as well as cumulative, in that information on the position of any respondent's last positive response allows the researcher to predict all of that person's responses to the other items (Nachmias and Nachmias, 1996; p. 474).

6.4.1 Fishermen's perception of their resources

This instrument was first developed by Salim (1996) to measure fishermen's perception of their fish resources in West Johor (Malaysia). The scale contains five statements devised to measure fishermen's awareness of the status of their fishery (see Table 6.2).

Table 6.2 Perception of Resource Status (original scale)

	Statement
1	Your fish catch per trip declines
2	Your prawn catch rate per trip declines
3	Your target species is difficult to catch
4	The large fish are difficult to find or catch
5	The percentage of trash fish in your daily catch has increased.

The researcher felt that the scale is relevant to the present study. However, some modification needed to be carried out because the original scale was developed for a prawn trawl fishery, whereas the present study concerns a small scale fishery where mobile gear such as gill nets and static gears such as traps are used. Item (2) was removed because the target species is not prawn in the present study, and indeed the fishery is considered as multi-species. One item was added to the original scale: "We need to spend longer hours looking for fish than we used to". The fishermen's agreement with this statement would also reflect another aspect of overfishing in Al-Batinah (see Table 6.3).

Table 6.3 Perception of Resources Status

	Statement
1	Your fish catch per trip declines
2	Your target species per trip decline
3	The large fish are difficult to find or catch
4	We need to spend longer hours looking for fish then we used to
5	The percentage of trash fish in your daily catch has increased.

6.4.2 Perceptions towards the cause of overfishing

The scale is also adapted from Salim (1996). This scale contains nine statements devised to measure fishermen's perception of the cause of overfishing (Table 6.4). The researcher found that the scale is relevant to the present study to measure fishermen's perception of the causes of overfishing in their fishery.

Table 6.4 Perception towards the Causes of Overfishing (original scale)

	Statement
1	Fish resources decline if too many vessels are operating in the same area
2	Fish resources are limited due to small area
3	Fish resources decline if all vessel are large in size
4	Fish resources decline if all vessels use high horse-powered engines
5	Fish resources decline if all vessels employ huge nets
6	Fish resources decline if fishermen increase their fishing time per trip
7	Fish resources decline if fishermen increase their fishing days per month
8	Fish resources decline due to pollution
9	Fish resources decline due to weather

To adapt the scale to the present study, the researcher made some modification. One item (10) was added so the scale contains ten items or statements which measure fishermen's perception of the likely causes of over fishing (see Table 6.5). Before the start of the study, the researcher visited a number of fishing villages in the study area and interviewed some fishermen. The researcher found that one of the causes of overfishing reported by fishermen in the area is the introduction of purse seining or encircling gear into the fishery during the last three years. Therefore, item 10 was added to see if fishermen claim that encircling gears which have been introduced recently into the fishery have a negative impact on fish stocks in Al-Batinah. In addition, the researcher modified item 5 by changing the words (huge nets) to (a large number of nets). This is because the original scale was developed for fishermen operating trawl nets, and the amount of catch rises with the size of the trawl net, whereas, in the present study, the target sample was small scale fishermen operating gill nets and traps among other fishing gears and the number of units owned by each fisherman determines his catch.

Table 6.5 Perception Towards the Causes of Overfishing

	Statement
1	Fish resources decline if too many vessels are operating in the same area
2	Fish resources are limited due to small area
3	Fish resources decline if all vessel are large in size
4	Fish resources decline if all vessels use high horse-powered engines
5	Fish resources decline if all vessels employ a large no. of nets
6	Fish resources decline if fishermen increase their fishing time per trip
7	Fish resources decline if fishermen increase their fishing days per month
8	Fish resources decline due to pollution
9	Fish resources decline due to weather
10	Fish resources decline if fishermen use encircling gear

6.4.3 The consequences of overfishing

The third scale employed for the present study is to measure Fishermen's Awareness of the Consequences of Overfishing. The original scale contains seven independent items developed by Salim (1996) to test trawl skippers' awareness of the consequences of overfishing in West Johor (Malaysia). The scale is important for the present study because it tests whether fishermen in the study area are aware of the consequences of overfishing in their fishery (see Table 6.6). If the results confirm this, we may conclude that fishermen in Al-Batinah would respond favourably to the chance of playing a better game (privilege game for example) as an alternative to solve their common problem.

Table 6.6 The Consequences of Overfishing (original scale)

	Statement
1	Your catch contains a high proportion of trash fish
2	Your fishing area becomes further away from your village
3	Your fishing hours become longer
4	Your fuel consumption increases
5	Many fishing areas are barren
6	You have to use high horse-power engine to catch fish
7	You want always to have abundant fishery resources

The researcher made some modification for the original scale in order to adopt it to the present study. First, three items (1, 6 and 7) were removed from the scale. Item 1 is already used in scale 1 (Table 6.2), "Status of fish resources", so the researcher decided to remove it. Item 6 was removed because there is no direct relationship between high horse-power and amount of catch in the trap and gill net fishery in the present study, as compared to the trawl fishery where the scale was first tested. Item 7 was removed because it does not reflect an aspect of overfishing and does not contribute to the overall scale results. In addition, two items were added to the scale (see Table 6.7). Item 5, "you have to use more fishing gears to catch fish" was added to test fishermen's awareness of the consequences of overfishing in their fishery. Item 7, "It is in God's hand how much fish remains in the sea" was also added so the scale contains seven independent items.

Table 6.7 The Consequences of Overfishing

	Statement
1	Your fishing area becomes further away from your village
2	Your fishing hours become longer
3	Your fuel consumption increases
4	Many fishing areas are barren
5	You have to use more fishing gears to catch fish
6	Your income declines
7	It is in God's hand how much fish remains in the sea

6.4.4 Externalities in coastal fishing

When resources are scarce, fishermen start to compete for limited resources. The ultimate results are negative externalities. Externalities in coastal fisheries are a sign of overfishing when conflicts among fishermen raises and the cost of fishing increases at the same time. To measure externality in Al-Batinah fishery, a scale that measures externalities in coastal fisheries was adopted. Salim (1996) first administered the scale to prawn trawl skippers in West Johor (Malaysia) (Table 6.8). The scale is appropriate for the present study to measure fishermen's awareness of the types of externality that exist in their fishery. The scale contains five independent items covering different dimensions of externalities such as mobile and static gear interaction, competition for good fishing spots, etc.

Table 6.8 Externalities in Coastal Fisheries (original scale)

	Statement
1	You may face some difficulty in fishing if too many vessels operate in a small area
2	Net entanglement problems often occur if too many vessels operate in the same area
3	You cannot fish in the area where your colleague is fishing
4	Less catch is expected if you operate in the area which has just been fished by your colleagues
5	You may face a higher cost if fishery resources deplete

In order to adapt the scale to the present study some modifications were made. First, item 5 was removed from the scale and three items (4, 6 and 7) were added, so it contains seven independent statements (see Table 6.9).

Table 6.9 Externalities in Coastal Fisheries

	Statement
1	You may face some difficulty in fishing if too many vessels operate in a small area
2	Net entanglement problems often occur if too many vessels operate in the same area
3	You cannot fish in the area where your colleague is fishing
4	You cannot fish in the area where many colleagues are fishing
5	Less catch is expected if you operate in the area which has just been fished by many colleagues
6	Less catch is expected if you operate in the area which has just been fished by a colleague
7	Conflicts among fishermen at sea are rising

6.4.5 Willingness to cooperate

One way of measuring a fisherman's cooperation is by predicting his willingness to limit his take from the fish stock when it is scarce, as well as his willingness to contribute toward the provision of institutions to manage the resources. There are no previous published studies, to the researcher' knowledge, that use an attitudinal scale to measure fishermen's cooperation towards the conservation of fish resources. Such a concept consists of a complex combination of phenomena and therefore it is difficult to measure using a single indicator or statement, because no single indicator will cover all the dimensions of the concept.

MacDonald (1993), for example, measured fishermen's cooperation by two indicators. The first indicator is fishermen's records of dues payment and the second is the number of organization meetings attended by fishermen. The index measures the individual's contribution of time and money to resolve a common problem. She devised a variable index where those who paid all their dues and attended meetings frequently were regarded as more cooperative than those who did not. The researcher felt that such a measure is inadequate for the present study because it only covers two dimensions of our concept. A fisherman could pay his money dues and attend the cooperative's meetings frequently, but may use destructive gear or free ride on the efforts of other fishermen to conserve their fish resource. Based on the above argument, by using several attitude statements, the researcher is more confident of being able to ascertain both the strength of a fisherman's attitude toward cooperation and the conditions under which his attitude may change.

The researcher decided to develop an index with several attitudinal statements to measure the dependent variable "willingness to cooperate". According to Nachmias and Nachmias (1996; p. 548), *"the index should contain a number of indicators carefully selected, each of which has a specific purpose that must be set forth and explained prior to construction of the index"*. The index developed for this study contains 14 independent items or statements, each highlighting an aspect of cooperation. Some of these items concern fishermen's contributions of time and money to solve common problems, such as informing on rule-breaking, renewing their fishing and vessel licence, and attending extension workshops (see Table 6.10). Other items concern the conservation of fish stocks such as returning undersized fish when caught in their nets, opposing the use of modern gear such as purse seines which may harm the resources and building artificial reefs to rehabilitate fish stocks. Numerical values are assigned to the items where a "yes" response to a statement in the index is given a value of one (1) and a "no" response is given a value of zero (0) and these values are then added to obtain the total scores. The scores are interpreted as indicators of the cooperative attitude of individual fishermen. A fisherman who obtains a high score on the index is more willing to cooperate than those who obtain low scores.

Table 6.10 Willingness to Cooperate

	Item	Yes	No
1	You return under-sized fish into the sea when caught in your net	1	0
2	Set your nets at a distance from other fishermen's gears	1	0
3	Inform on colleagues who break the fishing rules	1	0
4	Attend workshops arranged by the Ministry of Agriculture and Fisheries	1	0
5	Renew your fishing licence and vessel licence	1	0
6	Speak to the head of the tribe about the problem of your fishery	1	0
7	Discuss fishing problems frequently with more than one fisherman	1	0
8	Participate in a group to resolve conflicts in fishing	1	0
9	Persuade others to follow fishing rules	1	0
10	Participate in reef construction in your village	1	0
11	Share important information	1	0
12	Share information about fish concentration on the grounds	1	0
13	Tell your colleague about new technical developments	1	0
14	Share information about low cost sources of inputs	1	0

The development of the questionnaires was of paramount importance. Care was taken to obtain the necessary information without unduly influencing the respondents. Care was also taken to translate the research objective into specific questions. This is vital in questionnaire construction to ensure that answers to such questions will provide the data for hypotheses testing. The question must also motivate the respondent to provide the information being sought (Nachmias and Nachmias, 1996; p. 250). During the questionnaire development, consideration of the content, structure, format, and sequence of the questions was taken into account.

The first draft of the questionnaire was tested on a few fishermen of a fishing village in Barka to make sure that all the questions were clear and to measure the time required for each interview. Fishermen participating in the pilot study were excluded from the sampling frame so that they were not interviewed again. The first draft contained 12 pages and the average completion time for each respondent was 60 minutes. The results of the pilot study indicated that the questionnaire was too long and respondents became bored after about 40 minutes of interviewing. A decision was made to reduce the number of questions and the questionnaires were tested again. The pilot study, together with consultation with experts in the field, resulted in a number of refinements and alterations being incorporated into the final questionnaire which is now presented in the form used for the present study (see Appendix 1).

6.5 The Semi-structured Interview

Nachmias and Nachmias (1996) define an interview as a face to face interpersonal role situation in which an interviewer asks the respondent questions designed to elicit answers pertinent to the research hypotheses. In Section 6.4, the questionnaire survey, which is the main method of data collection in this study, was described. The feature of the questionnaire survey is its lack of flexibility, where the number of questions and wording of the questions are the same for all respondents. In this case the interviewer must ask questions in the same sequence in every interview and the researcher cannot probe to obtain more information. More flexibility in interviewing can be found in semi-structured in-depth interviews. Semi-structured interviews are used as a second method of data collection in which the interviewer does not need to use a schedule to ask a prepared set of questions. It is also not necessary to ask questions in the same sequence or wording in every interview (Fielding, 1993).

While conducting semi-structured interview, the interviewer must have a clear focus of inquiry in his mind by which he tactfully asks and actively listens to respondent. The interviewer asks questions pertinent to the study as each opportunity arises, then listen closely to responses for clues as to what question to ask next (Maykut and Morehouse, 1994).

Semi-structured interviews are carried out to add to the richness of the quantitative data obtained by the questionnaires. They generate qualitative data to support the research findings and to validate the results. The approach is very flexible where the respondents are encouraged to talk about the topic raised by the researcher from their perspective. The role of the researcher in semi-structured interviews is as a mediator to direct and control the interview. The researcher probes for more information when he feels that at a particular point during the course of the interview there is a gap in information which needs to be filled.

The researcher developed an interview guide containing a list of topics which were not covered by the questionnaires or needed more elaboration to support the evidence (Appendix 3). The topics focused on the changes in the fishery during the last 30 years, pattern of fishing activities, fish markets, collective activities, and possible solutions to the commons problem. The researcher discussed the indigenous institutions used by fishermen to manage their fish resources for many decades. The researcher was interested to determine the incentive structure of the system that encourages or impedes collective action at the village level. To obtain rapport and to build up a good information base, factual questions were asked first. These included the respondent's age, current occupation, involvement in the sector and experience.

The selection of interviewees was based on their long involvement in fishing, leadership and familiarity with the customs and rules of the indigenous fish management system. Key informants were selected so that they represented the three fishing areas chosen for this study. Fifteen interviews were conducted immediately after the completion of the questionnaire survey (16th to 30th May 1998). Each interview took around three hours. The researcher carried out all interviews and they were tape recorded and then transcribed immediately. It is recommended to transcribe the interview soon after it has occurred, while it is still fresh in the interviewer's mind (Maykut and Morehouse, 1994; p. 100).

All interviews were carried out in the key informants' houses. The researcher visited the key informant and after introducing himself he explained the objectives of the research and how the respondent had been selected for the interview. A letter from the Wali's (Governor's) Office permitting the researcher to carry out his study was shown as well, to make the respondent more comfortable talking to the researcher. Permission to use a tape recording was obtained before the start of the interview. The first topic asked was the status of fish resources in the area. The respondent then described the status of fish resources and the decline in landings at present. The researcher acted here as a listener with attention to what the respondent was saying to make the conversation more interesting to him. During the course of the interview the researcher felt that the interview has moved away from surface talk to a rich discussion of thoughts and feelings.

6.6 Observation of Fishing Operation and other Activities

The third method used to obtain data for the present study was field observation. Observation combines well with the questionnaire survey and semi-structured interview, to overcome any limitation of either method. In addition, observation was employed to collect supplementary data for use in interpreting or qualifying findings by other methods (Nachmias and Nachmias, 1996; p. 207). To understand, explain and predict fishermen's daily activities in their villages the researcher went into the field and observed their activities while they beached their vessels, mended and repaired fishing tackle and interacted with each other. The researcher's aim here was to have an insight into aspect of collective actions that take place on the beach. The researcher visited all 27 villages covered by the present study.

Field observation was carried out at the same time as implementing the questionnaire survey. On the beach and while the researcher was waiting for a respondent to arrive, he spent this time observing some of the activities. This helped the researcher to understand the interpersonal relationships of fishermen in the village, including those that may differ from one village to the other. Observations helped to explain how and why fishermen help each other in certain aspects of their daily activities. For example, seeing fishermen gathering to help beaching a fishing vessel of their colleague reflects the collective behaviour of the group. Another example of collective activity observed was a gathering of fishermen to help their poor colleague by mending his only gill net after it was entangled in an artificial reef.

The researcher observed the types of vessels employed, fishing nets and accessories, and landings and handling of fresh fish. The researcher visited a number of fish markets and auctions to gain a general idea of the selling practices. The researcher recorded these daily activities which helped him to remember the characteristics and activities of each village as well as helping him to interpret the results.

6.7 Validity

The question of validity draws attention to how far a measure really measures the concept that it purports to measure (Bryman and Cramer, 1997; p. 65). The five scales used in this study are intended to measure different concepts such as Fishermen's Awareness of the Status of the Resource, Awareness of the Cause of Overfishing, Awareness of the Consequence of Overfishing, Externalities in Coastal Fisheries and Willingness to Cooperate. The items in these scales measure the concepts from different dimensions and therefore these measurements are indirect. In this circumstance it is not certain that they are measuring the variable for which they designed for and hence supporting evidence is needed to prove that a scale is measuring what it appears to measure. This supporting evidence is obtained by testing the validity of the scale, which is a measure of scale's accuracy.

Several types of validity are typically measured when assessing the performance of a survey instrument: face, content, criterion and construct (Litwin, 1995; p. 34). Criterion and construct validity are difficult to measure because the former needs to be judged against some other method, known as a "gold standard", for assessing the same concept and the latter is determined only after years of experience with the instrument. As there is no known "gold standard" for the scales used in this study to be used to determine the criterion validity, the researcher had to settle for testing the face and content validity of the scales. As argued by Bryman and Cramer (1997; p. 66) "*at the very minimum, a researcher who develops a new measure or tests a used measure on a different population should establish that it has face validity-that is, that the meaning apparently reflects the content of the concept in question*".

6.7.1 Face validity

Face validity is the least scientific of the all validity measures (Litwin, 1995; p. 35). The researcher took the following steps to make sure that the questionnaire has high face validity. First, the questionnaire was reviewed thoroughly by the researcher and his supervisor to check on the clarity of the questions and to ensure that the contents were accurately interpreted. Then, the items were also shown to friends and fellow fisheries students at the University of Hull to rate scales' appropriateness to the variable they purport to measure. Their comments were considered and some of the questions and statements were modified accordingly.

The questionnaire was first written in English and then the researcher translated it into Arabic (Appendix 2). To ensure that colloquial terms and meanings were equivalent in both English and Arabic versions, the researcher gave both versions to an expert in Oman who is competent in translation from English into Arabic and vice versa. This ensured that the Arabic version of the questionnaire generated similar meaning to the English version.

6.7.2 Content validity

Content validity is a measure of how appropriate the items are to the scale as observed by referees who have some knowledge of the subject. To obtain the content validity of the scales used in the present study the researcher consulted a number of specialists in fisheries to rate the appropriateness of each item in the scale. The specialists were given the scales with a covering letter indicating the nature and purpose of the study and a description of each scale (Appendix 5a). Eleven specialists, five lecturers in fisheries from the Hull International Fisheries Institute, University of Hull and five lecturers in fisheries from the college of Agriculture, Sultan Qaboos University and a director from the Directorate General of Fisheries, Ministry of Agriculture and Fisheries (Oman) were given a copy of the questionnaire. They were asked to respond to whether the items are appropriate for the variable they designed to measure. They were asked to give their responses for each item on a scale of five, (extremely appropriate (5), appropriate (4), moderate (3), fairly appropriate (2) and not at all appropriate (1). They were asked also to add any comments or correct any item in order to improve the validity of the scale.

The specialists' responses were analysed and the mean value for each scale was determined. Items that scored less than the mean were then removed from the scales. The first scale, "Awareness of the Status of Fish Resources", scored a mean of (4). The five items in this scale scored appropriate (4) or above and therefore, they were all retained in the scale as they have high content validity (see Table 1 in Appendix 5b). The second scale, "Awareness of the Cause of Overfishing", scored a mean of (4) (appropriate). Items 2, 8 and 9 scored means of (3), (3) and (2) respectively which are lower than the mean value (4) and therefore a decision was made to remove them from the scale (see Table 2 in Appendix 5b). The mean value for the scale "the Consequence of overfishing" was (4). All items in the scale scored four or above except item 8, the mean for this item was (2.64), therefore, it was removed from the scale because its mean is lower than the overall scale mean (Table 3 in Appendix 5b).

The scale that measures Externalities in Coastal Fisheries contains seven items. The results obtained from the analysis of the specialist's response gave a mean score of (4) (appropriate). Four items scored (4) or above and two items, 3 and 6 scored below the mean so they were removed from the scale. Item 7 scored below the mean but it was retained as it measures an important aspect of coastal externality (Table 4 in Appendix 5b). The final scale then contains five items or statements designed to measure Externalities in Coastal Fisheries.

The scale designed to measure fishermen's willingness to cooperate contained initially 14 statements. The mean score for this scale is (4). The results indicated that most items scored above the mean. Although items 9 and 10 scored (3.73) and (3.91) respectively, the researcher decided to retain them as they reflect an important dimension of cooperation (Table 5 in Appendix 5b). Comments and notes of the referees were considered. According to their recommendations four items (11, 12, 13, and 14) were removed from the scale because: their mean was less than (4), to make the questionnaire as short as possible and because they did not highlight a real dimension of fishermen's willingness to cooperate. In addition, the referees recommended the addition of two items (M97) and (M98). Both items are included in the index and can be seen in the final version of the questionnaire (Appendix 1). They were important as they reflect another aspect of the concept measured which was not covered by other items in the scale. The former, "Have you been to the Governor's office to raise a case against those who violate the fishery rules?" reflects an effort by a fisherman when he visited the Governor's office to stop rule violators. The latter, "Do you oppose the use of purse seine nets to catch sardines in your fishery" reflects fishermen's concern about the introduction of modern technology that may affect their livelihood (see Appendix 1). The researcher modified the statements according to the specialists' comments before the implementation of the questionnaire to ensure that the scales measure what they purport to measure.

6.8 Reliability

Reliability is of central concern to social scientists because the measuring instruments (scales) are rarely completely valid (Nachmias and Nachmias, 1996; p. 170). This is because measurements in the social science are indirect and therefore, more errors are encountered when social variables are measured as compared to physical variables (Nachmias and Nachmias, 1996). For example, in the present study fishermen's awareness of the status of fish resources is measured with a scale containing five statements. These indicators are indirect as they measure fishermen's attitude towards a concept. In addition, the validity analysis carried out for this scale is a subjective one (face and content validity); therefore, the scale may not be completely valid and the researcher must evaluate the scale with respect to other characteristics. The degree of reliability is a method commonly used to evaluate the consistency of scales or instruments. Litwin (1995; p. 6) defines reliability as a statistical measure of how reproducible the survey instrument's data are. In other words, the researcher should expect the same results if he applied the same scale on different occasions or with a different set from an equivalent population.

Reliability analysis is carried out to assure the researcher that the scales are reliable and have a little as possible measurement error. Nachmias and Nachmias (1996; p. 170) argue that a measuring instrument contains variable errors, that is, errors that appear inconsistently from observation to observation during any one measurement attempt or that vary each time a given unit is measured by the same instrument. Therefore, each measurement contains a true component and an error component. Therefore, reliability can be defined as the ratio of the true score variance to the total variance in the score as measured (Helmstadter, 1970; cited in Nachmias and Nachmias, 1996; p. 171). From the above definition it can be seen that if there is no variable error the ratio of the true score variance to the total variance becomes one, and the scale is perfectly reliable. However, when the measurement contains only error, the above ratio tends to zero, and the scale is completely unreliable. The reliability measure varies on a scale from 0 to 1, where a value close to zero is an indicator of an unreliable scale and a value close to one is an indicator of a reliable measure.

When considering measurement reliability, a distinction is made between external and internal reliability. External reliability refers to the degree of consistency of a measure over time, or the possibility of an independent researcher replicating the same study in a similar setting. Internal reliability measures the consistency of the scale. It is applied to a scale containing several items that are thought to measure different aspects of the same concept (Litwin, 1995). High internal reliability indicates how different items measure a single concept. This is important for the present study as there are five scales to measure different concepts, each containing five or more statements. The aim here is to make sure that a group of items in a particular scale which purport to measure one variable should focus on that variable only.

Several procedures are commonly used to determine measurement reliability. Among the most common methods are:

(a) Test- retest, where the scale is administered to the same group on two separate occasions and then the correlation between the two sets of observation is computed. A high correlation between the two tests is an indicator of high reliability. Test-retest has two main limitations (Nachmias and Nachmias, 1996; p. 172). First, measurement on one occasion may influence measurements on subsequent occasions. Second, changes may have occurred in the measured variable during the period between the two tests which may cause low reliability.

(b) Parallel forms technique, where the researcher develops two parallel versions of the same scale and administers both forms to the same group. Correlation between the two versions is then computed to obtain an estimate of reliability.

(c) Internal consistency is another commonly used technique to assess instruments and scale reliability. Internal consistency determines whether each scale is measuring a single concept and hence the items contained in the scale are internally consistent. Internal reliability can be measured statistically by two procedures. First, Cronbach's coefficient, alpha, is the most frequently used measure of reliability. This coefficient is named after the 20th-century psychometrician who first reported it in 1951. It measures the internal consistency and homogeneity of a group of items combined to form a single scale (Litwin, 1995). Alpha varies between zero and one and the nearer the result is to one-preferably at or over 0.8 – the more reliable is the scale (Bryman and Cramer, 1997; p. 63)[6]. Secondly, a split-half reliability test is used. Here, the items in a scale are divided into two groups (on an odd-even basis) and the correlation between the respondent's scores for the two halves is computed. The rule of thumb is that the resulting coefficient should be 0.8 or above. Some authors argue that a

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[6] A 0.70 alpha is an acceptable level that indicates the items in the scale are "tightly connected" (Nachmias and Nachmias, 1996, p. 467).

coefficient above 0.6 is acceptable for exploratory research, although values over 0.7 are preferred (Bagozzi, 1994). Borg (1981; pp. 218 - 219) states that correlations below 0.35 show only very slight relationship between variables and have limited meaning in exploratory relationship, whereas a correlation within the range 0.35 and 0.65 shows a strong enough relationship between variables and is statistically significant beyond the 1 percent level[7]. The above points were taken into consideration, and any item with a correlation of less than 0.35 was omitted from the scale.

6.8.1 Internal reliability test for the main study

The researcher implemented six scales in the present study to collect the necessary data. It is important to note here that the five scales adapted for this study were tested for standard reliability by their developer. For instance, Salim (1996) used Cronbach's alpha; the results for Awareness about Resource Status, Awareness about Overfishing, Awareness about the Consequences of Overfishing and Awareness about the Externalities Problems were 0.92, 0.86, 0.85, and 0.84 respectively.

1. Awareness of resource status

The researcher tested the reliability analysis for all scales used in this study by using Cronbach's alpha (Appendix 7). As seen in Table 6.11 Cronbach's alpha for the Fishermen's Awareness of Resource Status scale is 0.76. This is above the 0.70 level and only just short of the 0.8 criterion and would be regarded as internally reliable for the purpose of this study. Inter item total correlation for this scale range from 0.37 to 0.69 and therefore, all items were retained in the scale.

Table 6.11 Perception of Resources Status (N=194)

No	The items	Item total correlation	Alpha if item deleted
E19	Your fish catch per trip declines	0.65	0.70
E20	Your target species is difficult to catch	0.69	0.68
E21	The large fish are difficult to find or catch	0.53	0.71
E22	We need to spend longer hours looking for fish then we used to	0.63	0.67
E23	The percentage of trash fish in your daily catch has increased.	0.37	0.82

[7] Litwin (1995) reported similar figures where he stated that correlation within the range between 0.25 and 0.55 have a strong relationship between variables.

It can be seen from Table 6.11 that if item E23 is removed, scale reliability or Cronbach's alpha is improved from 0.76 to 0.82. However, the item was retained in the scale as it measures an important dimension of resource status that was not covered by other items. In addition, the calculated alpha (0.76) for the scale was sufficient to carry out further analysis.

2. Perception towards the causes of overfishing

The alpha coefficient for the six items in the Perception towards the Causes of Overfishing scale was 0.76 and the item total correlation ranged between 0.31 to 0.60. Cronbach's alpha is almost 0.8 and all items have total correlation above 0.35 except item F28. The researcher decided to retain this item on two grounds. First, the item reflects an important aspect of the cause of overfishing, so it is preferable to have this item within the scale. Secondly, removing this item will not result in a significant improvement in the overall scale reliability as can be seen in Table 6.12 (SPSS outputs are shown in Appendix 7); If the item is deleted the alpha for the scale is 0.76, which is similar to the scale overall reliability coefficient.

Table 6.12 Perception Towards the Causes of Overfishing

No	The items	Item total correlation	Alpha if item deleted
F24	Fish resources decline if too many vessels are operating in the same area	0.51	0.72
F25	Fish resources decline if all vessel are large in size	0.60	0.70
F26	Fish resources decline if all vessels use high horse-powered engines	0.53	0.71
F27	Fish resources decline if all vessels employ large no. of nets	0.47	0.73
F28	Fish resources decline if fishermen use encircling gear	0.30	0.76
F29	Fish resources decline if fishermen increase their fishing time per trip	0.57	0.70

3. Awareness of the consequence of overfishing

This scale contains six items and their Cronbach's alpha was 0.79, highly reliable for most purposes. Item total correlations ranged between 0.50 to 0.68, well above Borge's (1981) 0.35 criterion, and therefore were retained in the scale (see Table 6.13).

Table 6.13 The Consequences of Overfishing (N=194)

No	The items	Item total correlation	Alpha if item deleted
G30	Your fishing area becomes further away from your village	0.60	0.75
G31	Your fishing hours become longer	0.50	0.77
G32	Your fuel consumption increases	0.56	0.75
G33	Many fishing areas are barren	0.68	0.72
G34	You have to use more fishing gears to catch fish	0.55	0.76
G35	Your income declines	0.51	0.77

4. Externality problems in coastal fishery

Cronbach's alpha for the five items scale was 0.77, which indicates that the scale has high internal consistency. Inter-item total correlation ranges from 0.38 to 0.73 and therefore the scale is adequately reliable and homogenous to measure externalities in the coastal fishery (Table 6.14).

Table 6.14 Externalities in Coastal Fisheries (N=194)

No	The items	Item total correlation	Alpha if item deleted
H36	You may face some difficulty in fishing if too many vessels operate in a small area	0.61	0.71
H37	Net entanglement problems often occur if too many vessels operate in the same area	0.73	0.66
H38	You cannot fish in the area where many colleagues are fishing	0.59	0.73
H39	Less catch is expected if you operate in the area which has just been fished by many colleagues	0.53	0.74
H40	Conflicts among fishermen at sea are rising	0.38	0.79

5. Benefits from collective conservation activities

The alpha coefficient for the four items in this scale was 0.29, which indicate that the scale has low internal consistency. Item total correlation ranged between 0.04 to 0.22 and therefore the scale is not reliable. Because Cronbach's alpha was very low and all items have total correlation below 0.35, the researcher decided to remove the scale from further analysis (see section E in Appendix 7).

6. Willingness to cooperate

This index was developed by the researcher to measure fishermen's willingness to cooperate to conserve their resource. The index contains 12 items each measuring a dimension of the concept. The alpha coefficient for the 12 items is 0.76 and the inter-item correlation ranges from - 0.01 to 0.65 (Table 6.15). Item N99 has an inter-item correlation lower than 0.35 and therefore it was removed from the index when testing hypotheses. When this item was removed, the alpha coefficient have increased from 0.76 to 0.80.

Table 6.15 Willingness to Cooperate

No	The items	Item total correlation	Alpha if item deleted
N88	You return under-sized fish into the sea when caught in your net	0.55	0.74
N89	Set your nets at a distance from other fishermen gears	0.52	0.74
N90	Inform on colleague who break the fishing rules	0.53	0.73
N91	Attend workshops arranged by the Ministry of Agriculture and Fisheries	0.24	0.77
N92	Renew your fishing licence and vessel licence	0.13	0.78
N93	Speak to the head of the tribe about the problem of your fishery	0.65	0.72
N94	Discuss fishing problems frequently with more than one fisherman	0.53	0.74
N95	Participate in a group to resolve conflicts in fishing	0.48	0.74
N96	Persuade others to follow fishing rules	0.43	0.74
N97	Visit the Governor's office to raise a case against rules violators	0.49	0.74
N98	Oppose catching sardine with purse seine nets	0.57	0.73
N99	Participated in reef construction in your village	-0.01	0.80

6.9 Implementation of the Questionnaires

During the first stage of this study, the researcher started by preparing the sampling frame and meeting officials at the Ministry of Agriculture and Fisheries to gather basic information about the study area. Field officers from the Extension Department in the Ministry stated that "*based on their experience, fishermen in the* *study area show no interest in previous studies conducted by the Ministry and they are less cooperative with them compared with fishermen from other regions"*. On the contrary, the researcher found that fishermen in the study area were very supportive of his study and showed a high level of willingness to participate in the survey This can be attributed to the approach used by the researcher before he commenced the actual survey.

Prior to the start of the actual survey, the researcher visited all fishing villages and had informal talks with some fishermen explaining to them his objectives and the importance of his study to their fishery. Official letters from Sultan Qaboos University (the researcher's employer) were sent to Wali's Office in the three towns chosen for this study to facilitate the work of the researcher. The Walis in their turn were very supportive and, therefore, wrote to the heads of the tribes to inform fishermen in their villages about this research (Appendix 6). All this contributed to raise fishermen's awareness of the importance of this study, which was essential for the success of this work.

The researcher himself carried out all interviews. The process was conducted on a face to face basis and normally took place either in the fishermen's houses or on the beach while they prepared their nets and vessel for the next fishing trip. Field visits started early in the morning at 8.00 a.m. and extended until 5.00 p.m. Fishermen are normally available after nine o'clock in the morning after they have returned from the fishing trip and selling of their catch in the market. Interviews were carried out between 9.00 a.m. and 1.00 p.m. and again between 3.30 p.m. and 5.00 p.m. Because of the hot weather in Oman it was not possible to interview fishermen between 1.00 p.m. and 3.30 p.m. as they go to pray, have their lunch and rest until 3.30 in the afternoon when they come again to the beach to prepare their fishing gear. Most fishermen in the target sample were located and sometimes the researcher had to visit the same village several times to interview a fisherman who was not available on the first visit. When a respondent was reported to be out of the village, had sold his vessel and had quit fishing or moved to another village, another fisherman was selected randomly.

Field work began on the 15th of March 1998 in Masn'a and finished on the 15th of May 1998 in Barka. A total of 194 fishermen were interviewed in 53 days and a very high response rate (97 %) was achieved.

6.10 Statistical Analysis of the Data

All fishermen responses for each question were processed and analysed by using the Statistical Package for Social Science (SPSS). Due to the type of instruments used (different kinds of questionnaires and the data collected are nominal, ordinal and interval), the researcher decided to employ both parametric and non-parametric statistical tests. Each type has its own advantages and disadvantages. For example, the non-parametric tests do not specify conditions about the parameters of the population from which the sample was drawn (Norusis, 1991 and Bryman and Cramer, 1997). What this means is that the test requires very limited assumptions about the distribution of the data (the tests do not assume that the data is normally distributed). However, these tests have been criticized based on the ground that they are not as powerful as their parametric counterparts (Hubert and Blalook, 1979; Bryman and Cramer, 1997 and Wonnacott and Wonnacott, 1990).

Parametric tests are more powerful tools in statistical analysis. Although the prerequisite for these tests is that the population from which the parameters are obtained is normally distributed, many researcher argue that it is almost impossible to find data that are exactly normally distributed; thus, approximation to normality is sufficient for such tests (Bryman and Cramer, 1997 and Norusis, 1991). Based on this criterion, for variables which did not satisfy the normality criterion, non-parametric tests were employed, whereas for those variables which are proved to be normally or approximately normally distributed, parametric tests were used.

6.10.1 Parametric tests

Among the parametric tests used, the researcher employed the following:

(a) Pearson's Product-Moment Correlation Coefficient

This test is often termed Pearson's r, which is the most common measure of correlation when the variables are measured in the interval or in the ratio scale. Correlation entails the provision of a yardstick whereby the intensity or strength of a relationship can be gauged (Bryman and Cramer, 1997; p. 172). Whether high scores on one variable tend to be found with high scores on an other variable, low scores with low scores and so on is assessed.

Pearson's r allows the strength and direction of liner relationships between variables to be gauged. The value for Pearson's r varies between -1 and +1. A relationship of -1 or +1 would indicate a perfect relationship, negative or positive respectively, whereas a value of zero indicates no relationship. The closer the value of r is to 1 (+ or -), the stronger the relationship between the two variables.

(b) The t-test

This test is used to determine if the means of two groups differ statistically. The t-test is calculated by comparing the difference between the two means with the standard error of the difference in the means of the different groups (Bryman and Cramer, 1997; p. 142). If the difference in the means of the two groups is close to zero, it is more likely that this difference is due to chance. To reject a null hypothesis, it is important to calculate the degree of freedom (df.) which is the number of subjects or respondents (N-1). If the calculated value of t is large than or equal to a critical value (in the t-distribution table) at the significant level of less than 0.05[8] (P-value is less or equal to 0.05), the null hypothesis can be rejected at that particular significant level[9] and degree of freedom.

(c) One-way analysis of variance

To compare the means of three or more groups, such as the mean fishermen's willingness to cooperate of the three fishermen groups (in the three towns selected in this study), it is necessary to compute a one-way analysis of variance. The test is often termed an F-test, in which an estimate of the between-groups variance (or mean square) is compared with an estimate of the within-groups variance (or mean square) by dividing the former by the latter (Bryman and Cramer, 1997; p. 146). The total amount of variance in the dependent variable (i.e., fishermen's willingness to cooperate) is often due to the independent variable (i.e., difference in attitude of the three fishermen

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[8] Significance levels commonly used in statistical research are the 0 05, 0 01 and 0 001 levels, though the usage of the 0.05 level is the most common (Hubert and Blalock, 1979; p *161*).

[9] The level of significance has nothing to do with the size or importance of a difference It is simply concerned with the probability of that difference arising by chance For example, if the level of significance is set at 0.05, it would be expected that the probability of that difference arising by chance is five times out of a hundred (i e, five times for every hundred times the same sample is collected from the same population).

groups) and that which is due to other factors. The variance that is due to the independent factors is referred to as explained variance, whereas the variance that is caused by other factors is described as error or residual variance. If the explained variance (between-groups) is considerably larger than the error or (residual) variance (within groups), then the F-ratio will be higher, which implies that the difference between the means is unlikely to be due to chance.

(d) Regression analysis

Regression analysis, in the form of multiple regression, is regarded as the most widely used and powerful tools for summarizing the relationship between variables and for prediction of the dependent variable (Bryman and Cramer, 1997; p. 256). In the computation of the multiple-regression equation, the researcher employed a procedure called *stepwise* to decide the sequence of the entry of variables into the equation. The *stepwise* selection of independent variables is the most commonly used method in testing regression (Norusis, 1993; p. 350, Bryman and Cramer, 1997; p. 267). It is a combination of forward and backward selection.

6.10.2 Non-parametric tests

From the variety of non-parametric tests available, the researcher decided to use the chi-square test. The chi-square test is widely used in conjunction with contingency tables (crosstabulation) which contains a cell for each combination of categories of the two variables[10]. It is used to test statistical significance, meaning that it allows the researcher to ascertain the probability that the observed relationship between the two variables may have arisen by chance. The test is calculated by comparing the observed frequencies in each cell in a contingency table with those that would occur if there was no relationship between the two variables (Bryman and Cramer, 1997; p. 168).

6.11 Conclusion

This chapter has explained the methods used to carry out the empirical survey to assess the collective choices of fishermen in South Al-Batinah, Oman. A triangulation method was employed to collect both qualitative and quantitative data. The data

[10] The test is used with ordinal and nominal scales.

gathered in the survey through different collection techniques provide more accurate testing of the assumption and hypotheses made by this study and to describe several dimensions of fishermen behaviour. The main survey instrument was a questionnaire, designed to provide quantitative data. The questionnaire was supplemented by qualitative data derived from interviews with key informants and observation of the daily activities of the target population. The interview and observations were useful in understanding the actual field situation and the issues that were not covered by the main survey instrument. The three methods, therefore, offer different types of data, which fit well together. In this case the researcher has more confidence concerning his conclusions than he would have if he had employed a single method.

The respondents included in this study were selected by a proportional stratified random sampling method. Beside its greater degree of representation and decreases the probable sampling error, the sampling technique selected minimize time and cost.

Before ending this chapter it is important to explain at this stage that all testing of hypotheses carried out in the following chapters was conducted at 0.05 level of significance. The t-test has been interpreted on the two-tailed test.

In the next chapters, the researcher will present the findings derived from these data. First, Chapter Seven presents the results of the socio-economic condition of the respondents.

CHAPTER SEVEN

A SOCIAL, ECONOMIC AND DEMOGRAPHIC PROFILE OF THE TRADITIONAL FISHERMEN IN SOUTH AL-BATINAH

7.1 Introduction

In this chapter, the results of the data collected to describe the study population, namely fishing vessel owners in South Al-Batinah (Barka, Masn'a and Suwaiq), are presented. Among the socioeconomic aspects of the vessel owners considered are their demographic attributes, income, assets and liabilities. A comparison is made, wherever possible, of their standard of living with that of other socioeconomic groups in the country. The figures presented in this chapter are based on a cross-sectional study carried out in the study area between February and May 1998 and therefore reflect the socioeconomic conditions of those included in the sample at the time of survey. The chapter aims to give a general picture of the structure, standard of living and other activities of fishermen in coastal fishing villages in South Al-Batinah.

The results presented in this chapter are very important when trying to assess the collective behaviour of traditional fishermen in coastal fisheries as they describe the different characteristics of the study population. Fishermen in Al-Batinah are living in fishing communities or villages within each town scattered along the coast. The collective behaviour in each town, therefore, can be assessed separately because each town forms a group where its members are interacting with each other more than with people from other towns. In terms of the number of vessel owners in each village, the size of some of these towns is relatively small while others are large. This could be analogous to Olson's (1965) terminology of group size in which he differentiates between small "privileged" groups and intermediate and large groups. Olson (1965), for example, predicts that the provision of the public good depends on group size (the smaller the group, the more it will succeed in providing public goods), so it might be thought, if Olson's hypothesis is correct, that collective action is more successful in smaller towns. Failure in the provision of public goods is also attributed to group heterogeneity (Olson, 1965; Baland and Platteau, 1996 and Libecap, 1994). These differences plus many others were seen in the present research project to create conflicting interests among fishermen relative to changes in the current situation.

Therefore, a description of the vessel owners' characteristics is presented in the following sections. The results obtained here are used for hypotheses testing in the following chapters.

7.2 General Profile

Oman can be described as a one-race, one-religion country. The 1993 General Census results of the population in Oman revealed that there is a negligible percentage of non-Muslim Omanis (Ministry of Development, 1993). As expected, the study population can be described as Muslim with an Arab origin. They speak a common language, Arabic, by means of which good communication between all resource users in the study area is guaranteed. Race, religion and language are commonly cited as factors that may promote or impede collective action (Baland and Platteau, 1996). In cases where resource users have a common language, common religion and originate from the same race, the chances of promoting collective action might be reasonably high. Therefore, it can be inferred here that religion, race and language cannot be considered as obstacles to collective action in the study area.

The role of religion in shaping people's behaviour is vital. Muslims perform five prayers per day and are asked to conduct their prayers in the Mosque (if possible). While in the field, the researcher observed that fishermen from the same village meet regularly in the Mosque and discuss various aspects of daily life after they have finished their prayer. One of the group discussions that the researcher held with fishermen was in the Mosque after a prayer[1]. The place was chosen because most of people in that village attend the prayer. The Mosque is therefore, a common place for each group of fishermen to meet regularly and such meetings are normally considered to facilitate the emergence of collective action. As described by Berkes (1986), the emergence of collective action started from a coffee shop in Alanya (Turkey) where fishermen meet regularly. For the present study, the Mosque can play the same basic role as the coffee shop and may witness the emergence of collective action to solve common problems. In such cases the cost of organising collective action would become relatively low.

To model the collective behaviour of the fishermen in the study area using a game theory approach it can be seen that the two-core parable of the Prisoners' Dilemma game does not hold (communication is forbidden and no future interaction). In

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[1] The group discussion was held on March 15th, 1998.

contrast to the Prisoners' Dilemma game, when examining this fishery, the simple PD model does not exactly capture individual rational action because the vessel owners jointly using common fishing grounds interact among themselves. They play a game repeatedly and non-anonymously, features which rule out the simple PD model as an appropriate description.

7.3 Respondents' Age

The fishermen's average age was 44.40 years, the oldest being 70 years and the youngest being 20 years. Table 7.1 shows age categories of the sampled vessel owners in South Al-Batinah. The largest age group is the older one (41-55 years), accounting for 64 percent of the total vessel owners, followed by the middle age group (26-40 years) which accounts for another 24 percent. When these two age groups are combined together they account for 88 percent of the total vessel owners. The youngest age group (less than 26 years) accounts for only 4.6 % of the total vessel owners. The results indicate that there is little variation in age structure between locations: fewer vessel owners under 40 years old are found in Suwaiq (21.9 %) compared to corresponding values in Barka (31.2 %) and in Masn'a (35 %). An earlier study found that the mean age of fishermen in the study area in 1979 was 35 years (Pollnac *et al.*, 1984; p. 5).

Table 7.1 Fishermen's Age in Years by Town (N = 194)

Age category (years)	Barka (n = 61)	Masn'a (n = 60)	Suwaiq (n=73)	All sample (N = 194)
Less than 25	6.6 %	3.3 %	4.1 %	4.6 %
26 - 40	24.6 %	31.7 %	17.8 %	24 %
41 - 55	65.6 %	58.3 %	68.5 %	64.4 %
more than 55	3.3 %	6.7 %	9.6 %	6.7 %
Mean	43.4	43.9	45.7	44.4
Std. Deviation	8.4	8.3	9.35	8.77

7.4 Education

Among the demographic variables that may have an important influence on the success or failure of collective action is educational attainment. Due to the long-run nature of productivity benefits from resource conservation, long planning horizons are expected to influence positively the individual's decision to participate in managing shared resources (Kalaitzandonakes and Monson, 1994; p. 202). Therefore, fishermen with higher educational attainments are expected to devote greater participation to conserve their fish resources. This is because higher education is associated with greater information on the productivity implication of overfishing and the benefits of various collective conservation efforts.

The educational attainment of the sampled fishermen is grouped into three levels according to the education system in Oman: elementary (six years), preparatory or lower secondary (three years) and secondary (three years) (Table 7.2). The results indicate that none of the sampled fishermen have education beyond the secondary level. Further, the results indicate a very low level of educational attainment. The mean education level is 1.10 years with a standard deviation of 2.58 years. From Table 7.2, it can be observed that the majority of the respondents (79 %) are virtually illiterate, whereas 13.4 percent are reported to have some form of elementary education, i.e., they have achieved between one to six years of elementary education[2]. Fishermen who have no formal education but have writing and reading abilities, which are gained by studying in the "Ko'ranic schools"[3], are regarded for the purpose of this study as having one year of formal education and are grouped under elementary education.

Table 7.2 Educational Attainment of Fishermen (N=194)

Education attainment (years)	Barka	Masn'a	Suwaiq	All sample
Illiterate	73.8 %	81.7 %	82.2 %	79.4 %
1 - 6	18 %	10 %	12.3 %	13.4 %
7 - 9	6.6 %	8.3 %	4.1 %	6.2 %
10 - 12	1.6 %	0 %	1.4 %	1 %
Mean	1.34	1.08	0.90	1.10
Std. Deviation	2.91	2.52	2.34	2.58

Variations in educational attainment by location can be noticed from Table 7.2 where the level of illiteracy is higher in Suwaiq (82 %) and Masn'a (82 %) as compared to its corresponding value in Barka (74 %). To compare the educational attainment of

[2] In Oman 29 percent of the male population aged 15 years and over are illiterate based on the 1993 General Census of the population (Ministry of Development, 1993).

[3] Ko'ranic schools are schools where the Koran (the sacred book of Islam) is taught. These schools teach how to read the Holy Book. Writing skills are taught as well. They were abundant before the start of formal education in 1970.

the respondents from the three towns, one-way analysis of variance was used (Table 7.3). From Table 7.3, it can be seen that these differences are not statistically significant at the 0.05 significance level. The F-ratio (the between-group mean divided by the within-groups mean (3.22 / 6.70 = 0.482)), is very small; thus, it is not significant (Table 7.3). Consequently, there is no statistically significant difference in educational attainment between respondents from the three towns as the P-value for the F test was greater than 0.05, although fishermen in Barka have slightly higher education (mean = 1.34 year) compared to those in Suwaiq (mean = 0.9 years) and Masn'a (mean = 1.08 years).

Table 7.3 A One-way Analysis of Variance of Educational Attainment Across Towns (N=194)

	DF	Sum of Squares	Mean Square	F-ratio
Between groups	2	6.46	3.22	
Within groups	191	1278.68	6.70	0.482; P > 0.05
Total	193	1285.14		

The very low level of education in the study area may be attributed to two factors. First, the relatively older aged group (41-55 years) is expected to have lower mean education level because its members missed the chance to enter schools as the formal education in the country was first started in 1970. This was confirmed when education attainment was crosstabulated with respondent's age[4] (see Table 7.4). The results indicate that 94 respondents (61 %) of the illiterate fishermen are over 44.4 years old compared to 60 respondents (39 %) who are below that age, which confirmed our predication that they might have missed their chance of getting into schools. The result of the Chi-Square test indicates that the difference is statistically significant at the 0.001 level as shown in Table 7.4; thus, there is a statistically significant difference between the two age groups with regards to their education level.

[4] The sample was divided into two groups so that two age groups are formed, one below the mean (age mean is 44.4 years) and the other above the mean.

Table 7.4 Education Levels Crosstabulated with Age Groups (N=194)

Age	Literate *		Total *
	Yes	No	
Below mean	33 (83)	60 (39)	93 (48)
Above mean	7 (17)	94 (61)	101 (52)
Total	40	154	194
Chi-Square	Value	DF	Significance
Pearson	24.11	1	0.000

*** Figures in parentheses are column percentages**

Second, fishermen leave school at less than 13 years old because they might be asked to do so by their parents to work as fishermen to provide another source of income for the family. A respondent told the researcher that two of his sons left school at the age of 12 years and 15 years respectively, and work as crew with him to help him to support the family.

There are two implications for the present study from the above statistics. First, owing to the low educational attainment of fishermen, employment opportunities outside the fisheries sector are reduced. Even in cases where fishermen might have occupations outside the fishing sector, these works are likely to be non-skilled, thus generating a very low income which makes them still economically dependent on fishing. Economic dependence on the resource can promote the emergence of collective action because the users consider their resource as generating an important source of income to support their families. The second implication concerns fisheries extension and training programmes in fishing communities. The low level of literacy implies that extension and training programmes need to be specially designed for communities.

7.5 Household size

Another demographic variable included in this study was household size. The results indicate that the average household size in the study area is relatively large. The average household size in the study area is 12.4 members with a standard deviation of 4.90 members. The average household size in the study area is higher than the average national family size of eight members[5]. The minimum size was found to be two members and the maximum was 30 members. Family size includes the respondent

[5] Average household in Oman is 8 members (Ministry of Development, 1993).

himself, his wife and children, parents and sometimes his brothers sharing the same house and meals. The Omani family is typically an extended family, and is not confined to parents and children only, but includes many branches and sub-branches which reflects a high degree of social cohesion (Ministry of Development, 1993; p. 64). Field observation indicates that large family size occurs because in some cases three or four brothers each have their own family sharing the house they have inherited from their parents. It is common to see a fisherman with more than ten sons and daughters living in the same house. Table 7.5 shows the percentage of vessel owners falling under each of the four household size categories: small household (less than 4 members), medium (5 to 9 members), large (between 10 to 14 members) and very large (more than 14 members). The results indicated that only 30.9 percent of the total fishermen interviewed have less than nine members in their house. Around 39 percent of all respondent's household is large-sized with 10 to 14 members. The second largest group is "very large" (29.9 %) with more than 14 members sharing the same house. There is a slight variation among the three towns. Around 77 percent of the respondent's household have more than nine members in Suwaiq; lower average figures are found in Masn'a (68 %) and in Barka (70 %).

Table 7.5 Household Size by Town (N=194)[6]

Size category	Barka	Masn'a	Suwaiq	All sample
Small (1-4)	1.6 %	8.3 %	0 %	3.1 %
Medium (5-9)	27.9 %	23.3 %	23.3 %	27.8 %
Large (10-14)	39.3 %	38.3 %	39.7 %	39.2 %
Very large (more than 14)	31.2 %	30.1 %	37.0 %	29.9 %
Mean (members)	12.4	11.9	12.8	12.4
Std. Deviation	4.5	4.9	5.2	4.90

With such large families, one would expect to see large numbers of working members per family. On the contrary, the results indicate that the average number of working members per family is 0.75 members[7] and the standard deviation is 0.84. This indicates that there is high economic dependency on the fish resources. The figure represents only those working in the public or private sectors. Other family members working as fishermen are not included as the figure includes only those who have a permanent jobs. When the working members are expressed as a percentage of the

[6] Includes the vessel owner.
[7] Excludes the vessel owner.

household size, it is found that the average number of working members as a percentage of family size is 6.3 percent. Table 7.6 shows working members as a percentage of family size by categories. The results indicate that there are 87 households (45 % of the total sample) dependent on the household head only. Families having between one and ten percent of their members occupying permanent jobs represent around 32.5 percent of the total vessel owners sampled. The third category (11 to 20 percent of the family members having permanent jobs) represents 19 percent of the sample. The average members with permanent jobs as a percentage of family size for the three towns Barka, Masn'a and Suwaiq are 6 percent, 7 percent and 5.9 percent respectively.

The results show that few members of the family have permanent jobs. This could be attributed to the lack of employment opportunities in these communities or to low literacy levels. It is clear that the household head (the vessel owner) provides a large proportion of the fishing household's income which makes him highly dependent on fish resources to earn his income, which might influence his willingness to cooperate.

Table 7.6 Members with Permanent Job as a Percentage of Family Size (N= 194)

Category	Frequency	Percentage
No working members	87	44.8
1 to 10 %	63	32.5
11 to 20 %	37	19.1
More than 20 %	7	3.6
Total	194	100

7.6 Occupational Structure

Fishermen were asked if they had other occupations besides fishing. The results of the analysis of the occupation structure crosstabulated with towns can be found in Table 7.7. It is clearly shown in Table 7.7 that vessel owners in the study area undertake supplementary occupations concurrently with fishing. Fishermen are undertaking fishing-related occupations such as fish trading as well as unrelated occupations to fishing such as working on agricultural gardens and working in Government offices. These supplementary occupations help to diversify the fishermen's income away from the highly uncertain and seasonal fishing operations. The percentage of vessel owners engaged in supplementary occupation is related to their need for such supplements, the profitability of fishing and the availability of employment opportunities in their communities or the surroundings area.

Table 7.7 Distribution of Vessel Owners by Occupation, South Al-Batinah (N=91)[8]

Occupation	Barka	Masn'a	Suwaiq	All sample
Farming	9 (25.7)	5 (22.8)	20 (58.8)	34 (37.4)
Government	25 (71.4)	16 (72.7)	7 (20.6)	48 (52.7)
Other jobs	1 (2.9)	1 (4.5)	7 (20.6)	9 (9.9)
Total	35	22	34	91

*** Figures in parentheses are column percentages**

When these supplementary occupations are subdivided into gardening, government jobs and other jobs (Table 7.7), it was found that 47 percent of the sampled vessel owners are occupational pluralists, that is, they combine fishing and other occupations to make their living, whereas 53 percent are pure owner-operators of fishing units. The most common combination of employment is fishing with non-fishing activities rather than with fishing related activities such as fish trading. Government jobs attracted 52.7 percent of the sampled vessel owners who have other occupations, whereas 37.4 percent combine fishing and gardening. Under the other jobs category, which accounts for only 9.9 percent of those who combine fishing and other occupations, small businesses, taxi drivers, fish traders and other activities are grouped together. The highest percentage of "pure" fishing vessel operators among vessel owners was found in Masn'a (63.3 %) and the lowest was found in Barka (42.6 %), with Suwaiq falling somewhere between these two.

Most of the fishermen who own gardens are actually keeping palm tree gardens to produce dates. In the coastal region of South Al-Batinah large farmed area have experienced salt-water intrusion into depleted aquifers since the early 1980s (incidentally, another example of a collective failure). Saline water has made irrigation impossible in many areas, with farmers' incomes falling rapidly in recent years. What

[8] Some boat owners combined fishing with more than one non-fishing occupation. For example, some fishermen combined fishing, farming and government job.

remain of these gardens are usually palm trees which are either insufficient or just sufficient to meet the household's needs. In the semi-structured interview a respondent stated that in most cases, little or no produce is left over for sale and, in general, garden-owning fishermen do not see gardens as equally important to fishing in terms of generating cash income. Another respondent stated that fishermen keep these farms as a security pledged for the repayment of loans (collateral). Farming seems to be less important in Barka (25.7 %) and Masn'a (22.8 %), whereas in Suwaiq 58.8 percent of those who have other occupations besides fishing are engaged in farming. As mentioned above, government jobs seem to attract a higher percentage of fishermen because these jobs provide secure and sustainable sources of income for the household.

Based on the above discussion and due to the salinity problem that affects farm production in the study area, it can be assumed that among the total number of respondents, only 29 percent have jobs that provide secure and sustainable sources of income. Therefore, it can be concluded that the majority of the fishermen (71 percent) included in this study are economically dependent on incomes derived from fishing.

Variation in the number of vessel owners working in government offices across the three towns may reflect the variations in employment opportunities among the three towns. For example, among those who reported having another occupation besides fishing, 71.4 percent of the surveyed vessel owners in Barka work in government offices whereas the corresponding figure in Masn'a and Suwaiq are 72.7 percent and 20.6 percent respectively (see Table 7.7). The geographical location of the three towns along the coast, especially their distance from Muscat (the country's capital) where most government offices are situated, and industrial activities and other businesses are located, accounts for the variation in employment opportunities outside the fisheries sector. Barka is the nearest town to the capital followed by Masn'a and then Suwaiq. The lower percentage of the vessel owners (20.6 %) in Suwaiq working in government offices can be attributed to its distance from the capital, Muscat (Table 7.7).

In an attempt to determine the characteristics of vessel owners who have other occupations besides fishing, other occupations were crosstabulated with age[9] and education level. To test the significance of the difference between these variables, a Chi-Square test was used. Table 7.8 indicates that younger fishermen (57 %) are more

[9] The sample was divided into two groups so that two age groups are formed, one below the mean (age mean is 44.4 years) and the other above the mean.

likely to have other occupations than older fishermen (38 %). The results obtained from the Chi-Square indicated that the difference between these two groups is statistically significant at the 0.05 level. This suggests that younger fishermen have better chances to be employed in non-fishing sectors than older fishermen.

Table 7.8 Age Crosstabulated with Other Occupation (N=194)

Age	Other occupation		Total
	Yes	No	
Below mean	53 (57)	40 (43)	93
Above mean	38 (38)	63 (62)	101
Total	91	103	194

Chi-Square	Value	DF	Significance
Pearson	7.29	1	0.007

*** Figures in parentheses are row percentages**

Other occupations were then crosstabulated with education level. Table 7.9 demonstrates that 65 percent of the literate respondents have other occupations as compared to 42 percent of the illiterate respondents. On the other hand, the difference is statistically significant at the 0.05 level as well since the p-value of the test is less than the 0.05 significance level.

Table 7.9 Literacy Crosstabulated with other Occupation

literate	Other occupation		Total
	Yes	No	
Yes	26 (65)	14 (35)	40
No	65 (42)	89 (58)	154
Total	91 (47)	103 (53)	194

Chi-Square	Value	DF	Significance
Pearson	6.62	1	0.01

*** Figures in parentheses are row percentages**

Differences in age and literacy status were also tested against government jobs- the highest frequency source of other occupations (Table 7.10). The Chi-Square test results indicate that there is a statistically significant relationship between age and working in government offices. Younger vessel owners are more likely to have a government job than older fishermen. The difference was statistically significant at the 0.05 level (P-value < 0.05). When government jobs was tested against education level, it was found that respondents with better education are likely to be engaged in government jobs beside their fishing occupation. The result of the Chi-Square test shows that the difference was statistically significant at the 0.05 significance level (Table 7.10). It can be concluded here that government jobs available for these groups are likely to attract younger and educated respondents. As indicated by the findings of this study, the largest age group is the older one (41-55 years) accounting for 64 percent of the total vessel owners. Thus, it can be concluded here that owing to their age and low educational attainment, the majority of the respondents have a high economic dependence on their fishery.

Table 7.10 Results of the Chi-Square Test Between Working in Government and Respondents Age and Literacy Level

	Chi-Square	Value	DF	Significance
Age	Pearson	17.12	1	0.000
Literacy level	Pearson	10.40	1	0.001

Fishermen in South Al-Batinah noted that employment opportunities are difficult for them and their family members at present. When they were asked how easy it is to find another job, 122 respondents answered this question; the remaining 72 respondents reported that they have another occupation besides fishing[10]. The results in Table 7.11 show that out of the 122 respondents, 90 respondents (74 %) claimed that it is not easy to find another job at present, the remaining 32 respondents (26 %) reported that they are not sure about the difficulties of getting another job.

Table 7.11 Difficulties of Finding another Occupation (N= 194)

Questions	Yes	No	Not sure	Total sample
Is it easy to find another job	0	90	32	122
	0%	74%	26%	63%

Respondents were then asked why it is difficult to find another job. The answer to this question is found in Table 7.12. Around 53 percent stated that there is no work

[10] Even those who report gardening as a second occupation are in fact looking for other work, especially in Government offices, to secure their family income. The reason why 122 respondents answered this question is because this figure includes those who do not have a job plus those who have farming as a second occupation besides fishing but are looking for a more secure job.

available and 22 percent attributed these difficulties to their old age and stated that no one will hire them at this age. The remaining 25 percent noted that they are happy with their fishing occupation and have not searched for employment opportunities.

Table 7.12 Reasons for Difficulties in Finding another Occupation

	All sample	
Reasons	Frequency	%
1- No work available	64	53%
2- Age	27	22%
3- Did not look	31	25%
Total	122	100%

7.7 Crew Structure

In general, crew size varies according to vessel size–the larger the vessel, the larger the crew- and to the type of fishing operation. For example, a crew of two or three is common in the gill net fishery, five crew in the purse seine fishery and the number often reaches as large as 15 to 18 members in the beach seine fishery. During the fieldwork, a crew as large as 30 (men and women) was observed operating a beach seine.

Because the vessels used are relatively small, the mean crew size aboard these vessels is 1.86 fishermen (including the skipper) with a standard deviation of 0.63 fishermen. The majority of respondents (68 %) go fishing with one crew member only, whereas 47 respondents (24.3 %) go fishing alone, and 15 respondents (7.7 %) go fishing with more than one crew member. Crew members were frequently from the same family; father and son teams are very common; brothers and other family relations were also observed. If not close family, they are frequently neighbours and friends from the same village. As shown in Table 7.13, out of the total respondents interviewed, 111 respondents (57 %) recruit family members as crew, whereas 47 respondents (24 %) go fishing alone, and the remaining 36 respondents (19 %) hire crew other than family members.

Table 7.13 Crew Structure

Crew source	Frequency	Percentage
(a) Family member	111	57.2
(b) Go fishing alone	47	24.2
(c) Hired labour	36	18.6

The systems for dividing the return from fishing between the vessel owner and the crew are influenced by several factors, including the relationship between crew and owner, fishing type and the availability of crew in that village. For example, from the semi-structured interviews it was found that when the crew and owner are from the same household, the return from fishing is often pooled into the household. Sons of the owner who still live with him in the same house and work as crew in his vessel receive pocket money from their father and the proceeds go into the household. Looking at the results, it was found that fishing is mainly a family occupation. It was found that out of the 194 respondents included in the sample, only 36 vessel owners (19 %) employ crew other than their family members.

Crew wages are calculated by two different systems encountered in the study area. The most frequently encountered, after deducting the cash operating expenses, is for total daily sales to be divided into one equal share for each crew and the vessel (including fishing gear). For example, when one crew member works with the vessel owner, the crew receive one-third and two-thirds goes to the owner, made up of his share which is the labour cost plus the vessel share which is the return to capital investment. In the second system, after deducting operating cost and auction commission, the balance of the daily sales is divided into two equal shares; one part goes to the vessel and the other is divided equally among crew members. The owner receives one share as his labour wage from the crew share. In this case, if one crew member works with the owner, the crew receive one-quarter, and the owner receives three-quarters of the balance from total fish sales. The results indicated that out of the 55 respondents who reported sharing the catch with the crew, 64 percent use the first system, whereas 36 percent use the second system. The same system of calculating crew wages was also observed in use among fishermen in the A'Sharquiyah region (the eastern part of Oman) (Omezzine, Zaibet, and Al-Oufi, 1996).

As noted above, the system of dividing fish sales is influenced by the availability of labour in the community with fishing skills. This could explain the difference between the two systems. The second system seems to be encountered in cases where there are plenty of fishermen with no capital assets or limited access to capital, coupled with paucity of alternative employment opportunities outside the fishery.

The average annual income of crew fishermen in the study area was higher in Suwaiq (RO 845) followed by Masn'a (RO 762) and then Barka (RO 745). When crew wage is compared to the national minimum wage (RO 1440 per year[11]), it was found that crew fishermen in South Al-Batinah receive less than the national minimum wage. Crew fishermen were not included in this study to examine the way they supplemented their household total income. The decision making during the fishing operation lies in the hands of the vessel's operator, who in the case of the present study is the owner.

7.8 Fishing Income

Considering the occupational structure described above, a fishing household's income may be broken down into fishing and non-fishing income. Furthermore, the household's income may be broken down into income earned by the vessel owner himself and by other family members. Additional household income may be received in non-cash form by consuming part of his own catch or by non-cash payments to hired labour. A contribution from the system of welfare and/or reciprocity in the fishing villages may provide part of the household income especially in the more traditional communities. It was observed that some of the catch was given to those who approached the vessel and asked for some fish. Frequently, those who receive part of the catch are the poorest neighbours and fishermen who did not go fishing that day. Describing this reciprocal system, a respondent stated that he expects like treatment on days that he does not (or cannot) go fishing. Because non-cash payments and the contribution of the welfare system in these communities are difficult to quantify, this study concentrates on income derived in cash by the vessel owners and/or that provided by other members of the household.

[11] Ministerial Decree, Cited from, Oman Daily Newspaper No. 6241, July, 4th 1998.

Because incomes reported directly can be over–or under-estimated due to failure to subtract certain costs or because respondents expect more government subsidies[12], it would be ideal to compare the reported income in this study to net income obtained from previous studies. Accurate figures for fishing income was difficult to achieve as there are no previous studies concerned with analysing cost and earning of fishing in the study area nor is there a reliable source to depend on (a cooperative for example) to determine fishermen's daily income from fishing. Therefore, the estimation of annual income from fishing was based on the amount of money declared by the vessel owners. Indirect questions were used to avoid under-reporting of income by respondents. Total fishing income of individual vessel owners was estimated using gross revenues for each vessel (by type of gear) reported by the respondent during the fishing season. The respondent was asked about the average daily sale, number of days fishing per month and the number of months fishing per year (by type of gear). Taking each fishing gear operated by the respondent, gross revenue was, therefore, calculated by multiplying the average sale per day times the number of days fishing per months times the number of months fishing per year. Net income was obtained by deducting cash operating costs (fuel, oil, ice, food and auction commission) from gross revenue and the balance was finally aggregated to determine the annual net income of individual vessel owner Panayotou, 1984). Net income obtained in this manner is in fact composed of labour compensation, vessel and gear consumption (capital consumption) and fishing rent.

When vessel owner's income is examined, the statistics revealed that the average annual income from fishing in the study area is RO 1869 with a high standard deviation of RO 1338 (Table 7.15). The high standard deviation explains the high disparity of income distribution. From Table 7.15, it can be observed that annual income varies across the three towns. Individual fisherman in Suwaiq earns an average of RO 1982, higher than those in Masn'a (RO 1897) and Barka (RO 1707). It is interesting to examine whether there are differences in income among respondents from the three towns. A one-way analysis of variance is used to test the null hypothesis that there is no significant difference in income among fishermen from the three towns (Table 7.14).

[12] Under reporting of income due to the fear of taxation is unlikely as there is no income tax on individuals encountered in the country.

Table 7.14 A one-way Analysis of Variance of Income in the Three Towns (N=194)

	DF	Sum of Squares	Mean Square	F-ratio
Between groups	2	2556793	1278397	
Within groups	191	$3.4 * 10^8$	1804114	0.71; P > 0.05
Total	193	$3.5 * 10^8$		

From Table 7.14, it can be observed that the results failed to reject the null hypothesis (p-value > 0.05). Thus, the difference in respondent's income between the three towns is not statistically significant at the 0.05 significance level.

As shown in Table 7.15, income is grouped into low (0 to 1000), medium (1000 to 2000) and high (more than 2000). The results indicated that the majority (71.6 %) of the vessel owners in the study area fall in the medium and high income group which means that they receive incomes higher than the national minimum wage. Slight variation in income groups among the three towns can be observed from Table 7.15. For example, in Suwaiq the percentage of those having high earnings and those who have low earnings from fishing are greater than those who have medium earnings, whereas the opposite is found in Barka and Masn'a where the medium earner dominates the three income groups.

Table 7.15 Vessel Owner's Annual Income from Fishing by Town

Fishing income	Barka	Masn'a	Suwaiq	All sample
Low (Less than 1000)	15 (24.6)	16 (26.7)	24 (32.9)	55 (28.4)
Medium (1000 –2000)	28 (45.9)	24 (40)	17 (23.3)	69 (35.6)
High (more than 2000)	18 (29.5)	20 (33.3)	32 (43.8)	70 (36)
Total	**61**	**60**	**73**	**194**
Mean (RO)	1707	1897	1982	1869
Std. Deviation	1108	1352	1498	1338

*** Figures in parentheses are column percentages**

Although annual fishing income is higher than the minimum national wage, the figure does not account for capital consumption (vessel and gear depreciation and loan repayments).

Having obtained income from fishing, it is a matter of aggregating fishing income and non-fishing income to obtain total income (Table 7.16). When examining vessel owners' dependence on fishing it was found that income from fishing accounted for about 74 percent of the total income, while non-fishing income accounted for only 26 percent (Table 7.16). The dependence on fishing as a source of income is similar for Masn'a (81 %) and Suwaiq (80 %), but considerably lower for Barka (60 %). As mentioned earlier, vessel owners undertake supplementary occupations and the contribution to the total respondent income from these occupations ranges from around 20 percent in both Masn'a and Suwaiq to 40 percent in Barka (Table 7.16).

Table 7.16 Annual Average Net Income (RO) of Vessel Owners by Source, South Al-Batinah

	Owner		Total income
	Fishing	Non-fishing	
Barka	1707	1119	2826
% of total	60	40	100
Masn'a	1897	443	2340
% of total	81	19	100
Suwaiq	1982	483	2465
% of total	80	20	100
All sample	1869	670	2539
% of total	74	26	100

A number of hypotheses may be advanced to explain the differences in economic dependence on fishing between Masn'a and Suwaiq in one side and Barka on the other side. The first hypothesis is the time spent fishing. As mentioned earlier, among those who reported other occupations besides fishing, 71.4 percent of the vessel owners in Barka are engaged in government jobs. This means that they have less time for fishing and marketing of their catch as compared to those in Masn'a and Suwaiq. For example, Barka's fishermen rushing to their work in the early morning after they have returned from a fishing trip sell their catch to fish dealers or middlemen and have no alternatives but to agree with prices offered by the dealers. This can be confirmed by examining fishermen's choices of marketing channels. In Barka, where 71.4 percent of respondents who have other occupations are engaged in government jobs, 47.5 percent of them sold their catch to fish dealers because they could not wait for the auction. The corresponding figure for Masn'a was 15 percent only, and although in Suwaiq the figure was slightly lower than Barka (43.8 %), the figures have to be taken with caution as there is no auction in this town and therefore, the presence of middlemen is anticipated anyway.

Another hypothesis is the degree of competition in input markets. A positive relationship exists between income level and current value of fishing assets. The current value of fishing assets (hull, engine and gear) was obtained as an index of catching power in the study area. The average value of these assets per vessel owner for all respondents was RO 3224 with a standard deviation of RO 2051. The average value of fishing assets per owner was RO 3929 in Suwaiq compared with RO 2923 in Barka and RO 2674 in Masn'a (Table 7.17). More capital investment in Suwaiq may explain the higher income from fishing, especially if we consider that larger fishing vessels and high-powered engines mean more extensive fishing grounds.

The apparent negative relationship between incomes from fishing and input of capital in Barka may be explained by the availability of non-fishing jobs which permit respondents to have access to credits either from local creditors or from the Bank of Agriculture and Fisheries and other commercial banks. It can be seen from Table 7.16 that non-fishing income in Barka is around 2.3 – 2.5 times higher than its counterpart in Masn'a and Suwaiq respectively. The lack of alternative work opportunities in Masn'a and Suwaiq, therefore, implies high economic dependence on fishing.

Table 7.17 Current Value of Fishing Assets by Town (RO)

	Barka		Masn'a		Suwaiq		All sample	
	Average	%	Average	%	Average	%	Average	%
Vessel	954	32.6	843	31.5	1120	28.5	982	30.5
Engine	798	27.3	809	30.3	1089	27.7	910	28.2
Gear	1119	38.3	912	34.1	1597	40.7	1235	38.3
Others[a]	52	1.8	110	4.1	123	3.2	97	3.0
Total	**2923**	**100**	**2674**	**100**	**3929**	**100**	**3224**	**100**

a. Includes trap hauler and cars used to tow fishing vessels out of the sea.

Having obtained fishing and non-fishing income of vessel owners, income of other family members can be added to arrive at the total household income in each town. As presented in Table 7.18, average total household income was highest in Barka (RO 5009), followed by Suwaiq (RO 4753), and the lowest average total household income was found in Masn'a (RO 4409). The high household income in Barka can be explained by the availability of employment opportunities outside the fisheries sector because of its relative closeness to the capital, Muscat, where the industrial city and other businesses are located.

Table 7.18. Annual Average Income per Household by Source in South Al-Batinah (RO)

	Owner		Other members	Total income
	Fishing	Non-fishing		
Barka	1707	1119	2183	5009
% of total	34	22	44	100
Masn'a	1897	443	2069	4409
% of total	43	10	47	100
Suwaiq	1982	483	2288	4753
% of total	42	10	48	100
All sample	1869	670	2187	4727
% of total	40	14	46	100

An index of the well-being and prosperity of citizens in any country is commonly measured by the average net value of production of that country which is its GDP (Gross Domestic Product) per capita[13]. To have a general picture of the vessel owner's well-being as compared to the rest of the population, GDP per capita (national) can be compared to the income of vessel owners in the study area. Furthermore, income earned from fishing in the study area can be compared to the average well-being of other productive groups in the country. For example, income from fishing can be compared to the GDP per capita in the fisheries sector and the GDP per capita in the agriculture sector. Table 7.19 presents the national GDP, the fisheries GDP and the agriculture GDP as measured in 1996. As indicated above, the average annual income

[13] Gross National Product (GNP) or the total value of a country's output is defined as the sum of values of both final goods and services and investment goods in a country (Marsh, 1992; p. 199). Income earned by the country's citizens working aboard and investments that take place aboard are accounted for to obtain the GNP. When the focus is on all production that takes place within the national boundaries, the measure is expressed as the Gross Domestic product (GDP) (Marsh, 1992; p. 199).

from fishing in the study area is RO 1869[14]. The average share of individual of the GDP in Oman (GDP per capita) for 1996 at market prices is RO 2620. It is clearly shown that the average annual income of vessel owners from fishing is slightly lower than the national GDP per capita and fisheries GDP per capita, but higher than the agriculture GDP per capita.

Table 7.19 GDP and GDP per Capita (RO) in the Sultanate of Oman for (1996)

Sector	GDP	Population	GDP / capita
1. National	5890×10^6	2,214,720	2659
2. Fishing	59×10^6	24,338	2320
3. Agriculture	100.8×10^6	55,257	1824.2

Source: Ministry of Development, 1997

7.9 Income Inequality

As noted above, the mean fishing income was associated with a high standard deviation. This indicates that earnings from fishing do not cluster around the mean income or there are some fishermen who earn low and others earn high incomes. Information concerning the variation in income can be embodied in an inequality curve which known as the Lorenz curve. The curve is constructed by plotting the percentage of the income received by different percentages of the population when the latter are cumulated from the bottom (Grand *et al.*, 1992; p. 188). This means that income distribution is displayed by plotting cumulative income shares against the cumulative percentage of the population. When there is full equality, e.g. when the bottom forty percent of the population receive forty percent of the total income, then the Lorenz curve will be completely straight, described by the diagonal line in Figure 7.1. Hence, the nearer the empirical line comes to the diagonal, the nearer is the income distribution to full equality (Grand *et al.*, 1992; p. 188). Therefore, it would be possible to obtain an indicator of the extent of inequality in a given distribution by observing the position of the Lorenz curve in relation to the diagonal line of full equality.

The analysis of income distribution is confined to fishing income received by the vessel owners only. The Lorenz curve shown in Figure 7.1, therefore, represents the

[14] The figure does not account for capital consumption (vessel and gear depreciation).

fishing income of vessel owners. A look at the Lorenz curve reveals the great disparity in income distribution, as shown by the deviation of the inequality curve from the absolute equality curve (Figure 7.1). The bottom 20 percent of the vessel owners receive merely five percent of the total income, while the top 20 percent receive 45 percent. To present the inequality figures differently, it can be stated that the income of the top 20 percent of the vessel owners is about nine times higher than the corresponding incomes of the bottom 20 percent. Though the method of collecting fishermen's income from fishing may not be very accurate, Figure 7.1 gives a first approximation of the magnitude of income inequality of fishermen in the study area.

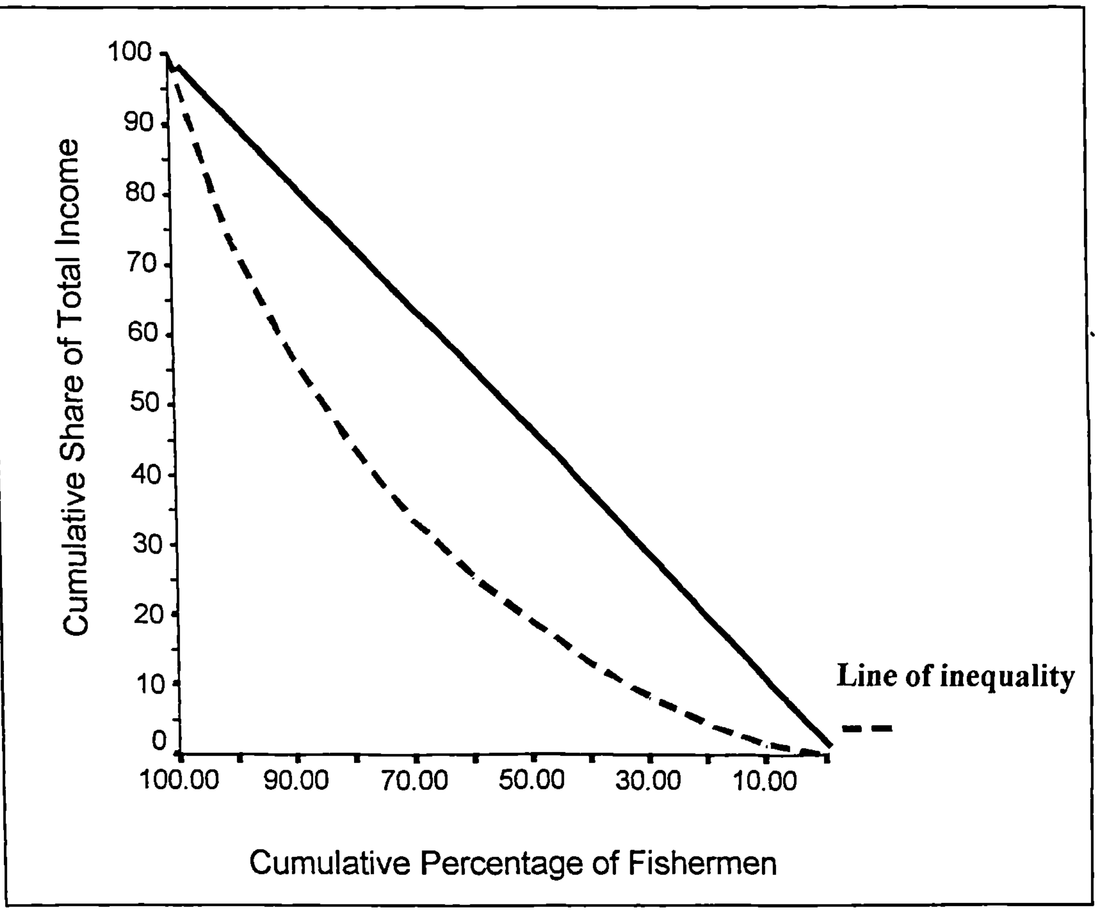

Figure 7.1 Distribution of Vessel Owners' Income in the Study Area (Lorenz Curve)

Another measure frequently used by economists to summarize the distribution of income is the Gini coefficient. Unlike the Lorenz curve which conveys a visual interpretation of income distribution, the Gini coefficient provides a measure of the amount of inequality implicit in the Lorenz curve. The Gini coefficient can be obtained geometrically from the Lorenz curve, since a computationally-convenient formula exists

(Cowell, 1977; p. 116) for computing the Gini coefficient. The formula is presented here: $Gini\ coefficient = \frac{2}{\overline{X} * N^2}\sum iXi - \frac{N+1}{N}$[15]

Values for the Gini coefficient vary between zero (perfect equality) and one (perfect inequality). The closer the value to zero, the nearer is the distribution to full equality (Atkinson, 1983; p. 53). Perhaps a fair way to evaluate income distribution in the study area is to compare the Gini coefficient in the three towns. As Table 7.20 revealed, the Gini coefficient of income inequality for all sample was found to be 0.39. Variation among the three towns is observed where the highest Gini coefficient was found in Suwaiq (0.40) and the lowest was recorded in Barka (0.34), with Masn'a lying in between. As can be seen from Table 7.20, the figure for the Gini coefficient deviated away from zero and hence it can be concluded here that income inequality was highest in Suwaiq as compared to Barka and Masn'a.

Table 7.20 Gini Coefficient Measure of Income Inequality in South AL-Batinah

Town	Gini coefficient
Barka	0.34
Masn'a	0.37
Suwaiq	0.40
All sample	0.39

7.10 Conclusion

The findings presented in this chapter are vital for studies that concern the assessment of the collective behaviour of people exploiting a common resource. In this study, it was found that the fishermen in the study area share the same race, religion and the language. This has a great implication for the study of collective action. Race, religion and language are among the factors that are responsible for the success or failure of collective action. As indicated in this chapter, fishermen in the study area have a common language, share the same religious belief and originate from the same race; thus, they are more or less homogeneous with respect to the above factors, a fact which

[15] $\sum iXi$ is a weighted sum of the data values, where the weight is the unit's rank order in the income distribution (Marsh, 1992). $\overline{X}$ is the average income and N is the number of respondents.

may induce fishermen to work collectively to manage their fishery. In such groups, rules are easier to formulate and enforce because fishermen's behaviour tends to be more predictable. Thus, they can establish institutions to manage the resources at low cost. The study also found that fishermen in the study area are living in fishing communities or villages scattered along the cost. Homogeneity coupled with high interdependence between fishermen in their daily lives in these small villages encourages compliance with the rules.

The study found that fishermen have a low level of educational attainment. The low level of education coupled with lack of skills reduces the chance of getting another occupation outside the fishing sector; thus, fishermen in the study area are highly dependent on the fishery. Regarding family size, the results indicate that the household size is relatively large (higher than the average national family size) suggesting a high population growth. To diversify the household income, fishermen in the study area are undertaking supplementary occupations concurrently with fishing. This has a negative impact on the success of collective action because fishermen who are involved in activities that take them away from their fishery and into an economy in which other opportunities exist are likely to adopt a higher subjective discount rate because they may care less about the future of their fishing incomes. It was found that slightly less than half of the sampled fishermen are occupational pluralists, i.e., they combine fishing and other occupations to make their living. However, most of the work in which they engage is that which requires little or no skill, generating low incomes, which makes them return to their fishing activities after working hours. Shortage of employment opportunities in South Al-Batinah at present could accelerate the pressure on fish resources in coastal areas. The low level of education, lack of skills and large family size make fishermen more economically dependent on fishing. High economic dependence can promote the emergence of collective action to manage the fishery; a rational strategy that might be considered by fishermen to avoid further deterioration of their livelihood.

The results indicate that the average income of vessel owners from fishing is slightly lower than the national GDP per capita, fisheries GDP per capita, but higher than the agriculture GDP per capita. The analysis of income distribution using the Lorenz curve indicates that there is a great disparity in income distribution between fishermen. It was found that the income of the top 20 percent is around nine times higher than the incomes of the bottom 20 percent. The Gini coefficient was also used to analyse the income distribution across the three towns included in the present study. The results indicate that the highest income inequality was found in Suwaiq, while the lowest was found in Barka.

The evidence presented in this chapter suggests that fishermen in the study area are more or less homogenous in many respects. However, the higher income inequality could be an obstacle to collective action as agreements to restrain the take from the fishery become more difficult as the difference in endowments among fishermen increased. The findings of this chapter will be used as the basis for further analysis of the collective choice carried out in the following chapters.

CHAPTER EIGHT

CHARACTERISTICS OF THE TRADITIONAL FISHERY

8.1 Introduction

The purpose of this chapter is to describe the characteristics of the traditional fishery in South Al-Batinah. The chapter begins by examining in detail the fishing activities and operations of the traditional fishermen in the study area. The chapter also goes on to evaluate fishermen's awareness of the common dilemmas they are encountering in this fishery.

The last section of this chapter covers the local institutions that govern the fishery in the study area. Evidence gathered through survey questionnaire, semi-structured interviews and researcher observation are used to highlight specific problems associated with the fishery and their outcomes. The researcher made substantial use of the qualitative data collected through semi-structured interviews.

8.2 Fishing Gears

Al-Batinah's fishermen use a variety of fishing gear. The employment of various gears depends on the types of fish available or the fishing season. There are eleven types of fishing gear recorded in the study area, the most common gear overall being gill nets, which are deployed in several ways in the study area. Netting materials made of multifilament nylon appear to have occurred in the fishery about the mid-1960s to replace cotton and other natural fibres used as netting material (the University of Durham report, 1978). As mentioned above, gill nets are employed in several ways: as drift nets to catch small and large pelagics, as fixed (set) nets to catch semi-pelagics species and as encircling nets to encircle a school of fish.

Because fishing in the study area is seasonal, fishermen tend to own several types of fishing gear in order to use them around the year. For example, a drift net for kingfish (*Scomberomorus commerson*) is used in winter (December to February) for three months only followed by Indian mackerel (*Rastrelliger kanagurta*) drift nets from February to the May. The results indicate that the average number of types of fishing gear owned by a single fisherman was three, with a standard deviation of 1.2 types. The minimum number was one and the maximum was seven types of fishing gear.

According to the fishing operation, fishing gear can be classified into drift fishing nets which contain all types of drift gill nets, static fishing gear including traps and set (or fixed) gill nets, beach seine, handline and encircling nets. A glance at Table 8.1 reveals that there were 339 drift nets owned by the surveyed vessel owners, 45 units of encircling nets, 170 static fishing gear, 29 handlines[1] and 18 beach seines. Out of the total drift nets recorded, kingfish drift nets were widely used by fishermen, representing 36 percent, followed by mackerel drift nets which represent another 34.5 percent. These two species are commonly fished in the coastal areas at a depth range between 6 to 12 fathoms (around 30 to 40 minutes steaming time from the shore).

Drift nets (called Hayyali locally) are usually used to catch pelagic species of different sizes. Therefore, they tend to be of a variety of mesh sizes. One drift net is generally made up of two or more separate pieces of netting joined end to end. Drift nets made up of as many as 14 separate pieces were recorded during the survey, though the average number of pieces in each drift net is around 7.3. Table 8.2 reveals that the majority (80 %) of respondents who owned gill nets joined between five and nine pieces of netting together to form a single unit of gill net. As fish get scarce, fishermen tend to add more pieces of gill net to increase their catch. Comparing this result to that collected by the University of Durham between 1974 –1976 (University of Durham, 1978; p. 27) the average number of pieces per drift net (tuna[2] drift nets) has increased from 4.5 pieces in 1976 to 7.3 pieces in 1998.

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[1] Almost all fishermen use handlines occasionally but such users are not recorded in this study. Those recorded as using handlines actually employ handlines as a main fishing gear.

[2] Species targeted by fishermen in Al-Batinah using drift nets include Sahwa (*Thunnus tonggol*), Suda (*Euthynnus affinis*), Yellowfin tuna or Gaydhar locally (*Thunnus albacares*).

Table 8.1 Type of Gear Used by Surveyed Fishermen

Gear type	Suwaiq	Masn'a	Barka	Total
a). Drift nets				
Tunas drift net	45	18	16	79
Kingfish drift net	38	40	45	123
Halwayooh[3] drift net	18	0	2	20
Mackerel drift net	36	38	43	117
total	**137**	**96**	**106**	**339**
b). Encircling nets				
Encircling gear for kingfish	0	1	4	5
Encircling gear for mackerel	3	11	16	30
Encircling gear for sardine	3	5	2	10
total	**6**	**17**	**22**	**45**
c). Static gear				
Traps	51	36	26	113
Kingfish set gill net	23	9	25	57
total	**74**	**45**	**51**	**170**
d). Beach seine	18	0	0	18
e). Handlines	14	7	8	29

As shown in Table 8.2, the difference between the mean number of pieces in the two studies was found to be statistically significant[4] at the 0.001 level, which suggests that more fishing effort has been added into the fishery. This could be attributed to the facilities provided by the Government in terms of subsidised fishing gears and the availability of credit from the Bank of Agriculture and Fisheries to purchase fishing vessels, engines and fishing gears.

[3] The English name for this fish specie is Grater Amber Jack in the family CARANGIDAE.

[4] An independent t-test was carried out to determine whether or not there is any significant difference between the mean values of the number of pieces of gill nets provided by the two studies.

Table 8.2 Distribution of the Number of Pieces per Yellowfin Tuna Gill Net

No.of pieces / gill net	No. of fishermen	Percentage
a. 1 – 4	6	7.6
b. 5 – 9	63	79.7
c. 10 – 14	6	12.7
d. > 14	0	0
Total	**79**	**100**
Mean =7.25 pieces **St. deviation = 1.92**		

*** t - value = -12.7; P = 000**

Another fishing gear widely used by fishermen in the study area is traps, which are deployed to catch demersal fish species and cuttlefish. Out of the 194 respondents interviewed, 113 respondents (58 %) were found to own fishing traps. Material for traps is normally precut wire mesh or steel cables assembled to form a flat-bottomed dome with an intrusive cone-shaped entrance on the side. Trap sizes vary; the approximate size may range from 1.5-metres diameter by 1.5-metres height to 2.5-metres diameter by 2.5-metres height. Traps are baited and set in areas where demersal species are known to be found. Fishermen who own artificial reefs set their traps close to the reefs and they check the traps to empty the catch every two or three days. A few fishermen mark their traps by a buoy on the surface of the sea, but the majority of them join five to ten traps together and then submerge them. They adopted this technique in their effort to avoid conflicts with mobile gear operators. Fishermen identify the location of their traps with the aid of landmarks (see footnote 9 for a description of this process). They tend to hide their traps as the incidences of trap theft and traps becoming entangled on drift nets and on passing vessels' propellers have increased rapidly indicating congestion problems. A respondent stated that "nowadays, when a trap mark or buoy gets caught on a vessel's propeller or a drift net it will normally be cut loose". This creates negative externalities represented by the catch and cost of the lost trap and by the phenomenon known as ghost fishing[5]. Methods of avoiding net entanglement problems are discussed later in section 8.6.3.

From Table 8.3, the average number of fish traps per vessel owner was 26.3 traps with a standard deviation of 23.5 traps. The minimum number owned were two traps and the maximum number of traps owned by a single vessel owner was 100 traps. As shown in Table 8.3, around two-thirds (64.5 %) of the respondents owned 25 traps or less, whereas one-third (35.4 %) owned more than 26 traps. According to the University of Durham report, the average number of traps per fishermen in 1976 was just over six (6.23 traps) and two-thirds of the surveyed fishermen had 6 or less traps (University of Durham, 1978; p. 36). In an attempt to investigate the difference between the mean number of traps found in both studies, a paired sample t-test was carried out. The results of the t-test indicated that the t-value (9.1; $p < 0.001$) is statistically significant at the 0.001 significance level, and there is statistically significant difference between the mean number of traps in both studies (Table 8.3).

Table 8.3 Distribution of the Number of Traps among Vessel Owners

No. of traps	No. of fishermen	Percentage
a) 1 – 10	39	34.5
b) 11 – 25	34	30.1
c) 26 – 50	26	23
d) > 50	14	12.4
Total	**113**	**100**
Mean =26.34 traps **St. deviation = 23.5**		

*** t - value = 9.1; P = 000**

Encircling nets or seines are also worked on the South AL-Batinah coast to catch small and large pelagic fish species. No special net is needed for this type of fishing. A drift net of four to five pieces joined together can be used as a seine net, though mesh size depends on the target species. Fishing vessels start searching for fish shoals and when a school of fish is spotted the actual encirclement of the fish must be carried out at the maximum vessel speed possible. For small pelagic species such as sardine

[5] Fishermen reported that the average life span of traps is around six months to one year; after that it will have rusted through. When a trap is lost it will continue fishing for several months and fish caught inside will be bait for other fishes to enter.

(*Sardinella longiceps*) and Indian mackerel, the fishing operation is carried out during the day because it is easy to spot fish shoals whereas kingfish concentrate near the sea surface in shoals on moonlit nights, which makes them vulnerable to this kind of fishing.

Based on the questionnaire survey, semi-structured interviews and observation, encircling nets were found not to be popular among fishermen in the study area. It was found that out of the 194 respondents surveyed, the number who owned encircling nets was only 45 (23 %); 50 percent of these were in Barka. In general, Suwaiq fishermen seem reluctant to use encircling nets in their fishery as they see this type of gear as a new innovation recently introduced and unacceptable to the majority of fishermen in the study area and particularly in Suwaiq. This is confirmed by the results presented in Table 8.1, where out of the 73 fishermen interviewed in Suwaiq, no fisherman deployed kingfish encircling nets. Similar results were obtained for the Indian mackerel encircling nets; only three fishermen (4 %) in Suwaiq used Indian mackerel encircling nets, compared to 11 (18 %) in Masn'a and 16 (26 %) in Barka.

As mentioned above, encircling nets are new in the fishery and the exact year of their appearance in the fishery is not known. Many fishermen reported that this technique was first introduced five to ten years ago to catch large pelagics such as kingfish while sardine seine nets occurred in the fishery only three years ago.

8.3 Fishing Vessels

The most notable change that has taken place in the composition of the fishing fleet during the last thirty years is the introduction of fibreglass vessels and outboard engines to replace the non-mechanised wooden vessels. As noted above, the outboard engine was introduced in the area in the mid-1960s, to motorise wooden vessels. Then, during the early 1970s, fibreglass vessels powered by outboard engines started to appear in the area to replace wooden vessels. The acceleration of these changes can be attributed to the Fishermen's Encouragement Fund established by the Government in late 1970s which resulted in almost all wooden vessels being replaced by fibreglass vessels. For example, among the fishing fleet, the current number of wooden vessels in Barka, Masn'a and Suwaiq was found to be 17 (3.5 %), 10 (3.4 %) and 2 (0.24 %)

respectively. During the field work, wooden vessels were not observed fishing or landing fish on the market.

The mean vessel length of the sampled vessels was 6.74 metres. There was no significant difference in vessels length across the three towns. Vessel length was then categorised into three groups: small (4.5 – 5.9 metres), medium (6.0 – 7.0 metres) and large (7.1 – 8.5 metres). As can be seen in Table 8.4, medium sized vessels (6.0 – 7.0 metres) constitute the majority (54.2 %) of the total vessels owned by respondents included in this study, followed by large sized vessels which represent 27.8 percent.

Table 8.4 Vessel Length by Town

Vessel size (metres)	Suwaiq	Masn'a	Barka	All sample
Small (4.5 – 5.9)	18 (24.7)	11 (18.3)	6 (9.8)	35 (18)
Medium (6.0 – 7.0)	26 (35.6)	37 (61.7)	42 (68.9)	105 (54.2)
Large (7.1 – 8.5)	29 (39.7)	12 (20)	13 (21.3)	54 (27.8)
Total	73 (100)	60 (100)	61 (100)	194 (100)
Mean	6.77	6.68	6.77	6.74
St. deviation	0.85	0.73	0.62	0.73

*** Figures in parentheses are percentage of the total**

When considering vessel length groups in the three towns, Table 8.4 presents some interesting data. The large vessel size constituted around 40 percent of the total fleet in Suwaiq, whereas the corresponding figures in Barka and Masn'a were 21 percent and 20 percent respectively. This finding confirms earlier results on income and amount of investment, which showed that fishermen in Suwaiq have the highest income from fishing and the highest capital investment. Vessel size can represent productivity somewhat loosely, especially if we consider that larger fishing vessels mean more extensive fishing grounds, can carry more fishing gears and withstand rough weather conditions better than smaller vessels.

Field observations and interviews with key-informants found that fishermen in Suwaiq choose large vessels to suit their conditions as they go fishing in the offshore waters to catch yellowfin tuna. The time required to reach the fishing ground is around three to four hours, so larger vessels are needed, especially when the weather gets bad while they are on the fishing ground. Another interesting finding is that as there are limited non-fishing work opportunities in Suwaiq, as described in Chapter Seven, the fishermen depend largely on the fishery and this encourages them to explore fishing grounds away from their home village.

It can be observed here that fishermen in the study area are using similar fishing vessels, a result which indicates that they constitute a homogenous group with respect to their fishing fleet.

The survey questions also asked the age of the vessel (Table 8.5). This information provides information concerning the status of the fishing fleet. The results in Table 8.5 indicate that the mean age of the fishing vessels was 11.8 years with a standard deviation of 5.3 years. Key-informants reported that the useful life of this type of vessels is around 20 to 25 years. In an attempt to determine the status of the fleet, vessel age was dichotomised at the mean age (11.8 years), i.e., two groups are formed, one below the mean and the other above the mean. The results indicated that 113 vessels (58 %) were 11.8 years or older and 81 vessels (42 %) were less than 11.8 years old (Table 8.5).

Table 8.5 Vessel Age by Town

Vessel age	Suwaiq	Masn'a	Barka	All sample
Less than 11 years	31 (42.5)	31 (51.7)	19 (31.1)	81 (41.8)
More than 11 years	42 (57.5)	29 (48.3)	42 (68.9)	113 (58.2)
Total	73 (100)	60 (100)	61 (100)	194 (100)
Mean	12.2	10.6	12.4	11.8
St. deviation	6.2	5.1	4.3	5.3

* Figures in parentheses are column percentages

To determine the variation in fleet age among the three towns, vessel age was crosstabulated in the three towns. A noticeable, though not statistically significant difference, in vessel age was found in Barka where 70 percent of the vessels are older than 11.8 years (the mean age) as compared to 48 percent in Masn'a and 58 percent in Suwaiq. This suggests that fewer fishing vessels are being added to the fishery in Barka.

Respondents were also asked the source of finance for their vessels. The results indicated that the majority of the surveyed vessel owners (69 %) purchased their vessels using their own savings. Vessels subsidised by the Government accounted for only 27 percent, whereas vessels financed through the Bank of Agriculture and Fisheries accounted for only 3.6 percent.

8.4 Engine Horse Power

Fishing vessels in the study area are all powered by outboard motors. The results shown that one-third (29 %) of the vessels are powered by two outboard motors, a main motor and an auxiliary one which is used to increase the speed of the vessel as well as an emergency motor in case of failure of the main motor. Vessels with two motors are likely to be larger ones, which are used for offshore fishing. As explained above, bigger vessels mean that fish resources found beyond the continental shelf can be exploited. Unlike the trawl fishery where faster vessels means more catch as the vessels can tow the net at a certain speed, most traditional fishing methods used in the study area do not depend on the size of the engine. The engine is used only to travel from and to the fishing ground. It may be claimed that faster vessels can transport the catch from the fishing ground to the market in a short time period, which benefits the fishermen and the market by providing high quality fish. Therefore, individual vessel owners may tend to achieve this by using more highly-powered motors so that more time is devoted to fishing rather than steaming from and to the fishing grounds. However, some of them might use more powered motors to make multiple fishing trips in the vicinity of the village per day, hence, to increase fishing effort.

The mean horsepower of the surveyed vessels was 57.4 horse-power with a standard deviation of 31.0 horse-power (Table 8.6). Two-thirds of the respondents (69.6 %) had medium engines with horse-power between 40 and 80. Those who used larger motors (more than 80 HP) represented 18 percent of the total sampled vessels. The results indicate that only 24 respondents or 12.4 percent had motors less than 40 horse-power. The results in Table 8.6 reveal that the mean motor horse-power in Suwaiq is higher than those in Barka and Masn'a. In addition to the mean motor higher horse-power in Suwaiq, it was found that more respondents in Suwaiq (24.7 %) have motors with more than 80 horse-power, as compared to Barka (13.1 %) and Masn'a (15 %). This result is in line with earlier findings of larger vessel size, higher income and high investment in fishing in Suwaiq compared to the other two towns, Barka and Masn'a.

Table 8.6 Vessel Engine Horse-Power by Town

Engine HP	Suwaiq	Masn'a	Barka	All sample
Less than 40	15 (20.5)	7 (11.7)	2 (3.3)	24 (12.4)
40 to 80	40 (54.8)	44 (73.3)	51 (83.6)	135 (69.6)
More than 80	18 (24.7)	9 (15)	8 (13.1)	35 (18)
Total	73 (100)	60 (100)	61 (100)	194 (100)
Mean	64.3	53.4	53	57.4
St. deviation	36.0	29.7	24.0	31.0

* Figures in parentheses are column percentages

8.5 Fishing Operations

Data obtain from field observation, interviews with key-informants and the questionnaire provide a general picture of the type and timing of fishing trips conducted by fishermen in the study area. In general departure time, duration and the return time all depend on the type of fishing gear employed. Where all drift net fishing is done at night, traps are set, inspected and emptied during the day. Because multifilament netting is visible to the fish during the daylight, fishing by drift net is restricted to night time only. This technical obstacle prevents fishermen from extending their fishing hours beyond what has normally been practised in the area for several generations. The use of monofilament netting would permit the use of such material during the day, but the government has banned this material. While the researcher was in the field, no observations of such nets were recorded in the study area; thus, full compliance with the rule has been achieved.

The departure time for the offshore drift net fishing is normally a few hours before dusk. All respondents reported that they have to be on the fishing ground just before sunset in order to set their nets in good fishing spots and to avoid net entanglement with other fishermen's nets. Fishermen reported that their drift nets are soaked and drifted by the current with the vessel for four to six hours. After that and around midnight the net is hauled in and the catch is emptied. The majority of fishermen set their nets again to be retrieved before dawn, although those who obtained a big catch at the first haul return to the village at midnight. In general, fishermen who remain on the fishing ground the whole night haul in their nets few hours before dawn to arrive at the market on time.

Fishermen targeting kingfish, Indian mackerel and other pelagic species which are found on the coastal waters (20 to 45 minutes steaming time) normally depart from their villages just before sunset. The nets are set adrift with the vessel for around three hours and then hauled and emptied. Because the fishing ground is in the vicinity of the village, the fishermen return home two to three hours before midnight to sleep. Some fishermen, especially those who do not have to be at their work early in the morning, return to the fishing ground during the last quarter of the night to fish and then haul the nets just before dawn, to be in the market at the appropriate time.

Trap fishermen depart the fishing villages just before dawn to be in the fishing ground after sunset. After the catch has been emptied, the traps are then baited and moved to another location if needed and set again. The fishermen then head to the market to sell their catch.

8.6 Common Dilemmas

Information collected through questionnaire, key-informants interviews and observation were used to identify problems of resource use encountered by fishermen in South AL-Batinah. Problems of resource use that constitute common dilemmas are those situations in which fishermen continue to harvest their fishery at a sub-optimal level even though an optimal level can be reached unilaterally or collectively. The main theme here is, therefore, to evaluate fishermen's awareness of the common dilemmas they are encountering in this fishery.

Lack of information about common dilemmas may hamper the emergence of collective action, as those who are not aware of the problem are likely to be reluctant to participate in collective action. In an attempt to present a clear picture of the common dilemmas in this fishery and following Gardner *et al.* (1990) and Ostrom (1990), common dilemmas are divided into two broad classes: appropriation problems and provision problems. Appropriation problems are those related directly to resource use (i.e., appropriation externalities, technological externalities and assignment problems) whereas, provision problems are those pertaining to the supply and maintenance of CPR institutions (Schlager *et al.*, 1994; p. 296). Common dilemmas and the consequences associated with sub-optimal use of the fishery are described in this section.

8.6.1 Overall status of the fishery

Among the resource use problems that occur in real world situation are those pertaining to fish resource status. The results indicated that fishermen were in general in agreement on the status of their fishery. Almost all respondents (190 respondents or 98 %) reported that fish resources in the area are declining. Only three respondents reported that fish stocks are not declining. Many fishermen reported scarcity of certain demersal species in comparison to availability when they were fishing several years ago. In an attempt to investigate the situation further, fishermen were asked to rank the status of the declining fishery from no problem to extreme. Out of the 190 respondents indicating a declining fishery, two-thirds (66 %) reported that the decline of fish stock they are encountering is extreme. Those who reported that the decline in their fishery is moderate constitute around 14 percent, whereas 17 percent reported that the decline is severe. Therefore, fishermen share a similar view regarding the status of their fishery, in which the majority (83 %) perceive the problem of declining stock in their fishery as either severe or extreme, indicating a common dilemma.

The results indicate that fishermen in the three towns have similar views regarding the status of the fishery by conveying a distressing fact of an overexploited fishery, at least for the most commercial species, if not the overall status of the fishery. Sharing similar views about a particular common dilemma by a majority of resource users may foster the emergence of collective action because it is possible that the majority of the fishermen will participate in collective action, if initiated, to solve their common problem.

The presence of the many fish species in this fishery makes generalization of the status of fish stocks difficult. In order to overcome this, respondents were asked to list those species in which they had witnessed a sharp decline recently. Among those who said fish stocks are declining, just over two-thirds (69 %) indicated that they are witnessing a sharp decline in the landing of kingfish. The remaining respondents listed other species, for example, 12 percent listed Indian mackerel, 6.5 percent listed cuttlefish, 3.8 percent listed sardine species and 3 percent listed other fish species. There was a general agreement among fishermen that the landings of almost all important demersal species have severely declined over the last few years. In order to validate these results, fishermen's responses were compared to landing statistics provided by the Ministry of Agriculture and Fishery and other research (Moore and Dorr, 1994; Hooker and Parsons, 1995 and Marine Science and Fisheries Center, 1995) which indicate that kingfish is highly overexploited, confirming that respondents were telling the truth. The validity of the responses was also checked by looking at the results presented in section 8.2 regarding fishing gear, which indicated that a high level of fishing effort was devoted toward kingfish because of its high commercial prices in the local and international market[6].

As presented in the above discussion, fishermen in the study area are aware of the deteriorating status of their resources, but the crucial issue that interests us here is whether they know the factors that cause fish resources to become depleted. For collective action to emerge, resource users must be faced by a common problem, of which the causes are known to them and its solution is approachable. If fishermen in the area have identified these factors and share similar views about these factors, they might be motivated to achieve an effective form of governing and managing their fish resources. As argued by Baland and Platteau *"for corporate management of CPRs to be effective, an essential prerequisite is that resource users correctly perceive the potential benefits of collective action, which requires that they are well informed not only about the state of the resource but also about the possible impact of use behaviour on its stock"* (Baland and Platteau, 1996; p. 290).

To elicit information concerning factors that cause overfishing, vessel owners were asked, "what makes your fish resources decline?" to address these factors. Out of the 194 respondents included in this study, 187 respondents answered this question. Among those who answered this question, 154 respondents (82.4 %) indicated that overfishing depletes their fishery, whereas 33 respondents (17.6 %) reported factors other than overfishing such as no reason or that decline of fish stocks is caused by God. The responses of those who indicated overfishing as the likely cause of resource depletion were grouped into four basic factors: large number of vessels, sardine seine fishing, encircling nets and industrial trawlers (Table 8.7). Slightly over one-third (70 respondents or 45.5 percent) reported too many vessels in the fishery as the main factor that causes overfishing. The second important factor was sardine seine fishing, reported by 50 respondents or 32.5 percent, followed by encircling gear reported by 26 respondents representing 16.8 percent of those who answered this questions. Only eight

[6] Kingfish drift nets were found to be widely used by fishermen, representing 36 percent out of the total drift nets surveyed in this research.

respondents (5.2 %) indicated that fish stocks were depleted by the intrusion of industrial trawlers into their traditional fishing grounds

Table 8.7 Frequency and Percentage Distribution of Fishermen's Responses to Question on the Likely Causes of Stock Depletion

Causes of stock depletion	Barka n = 60	Masn'a n = 59	Suwaiq n = 68	Overall n = 187
a). Overfishing				
1) Large no. of vessels	28 (46.7)	11 (18.6)	24 (35.3)	70 (45.5)
2) Sardine seine fishing	5.0 (8.3)	30 (50.9)	15 (22.0)	50 (32.5)
3) Encircling nets	17 (28.3)	11 (18.6)	5.0 (7.4)	26 (16.8)
4) Trawlers	2.0 (3.3)	1.0 (1.7)	5.0 (7.4)	8.0 (5.2)
total	**52 (86.7)**	**53 (89.8)**	**49 (72.1)**	**154 (82.4)**
b). Outside causes, i.e., natural reasons or God	8 (13.3)	6 (10.2)	19 (27.9)	33 (17.6)
Total	60 (100)	59 (100)	68 (100)	187 (100)

*** Figures in parentheses are column percentages**

In the past, industrial trawlers used to enter into coastal areas violating government restrictions[7]. However, tighter restrictions against trawlers are enforced at present after many complaints and conflicts with traditional fishermen in the area. In Suwaiq, for example, a number of fishermen from Al-Qurha village reported that they had suffered from demersal trawlers operating in their fishing grounds. They had informed the Ministry of these violations several times. Then the village leader called for a meeting and almost all fishermen participated and decided to capture the trawlers. Twenty traditional fishing vessels were involved in this operation and a trawler and its crew were captured. The trawler was towed to the village. The catch was confiscated and the captain and the crew (foreigners) were locked in a room in the village leader's house. The police were involved to free the captain and his crew, but the fishermen demanded a high representative from the Ministry to come to the village and give them an assurance that trawlers would not operate in the area again. Fishermen from this

[7] Reports indicated that the Govermement operated three medium size trawlers of about 60 feet overall length and 280 horsepower in Al-Batinah for many years during the mid 1970s and mid 1980s. The

village reported that they have never seen a trawler on their fishing ground since this incident.

This case shows how collective action emerged as a result of the intrusion of outsiders and how fishermen in this village had managed to coordinate their effort against a common threat. As argued by Baland and Platteau (1996; p. 337), "*it is much easier to unite against some external enemy than to establish co-operation among individuals in the absence of any outside threat*".

A few fishermen in another village thought that sometimes trawlers still violate the rule and operate at night close to their area. They had found trawl nets snagged on rocks on the bottom of the sea. Two fishermen from Al-Jalil in Suwaiq showed pieces of trawl net they had found in the fishing ground to the researcher and said they might take the pieces to the Ministry. They reported that their fishery has declined as a result of the operation of these trawlers in their area in the past. They reported that the trawl net catches quantities beyond the capacity of the fishery and it destroys the habitat of demersal fish by damaging coral reefs.

Responses to the likely factors that cause resource depletion showed somewhat more variation among the three groups (Table 8.7). Whereas more fishermen in Barka and Suwaiq had indicated a large number of fishing vessels than other factors as a cause of resource depletion, one-half of the fishermen in Masn'a had indicated sardine seine fishing as the main cause of overfishing.

The results indicate that more fishermen in Masn'a (89.8 %) identify overfishing as the factor that causes the fishery to decline. In Barka, a slightly lower figure was found (86.7 %), whereas only 72.1 percent of the fishermen in Suwaiq regarded overfishing as the cause of resource decline (Table 8.7). The near consensus by fishermen in Masn'a (89.8 %) on this issue may reflect the group's smaller size compared to Suwaiq's and Barka's. It is anticipated that those who attributed resource decline to factors other than overfishing (e.g., the 27.9 % in Suwaiq) might show no interest in participating in collective action, as they believe the problem is caused by outside factors and the solution is not reachable. Those who do not perceive their fishing activities as factors affecting the fishery are likely to continue their abuse of the

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trawlers were based on Muscat and trawl the Batinah coast frequently, particularly in the summer and autumn (Mundt, 1980, p. 14).

resource, waiting the mercy of God or hoping that the natural factors affecting the fishery will correct themselves. However, because the majority (more than two-thirds) of the fishermen in the study area do perceive interdependence between their fishing activities and resource status, the scope for collective action still exists, but perhaps not without state intervention.

8.6.2 Stock externalities

Fishermen's answers on the status of the fishery were further examined for indications of stock externalities. Recognition of stock externalities were identified in fishermen's responses to the decline of the fishery as caused by their harvest activities leading to increased harvesting costs per unit of output. Two types of fishing gears were blamed by fishermen for causing resource scarcity: encircling nets known locally as Tadwerah and sardine seine fishing, known locally as Tahweta.

Among those who stated that their fishery is declining, around one-third (32.5) indicated that the cause is sardine purse seines (Tahweta). This fishing technique was introduced recently into the fishery as a result of high demand for this species in Dubai (UAE). Fish traders with trucks fitted with an isolated fish box were observed by the researcher near the shore waiting to fill their trucks and then drive to Dubai, a two-to-three hours journey by road.

A number of key informants interviewed by the researcher listed many problems that affect their fishery as a result of the use of Tahweta. First, they explained that sardine stocks have been depleted during the last three years after the introduction of this net. Almost all fishermen considered sardine as the main food for most of the pelagic and semi-pelagic fish species they catch. As many fishermen put it, "fish come to the coastal water of our villages because they are looking for the food (sardine and other small pelagics) that we used to conserve". They added, "if we don't keep sardine to be fed on by bigger fish, these fish will migrate to other places, and that is what happening now". They argued that the Tahweta's smaller mesh size is deployed close to the shore, where juveniles and undersized fish are present; this non-selectivity feature is responsible for the disappearance of many high-valued pelagic species. In addition, because the traditional fishing vessels used for Tahweta are relatively small, fishermen tend to discard part of the catch into the sea when their vessel's capacity is reached. In the semi-structured interview, some key informants reported that fishermen employing

Tahweta discard a substantial amount of dead sardine, wasting an important resource and causing environmental pollution. They added that dead sardine pollute sea water, causing bad smells and turning other fishes away.

The other fishing gear cited by fishermen as negatively affecting their fishery and identified here as a source of stock externality is Tadwerah. This type of fishing gear is actually a number of gill nets joined together to form a long gill net which is then used to encircle schools of fish. It was criticized by many fishermen for catching the entire school of fish at once. In fact, these responses address the appropriation externality, where excessive harvests have severe effects on fish stocks. Fishermen using this technique are also accused of damaging others' static and drift nets as well as artificial reefs as they search for fish schools at night, hence creating technological externalities. Fishermen argued that these nets catch huge quantities of fish, depleting the whole stocks and leaving only a few to breed.

The qualitative data collected from interviewing key-informants supported the above claim. All the 15 key-informants interviewed mentioned that the technique is quite new to them and harmful to the resources as it catches quantities beyond the capacity of the fishery. As some fishermen put it, "what the Tadwerah's fishermen earn in one night is similar to what we earn in several months. We have the ability to use similar nets but we do not want to harm ourselves and the rest by depleting our resources". The master of Senat Al-Bahar in Suwaiq in the semi-structured interview made a similar statement.

During this study, Tahweta and Tadwerah use was a continuous source of conflict among fishermen in the study area. Whereas the operators of these nets claimed that these new innovations are within the Ministry policies of developing the fishery, the majority related stock depletion to the use of such nets.

Many conflicts have erupted between fishermen in the study area. The following example is a typical case and will be highlighted here to show how tense is the situation. In 1996, ten fishermen from Al-Sawadi in Barka were sentenced to two years imprisonment by the juridical court and fined 2000 Omani Rials when they held some fishermen from another village and confiscated their catch, gear and the vessel. The incident happened when fishermen from Al-Haradi were trying to challenge a local rule announced by local fishermen in Barka to ban sardine fishing by Tahweta. Fishermen in the area have had an accord (the product of Senat Al-Bahar, which is an indigenous institution of fish resource management) to conserve sardine resources for many generations in the past. They have devised many rules to ensure that sardine resources would not be depleted. For example, fishermen can only land sardine caught by gill nets into the market. Night fishing for sardine using any fishing gears is banned as well, except fishing for bait. The selectivity of gill nets allows smaller sardine to pass through the meshes to reproduce. Sardines caught by cast nets are normally used as baits for handlines and traps, but not allowed to be sold in the market (personal communication with Suliman Al-Mamari, master of Senat Al-Bahar in Suwaiq). Cast nets are known to have a very small mesh size, which will cause stock depletion if used to land sardine for sale in the market. In addition, when the sardine seines were introduced in the study area recently, it caused many conflicts among fishermen in the study area. Therefore, fishermen used to restrict their take from the sardine fishery by specifying the use of certain fishing gear to catch sardine for commercial purposes, preventing the overexploitation of the resource.

Fishermen in Al-Sawadi banned sardine seines (Tahweta) in their village and they warned other fishermen not to use such techniques in front of their village. As stated above, a few fishermen from Al-Haradi used Tahweta in front of Al-Sawadi village to challenge this local rule. Fishermen from Al-Sawadi informed the leader of the other village in order to resolve the dispute and they informed the local authority (the Wali). After many violations by fishermen from Al-Haradi, Al-Sawadi's fishermen decided to capture those fishermen. The violating fishermen were caught fishing by Tahweta and their vessel was towed to the village. The police as well as the local authority (the Wali) were involved in freeing the fishermen. The fishermen from Al-Sawadi released the three fishermen but they refused to free the vessel and the gear. The local authority failed to resolve the conflict and the case was then raised to the juridical court. Those fishermen who had tried to control the use of the resource were found guilty of hijacking three fishermen and were sentenced to two years and paid a fine of RO 2000.

As shown by the results, the majority of respondents (95 %) do not use this technique and have attempted several times to ban the use of these nets in their fishery. The nets have been banned on several occasions, either by fishermen themselves, by the local authority or sometimes by the Ministry itself. However, because the parties (local authority, the Ministry and the local institution of resource management) claiming responsibility for the management of the resources have conflicting views regarding this issue, the result is collective failure. For example, an extension officer from the Ministry sees the Tadwerah and Tahweta as new developments in the traditional fishery to increase fish landing and as being consistent with the Ministry's effort to increase fish landing.

8.6.3 Technological externalities

Technological externalities were identified as problems of decreasing ability to catch fish as a result of obstruction by other fishermen's gear, gear loss and conflicts between fishermen from the same village and / or town and with fishermen from other towns. The resulting sub-optimal outcome can be indicated by loss of catch, loss of fishing gears and the results of conflicts erupting between fishermen in the study area. These problems may not affect the fish stocks directly, but they create negative externalities imposed by some fishermen on others. Technological externalities are expected to be prevalent in a multi-gear fishery as a result of interaction between mobile and static fishing gear in the absence of an institution (or in the presence of a weak institution) to govern and coordinate resource use.

A technological externality is created when a fisherman places his gear so close to another fisherman's gears so as to obstruct the latter's ability to catch fish. Fishermen using drift gill nets cite this problem. Setting one's drift net across or parallel and close to another's reduce the catching ability of both fishermen. The study, however, found that fishermen in the study area have their own rule to overcome or to reduce the consequences of technological externalities. First, fishermen have a collective rule that "the first to arrive to the spot has the right to fish". The rule states also that those who come later should not set their nets in line, either in front of or behind another's net, but there is no ban on setting either side of it making a straight line and giving everyone an equal chance of catching fish. The convention was established because if one net is set in front of another, both lose the catch, one at the flow and the other at the ebb of the tide. Although fishermen have devised their own conventions to govern placing of nets, the group rule is relaxed when the fishing ground is congested.

Another technological externality is created by operating drift nets or encircling nets on fishing grounds used by trap fishermen and in areas of artificial reefs. This activity reduces the ability of the static gear to catch fish and raises the incidence of gear damage and losses, hence increasing fishing cost. Many fishermen have discontinued their artificial reefs due to activities of mobile fishermen gear whose drift nets and encircling nets destroy the artificial reefs. Because defending individual artificial reefs and static gear is costly, many fishermen have substituted static gear with mobile fishing gear such as drift nets. As one fisherman put it, "if you keep an eye on your fishing gear, nobody will come close to it". For example, during the survey, trap fishermen in Al-Maragh (Barka) were engaged in disputes with drift nets and encircling nets fishermen from a neighbouring village (Al-Haradi), with the hope that their rights in the fishing ground would be respected. They wanted to ban the use of drift gill nets and encircling gear near their traps. The fishermen from Al-Haradi do not use traps and always reply that the "the sea is free or the sea is owned by the state[8]". Fishermen owning artificial reefs also indicated technological externalities. They argued that despite the damage caused to their reefs, when other fishermen set their traps, or operate drift and encircling nets close to the reefs these nets catch the fish attracted by the reefs, thus reducing the reef owner's ability to catch fish and raising his cost.

Setting or operating one's gear close to another's reduces each fisherman's ability to catch and increases the risk of gear entanglement, which is a symptom of technological externalities that result in reduced catch, damaged gear and reefs and direct conflicts among resource users. During the survey, the researcher interviewed a fisherman (from Badewooh village in Suwaiq) on the shore while he was mending a big portion of his drift net damaged by another fisherman's vessel passing over the net and cutting it into pieces. The fisherman indicated that he could not afford to replace the damaged drift net and he had no other fishing gear; thus, he was forced to stop fishing at least temporarily, resulting in lost income for his family, an incident he was trying to avoid. The researcher observed a few fishermen helping their poor colleague and one of them indicated that he had supported this poor fisherman by giving him a piece of netting to get him fishing again.

Fishermen were asked about the different methods that they adopted to avoid gear entanglement problems. Responses to this question for the 194 respondents included in this study are presented in Table 8.8. Fewer than one-half (48 %) indicated

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[8] They mean that the traditional rules do not apply nowadays as the fishery is regulated by the Government.

that they keep enough distance between their gears and others to avoid conflicts caused by gear entanglement and reduced catching abilities. Others (6.7 %) indicated that they respect whoever comes first to the fishing spot and wait for him to set his gear. Another 6.3 percent indicated that they mark their gear with floats on the surface to avoid damage caused by passing fishing vessels, encircling nets and drift nets. Fishermen operating traps have also contributed to reduce gear damage. They connect ten traps or so together and then submerge them into the bottom of the sea, while they identify the location by land marks, especially mountains[9]. Although the technique they have adopted increases the searching time for traps, it has greatly reduced tensions between mobile gear operators and trap fishermen.

Table 8.8 Methods Adopted to Avoid Net Entanglement Problems

Methods	No. of Respondents	Percentage
a). Keep enough distance	93	48
b). Wait until others set their nets	13	6.7
c). Mark my traps and set nets	12	6.3
d). Do nothing	76	39
Total	**194**	**100**

From Table 8.8, the results also revealed that among the 194 respondents who answered this question, 76 respondents (39 %) said they do nothing. This figure indicates a congestion problem which makes the group rule of avoiding gear entanglement difficult to implement. Those fishermen are likely to be from villages with many fishermen fishing in a limited fishing area. An example of this was seen in the drift net fishery for Indian mackerel, the operation of which took place in coastal waters. Fishermen reported that because many fishermen operate in a small area, it is very difficult to keep enough distance between gears. Although net entanglement was not cited by fishermen in this fishery as a major problem, nevertheless, reduced catching ability of nets is prevalent.

[9] Fishermen with long fishing experience of the fishing area use this technique. They identify their location on the sea by taking a fix of two high mountains on the land. When they come to search for their traps, they first identify their location in relation to the land-marks, and then they drop a long rope with a hook (messenger) at the end and weighted by stones to send it to the bottom of the sea. Then they tow the rope at slow speed until the hook gets caught in the rope that connects the traps. The researcher participated in an operation to search for traps, which sometimes may take quite a long time, especially when visibility is poor.

8.6.4 Conflict resolution

Fishermen's participation in collective effort to resolve conflicts, in a sense, can be considered as solving the demand-side[10] provision problems (Gardner *et al.*, 1990; p. 344) where fishermen engage collectively in one way or another to alter their fishing activities in order to avoid degradation of their fish resource. To elicit information on their behaviour, fishermen were asked if they have united to resolve conflicts in their village or town. The results indicated that fishermen's participation in conflict resolution varies and were identified by the effort the fisherman made toward the group. Some fishermen took the lead and went to the local Governor's office, "the Wali office", to report trespassers. Others went further, to the Ministry of Agriculture and Fisheries and others gave their support to the group by attending village meeting called by the head (sheikh) of the village. Among the 194 vessels owners included in the survey, the majority (75 percent) did participate in their group to resolve a conflict. To examine the type of conflicts fishermen face in their fishery at the time of the survey, they were asked to give details about disputes they came across. Four main types of conflicts were identified from the questionnaire survey (Table 8.9). The most cited one was conflict between two villages on the sardine seine fishing. Fishermen using Tahweta search for schools of sardine and sometime they operate in front of other villages, which may have an accord not to use such gear. This problem was cited by more than one-half (55.2 percent) of those who participated in conflict resolution. Another type of conflict cited was between users of mobile and static fishing gear, which was indicated by 23.4 percent of those who answered the above question. A few respondents (8.3 %) indicated conflicts on encircling gear (Tadwerah) for kingfish, while 19 respondents (13.1 %) reported conflict between fishermen from the same village on sardine seine fishing.

10 "demand-side" because this represents the demand for collective endeavours to solve problems.

Table 8.9 Conflict Types

Conflict type	No. of Respondents	Percentage
a). Conflict with other village on sardine seine fishing	80	55.2
b). Between operators of mobile and static gear	34	23.4
c). Conflict on encircling nets for kingfish	12	8.3
d). Conflict within a village on sardine seine fishing	19	13.1
Total	**145**	**100**

The Ministry of Agriculture and Fisheries, in an attempt to reduce conflict between mobile and static fishing gear after an endless dispute among fishermen, proposed a rule to establish fishing zones so that diverse gears were not utilised in the same area. The rule stated that "drift nets should be operated beyond 30 fathoms depth only", allocating the shallower water for static fishing gear. The rule has failed because the Ministry officials have not considered local conditions and fishermen's knowledge about their coastal fishing area. In an attempt to examine why the zoning regulation had failed, respondents were asked if they had heard of this rule in the first place. The majority (93 %) of vessels owners included in this study were aware of the zoning regulation (Table 8.10). Although most of them were aware of the zoning regulation, 95 percent of the respondents reported that the majority of fishermen in the area do not obey the rule.

When they were asked if they would inform authorities of fishermen violating the zoning regulation, just less than two-thirds were reluctant to cooperate in enforcing the zoning regulation and indicated that they would not inform the authority about those who violate this rule (Table 8.10). From Table 8.10 it can be seen that the number of respondents who were willing to inform the authority of violating fishermen represented 35 percent only. Most of them indicated that they would inform the authority only if asked, showing fears of further questioning by the authority for covering rule breakers. The results indicated that the rule has little support from fishermen and the chance of its implementation to reduce conflict is very small.

Respondents were then asked that if they think this regulation, if enforced, would reduce conflicts in their fishery. The results indicated that only 29 percent of the respondents (mostly trap fishermen) thought that this rule would reduce conflict, whereas, just less than two-thirds (64.9 %) indicated that this regulation would not reduce conflicts among fishermen (Table 8.10). The remaining 5.7 percent were not sure about their answers.

Table 8. 10 Respondents' Responses to the Zoning Regulation

Statements	Yes	Not sure	No	Total
a). Have you heard about the zoning regulations?	181 (93.3)	0	13 (6.7)	194
b). Did fishermen obey this rule?	7.0 (3.6)	1.0 (0.5)	185 (95.9)	194
c). Are you willing to inform authority about those who violate this rule?	68 (35.1)	5.0 (2.6)	121 (62.4)	194
d). Do you think the rule will reduce conflicts?	57 (29.4)	11 (5.7)	126 (64.9)	194

*** Figures in parentheses are percentages of the total**

When fishermen were asked for the reasons behind their answers, those who thought the regulation would reduce conflict indicated that it would reduce damage to traps and static gear caused by mobile fishing gears. However, those who opposed the zoning regulation (126 respondents) listed three reasons presented in Table 8.11. The results show that 84 respondents (66.7 %) viewed the regulation as unfair to drift net fishermen, because most of the species they target are found in the shallow water at depths between 8 and 14 fathoms. Others (35 respondents or 27.8 %) indicated that it is very risky to go to the open ocean with their small fishing vessels, especially in winter. The remaining 7 respondents (5.50 %) based their opposition to this regulation on the fact that the regulation was designed for those who operate tuna drift nets, and they indicated that there are no fish for them in the open ocean.

Table 8.11 Reasons for the Failure of the Zoning Regulation

Reason	No. of fishermen	percentage
1. Most species found at depths 8-14 fathoms	84	66.7
2. Rough weather in winter	35	27.8
3. The regulation was designed for tuna fishermen	7	5.55
Total	126	100

8.7 Indigenous Management Institutions

For as long as people have engaged in fishing, harvesting of fish and its related activities has been at least a partially collective business. Fishermen have worked together on a host of activities such as resource management, labour sharing and marketing of fish products. It would be too costly, sometimes impossible, to undertake some of these activities individually. The case of resource management, which needs a collective effort if the fishery is to be sustainable, is obvious. Therefore, indigenous institutions have long been important for communities sharing a common resource to avoid the adverse outcomes of independent actions, the results of which are sub-optimal, not only for the users themselves, but also for the whole society.

For example the manorial system of medieval Britain, a classic example of integrated farming, was sustained for some 700 years by a high degree of cooperation between farmers (Pretty, 1995; p. 133). There are many cases from around the world where local groups established detailed management measures for sustainable use of village resources. These local groups provide support and mutual help through sharing arrangements while they took communal decisions to punish individuals who attempted to violate the group rules by overconsuming or under-investing in common resources (for detailed cases see: Baland and Platteau, 1996; Berkes, 1989 and Ostrom, 1990). The central question here is how resource users have succeeded to form such institutions and make them effective and sustainable, at least for a period of time, when they all have the opportunity to free ride and shirk? As important as the first question is why some of these institutions have survived while others have collapsed. In the present section, the researcher wants to look at the indigenous institution that governed Al-

Batinah fishery for many years and investigate the factors that made such institution incapable of withstanding the current changes.

The literature abounds with examples of indigenous institutions organized by rural communities to coordinate resource use. Many of these institutions have been effective and sustainable over periods of hundreds to thousands of years in many cultures and ecosystems. A few of these include, for example, mountain grazing and forest CPRs in Switzerland and Japan, irrigation systems in Spain and the Philippine islands and a self-governing institution to manage fish resource in Turkey (Berkes, 1989; Baland and Platteau, 1996; chap. 12 and Ostrom, 1990; p. 58). Many others may not yet have been documented, which may include both successful institutions and failed ones.

The success of a sustainable fishery depends neither on skills and knowledge of individual fishermen nor on economic incentives alone, but on action taken by the community as a whole within the framework of an institution to govern its member activities. This is regarded as the biggest challenge facing world fisheries at present especially those in developing countries. For example, in the absence of an institution, aimless unilateral effort to reduce fishing effort in an overexploited fishery will not achieve socially optimal results, as the situation raises the temptation of many to free ride on the effort of others.

Let us describe briefly the institution that governs the usage of fish resources in South Al-Batinah. Fishermen in Al-Batinah are not free to engage in catching fish in any manner. They are governed by an institution named <u>Senat Al-Bahar</u> in local parlance; where "<u>Senat</u>" means code and "<u>Al-Bahar</u>" means the sea; thus, "code of the sea". The institution directly addresses technological externalities and assignment problems, and in some cases the amount of fish harvested. Although <u>Senat Al-Bahar</u> seems incapable of withstanding current changes, some of its rules are still followed and supported by the legal system in the country. A charismatic local leader who is an experienced fisherman and a former captain normally chairs the institution. The leader's prestige and the trust he evokes impart a great deal of legitimacy to his decisions. Because access rules to the fishery are quite strict (in some cases) and conservation mechanisms are adopted, the local institution (<u>Senat Al-Bahar</u>) is similar to "type III societies" as described by Baland and Platteau (1996; p. 217) in their typology of local institution of resources management. Although the institution does not have a special monitoring device to monitor the activities and behaviour of fishermen at sea, fishermen themselves enforce some of the rules. In addition, moral norms play a central part in the success of Senat Al-Bahar and serve as a substitute for monitoring devices.

In south Al-Batinah as well as all around the Omani traditional fisheries the people have inherited a system of regulation called Senat Al-Bahar to address the problems associated with their activities in fishing and to govern the use of the fish resources. A number of rules were devised at different times to address common problems faced by fishermen. Some of these rules, as we shall see later, are still in use. According to the master of Senat Al-Bahar in Suwaiq, "specific rules were devised for all types of fishing gear and for different fish species when needed". Among the rules that were used to limit harvest activities in some spots and limit the types of technologies that can be used is the rule that bans all fishing gears from being used on sea-mounts, except for handlines. For instance, in Suwaiq there are three well-known sea-mounts which are very productive. This rule is used, in part, as a method of minimizing technological externalities, as the area of the sea-mounts is too small for the operation of gill nets, for example. Second, the non-selectivity characteristics of gill nets will threaten the productivity of the spot. The same rule is also applied to fishing grounds around islands, as these places are reserved for fishing with handlines.

Fishermen in Barka have a local accord to band drift net fishing in areas less than 20 fathoms depth around islands. The shallower areas around islands in Barka are restricted as there are plenty of coral reef grounds and because the area is a nursery ground for juvenile fishes (personal communication with Sheikh Ahmed Al-Hamdani from Al-Sawadi, Barka). Therefore, to avoid technological externalities and to restrict the amount of fish harvested, local accords were devised to govern the activities of fishermen on these scarce fishing spots. All these rules are documented in the Wali office and when a dispute erupted fishermen and local authority refer to this documentation.

The most often used rule is the one that concerns the assignment of fishing spots. The rule states that "the first to arrive has the right to fish" in the spot. This rule applies to all fishing gears operated in the area. The exception to this rule is found where fishermen have built artificial reefs on the floor of the sea (called locally "*shad*" or "*shadood*" in the plural) to enhance the productivity of these spots because they provide habitats and "refuge sites" for fish. Such fishing spots belong to those who constructed them or inherited them from their fathers. Interestingly the ownership of these spots is transferable but the price is relatively high, especially for the well maintained reefs, reflecting their high productivity. Owners' rights over these spots are well respected by all fishermen and backed up by the legal system. Other fishermen wishing to fish in the area should watch the distance rule. The distance at which one can place fixed nets or traps near artificial reefs belong to others is approximately 100 metres in all directions, except to the seaward of the reef, where it should be doubled because normally shadood attract fish or provide shelter for fish coming from offshore. Most fishermen stated that they have to be at a distance from others' gears, whether this was artificial reefs or any other fishing gear. Although they did not specify any distance, nevertheless they knew that they had to give enough distance so as not to reduce others' gear catching ability. Mobile fishing gear used to be relegated to areas outside the location of these spots, as well as areas of static gear, in order to minimize conflicts erupting through the use of diverse fishing gear in the same area. As one respondent put it, "fishermen in the area used to respect each other's gear and territories, but now trespassers are many".

Constructing a new artificial reef required the permission of the owner of the closest artificial reef to the spot preferred. The owner of the established reef will indicate how far from his reef the new reef should be constructed and in which direction. In most cases the master of Senat Al-Bahar will mark the place for the new reef to be constructed. Fishermen are not allowed to build shadood in front of another village. All these rules are devised in order to avoid placing one's reefs close to another's, hence reducing his catching ability.

In the beach seine fishery for sardine, competitive encounters may easily arise if several vessels are running after a sizeable school. To cope with this kind of assignment problems, specific rules have been devised and interestingly are still followed by fishermen. As sardine schools migrate across the coast from west to east or from east to west, net bosses established a collective procedure to establish the sequence of net shooting rights. For example, if a fisherman spots a school of sardine, he is allowed to follow the school even if it passes his neighbours' location, but he is allowed to cast his net once only and if he fails to encircle the school (or catch part of it), the turn transfers to his neighbour and so on for all net bosses waiting to catch the sardine school[11]. Similar fishing turns are adopted by beach seine fishermen in Bahia (Brazil), but a lot-drawing procedure decides who will cast first (Cordell and Mckean, 1986, cited in Baland and Platteau, 1996; p. 208).

Because fishermen using cast nets can catch sardine from the shore, the rules of Senat Al-Bahar do not allow them to sell their catch in the market[12]. Sardines caught by cast nets are normally used as baits for handlines and traps (personal communication with Suliman Al-Mamari, master of Senat Al-Bahar in Suwaiq). For example, fishermen can only land sardine caught by gill nets (minimum mesh size enforced) into the market. Night fishing for sardine using any fishing gears is banned as well, except fishing for bait. The selectivity of gill nets allows smaller sardine to pass through the meshes to reproduce.

The discussion above suggests that traditional fishermen in the study area may possibly fail to adopt rules other than those that address technological externalities and assignment problems, even when an important fish species is threatened with depletion. However, there are some evidences that these communities, at least in the past, did take steps to conserve important fishery from depletion. These evidences are reported by many fishermen and masters of Senat Al-Bahar interviewed by the researcher, as they remembered the time of their fathers and grandfathers when they devised rules to conserve the sardine fishery. The sardine fishery was an important fishery in Al-Batinah in the past and continues to be so at present. In his description of the fishery of Oman in 1948, Bertram indicated that landing of sardine predominated other fish species and was an important resource in Al-Batinah (Bertram, 1948; p. 6). Because of its importance, we found that the take from the sardine fishery was restrained by limiting the time of harvest every day. A few old fishermen (in Al-Qurha village, Suwaiq) remembered a time during which sardine became scarce, and therefore fishing orders were only given by the master of the Senat Al-Bahar. Sardine appear in the coastal waters in small schools at the beginning of the season. The master of the Senat Al-Bahar asked fishermen not to catch sardine for at least two weeks from the start of the season. He justified this on the basis that the sardine were small and should be kept to grow and lay

[11] The researcher has observed the operation of beach seine and how the rule of fishing order was followed by two neighbours. Two net bosses explained the order of casting beach seine nets.

[12] Cast nets are known to have a very small mesh size, which will cause stock depletion if used to land sardine for sale in the market.

their eggs; as well as to avoid frightening the fish as they approach coastal villages. When the fishing season started, the fishermen were not free to catch sardine as they desired. They were only allowed to start fishing in the afternoon, specifically after they finished the afternoon prayer (around 3.30 p.m.) until sunset (around 6.00 p.m.). The start of fishing on any day was marked by a white flag raised by the master of the Senat Al-Bahar permitting fishermen to go to sea to catch sardine. An old fisherman added, "restricting fishing time to a few hours in the afternoon allowed plenty of time for fish to breed and feed, which resulted in plenty of sardine for all fishermen in that season and the seasons that followed".

At present, many rules concerning sardine fishing are still applied and enforced. For example, sardine fishing is still banned at night except in few situations where baits are needed by fishermen to catch other species, but in any case sardine caught at night can not be sold in the market. Another rule, devised to conserve the small pelagic stocks, like sardine and Indian mackerel, prohibits fishing at depths between one fathom and three fathoms as these areas are known as hatching grounds for fish to lay their eggs[13]. Fishing outside the restricted area was also restricted to the morning only. In Seeb (a neighbouring town to Barka but not included in the survey) fishing time for small pelagics has been further limited to take place between 6 o'clock in the morning and 12 o'clock noon only, since 1994. This recent rule is a direct response of fishermen to the threat of degradation of their fishery caused by intensive fishing.

The above description gives a general picture of the type of institution governing fishermen's activities at sea in Al-Batinah. Rules vary from one town to another according to the situation in each town and to the type of leader chairing the Senat Al-Bahar, but the above description highlights common rules devised by fishermen in the three towns studied in this research.

Although some of these rules are still followed, the Senat Al-Bahar seems incapable of withstanding current changes. One can think of a host of factors that might undermine the capabilities of villages' collective action as described by many scholars. Technological change, population growth and market links are all crucial factors but not the only ones. Baland and Platteau, in their analysis of failure of many natural resource management institutions around the world, found a centralised approach to resource

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[13] The rule was announced in 16 August 1993 in the Wali office after a long debate among fishermen to conserve the sardine fishery. The Wali indicated that any violation of the rule would be punished.

management by the state as the main factor that undermines the capabilities of collective action (Baland and Platteau, 1996; p. 279; see also Ostrom, 1990). The case of south Al-Batinah fishery has some similarities to many cases described by the above authors. Before 1970, the fisheries management in Oman was the responsibility of the Senat Al-Bahar which was supported by the local authority in each town, normally the Wali (governor) and the "khadi[14]". The local authority in each town provided an environment that is supportive of fishermen devising rules to manage the fish resources. The rules of the Senat Al-Bahar, as well as agreements made among fishermen were recognized, documented and enforced by the local authority (the Wali). In the case of a fishing dispute between fishermen in the same village or from two villages, the sheikhs (village leaders) would try to solve the dispute peacefully. If the sheikhs were unable to resolve the conflict, the case would be raised to the Wali who would ask the master (s) of the Senat Al-Bahar and other old fishermen in the town to state the rules of the Senat Al-Bahar applicable to the case.

The same procedures are applied at present, but because the Ministry of Agriculture and Fisheries claims sole responsibility for managing the fishery, as will be discussed below, there are conflicting views between the Senat Al-Bahar and the Ministry staff regarding the fishery. For example when local authority and fishermen decided to ban the use of Tahweta to catch sardine, users of these gears went to the Ministry of Agriculture and Fisheries and obtained permission to use the same gear undermining the collective arrangement devised by the Senat Al-Bahar.

The modernisation process that has taken place in Oman during the last thirty years tends to make village based institutions for resource management increasingly difficult. The political legitimacy of local management authorities has been reduced by political and technological changes. The same findings were noticed by Lawry, 1989 (cited in Baland and Platteau, 1996; p. 284) and Wade (1988; p. 216) who concluded that the modernisation process has reduced incentives for individuals to participate in localised collective arrangements.

As part of its national development strategy, during the early 1970s, the government introduced a new system of fisheries management, the implementation of which was assigned to the Ministry of Agriculture and Fisheries. As a result, the Senat

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[14] Judge of the "Sharia" court where judicial system is based upon Islamic laws "Sharia".

Al-Bahar lost a great deal of its autonomy and its masters or leaders, virtually stripped of their control of the resources, now have to come in terms with the new management plans which are new to traditional fishermen. Despite the intention of the government to improve the local level management of fish resources, the power and control have remained considerably centralised and the input of local fishermen and masters of the Senat Al-Bahar has been minimal.

Therefore, at present, the erstwhile legitimacy and control of the Senat Al-Bahar has been hampered and its function has been usurped by government administration. The process of transformation has created some confusion at local level, as it is not clear who should be responsible for the management of the resource. The same effect of weakened local institutions as a result of transferring power and control from the local level to government officials is found in many developing countries. A similar situation to the one described above is found in Kordofan (Sudan) where the traditional system of forest management has failed in recent decades because the power of village sheikhs to control tree-cutting has been replaced by government legislation (Bruce and Fortmann, 1989, cited in Baland and Platteau, 1996; p. 275). Another situation was also observed in India after the *panchayat* system replaced the traditional system of forest management (Baland and Platteau, 1996).

The new system of fisheries management made access to the fishery simple and encouraged non fishermen to enter into the fishery. The process of obtaining a licence is very simple, any national Omani can obtain a licence regardless of his occupational background. The Ministry requires a signature of a coastal villages' sheikh in order to issue the licence. People tend to bribe the sheikh in order to obtain his signature and as a result many non-fishermen and even some rich elite obtained fishing licences and entered the fishery either themselves or by hiring fishing labour. Many use the licence to apply for government free interest fishing loans and subsidies to acquire vessels, engine and fishing gear and then sold them to fishermen. Entry of people who have no background in the practice of fishing has eroded local collective arrangement the result of that is illegal-fishing practices and the dependence of the Senat Al-Bahar on moral norms to preclude certain activities was hampered.

Fishermen find themselves in difficult position to form collective action and to adhere to moral norms to preclude certain activities of resources appropriation because new entrants do not obey tradition rules of the Senat Al-Bahar.

New entrants into the fishery are less likely to be involved in the local management of the fishery. Therefore, they tend to break the rules devised by the Senat Al-Bahar (use prohibited gears, fish in restricted areas, increase fishing time, etc.,) not because they try to maximise their profits, but because they felt no moral responsibilities toward the institution. The current situation tends to allow the population of access rights-holders to grow so that individual incomes extracted from the fishery fall below the subsistence level. Even local fishermen, in their struggle for survival, are tempted to violate rules devised by the Senat Al-Bahar and free riding behaviour (stealing others catch, fishing in prohibited areas, using smaller mesh size, etc.,) appears to be the natural way of subsidising individual income, hence raising the discount rate of appropriation beyond what is desirable for the society. However, what is still observed is that in places where the local institution is legitimate, fishermen's adherence to moral norms precludes certain activities of resource appropriation.

8.8 Conclusion

In this chapter, the characteristics of the traditional fishery of South Al-Batinah were presented. The study found that fishermen used a variety of fishing gear in order to diversify their income from fishing. The results proved that more fishing effort has been added into the fishery.

Fishermen in the area own more or less similar fishing vessels in terms of size, hull construction and engine horsepower. Fishermen, therefore, can be considered as a homogenous group with respect to their fishing fleet. Therefore, the fishing fleet could not be an obstacle to achieve collective action as agreements to restrain the take from the fishery become easier as the difference in the characteristics of the fishing vessels among owners is negligible.

The above findings strongly suggest that fishermen were in general in agreement on the status of the fishery. They perceived the problem of declining stocks in their fishery as either sever or extreme, indicating a common dilemma. Sharing similar views about a particular common dilemma by a majority of resource users may foster the emergence of collective action because it is possible that the majority of the fishermen will participate in collective action, if initiated, to solve their common problem. Fishermen were also aware of the factors that cause their fishery to be depleted. High awareness of the resource exploitation problems and the factors responsible for these problems can induce fishermen in the area to work collectively to avoid the tragedy of their fishery.

The chapter also highlighted the management institution that governed the fishing activities of the fishermen in the study area. The results suggest that the fishermen in the study area are not free to engage in catching fish in any manner. Fishermen have inherited an indigenous management institution, which address the problems associated with their activities in fishing and to govern the use of the fishery. Many local accords were devised by the local institution to address common problems faced by fishermen, of which many are still in use. Although the local institution at its current form seems to address technological externalities and assignment problems, there are some evidences that fishermen in the area, at least in the past, had devised rules to conserve important fishery from depletion.

The study findings indicate that the capabilities of the local institution have been undermined as the result of the centralised approach to resource management by the state. The modernisation process that has been taken place in the country during the last thirty years tends to make collective action at village level to manage the fishery increasingly difficult. The erstwhile legitimacy and control of the local institution has been hampered and its function has been usurped by government administration.

The new system of fisheries management, by implementation of a licensing scheme, has made access to the fishery simple, and encouraged transforming the fishery from a common property to an open access. Entry of people from outside the fishing village has eroded local collective arrangements and the dependence of the local institution on social ostracism and moral norms to preclude certain activities was hampered.

CHAPTER NINE

ANALYSIS OF THE FACTORS THAT INFLUENCE THE EMERGENCE OF COLLECTIVE ACTION

9.1 Introduction

The purpose of this chapter is to identify and quantify factors or attributes that are influential in fishermen's decision to adopt a cooperative strategy toward the management of the coastal fish resources in South Al-Batinah, Oman. The identification and quantification of these factors will allow an increased understanding of the process of emerging collective action and will help provide policy guidance to promote collective action at the village level. The results presented in this chapter are very important when trying to assess the collective choice of the traditional fishermen in the study area. After identifying the factors influencing the fishermen's tendency to cooperate or defect, these factors will be included in a regression model to determine what can be regarded as the main predictors of the success and failure of collective action.

The chapter begins by constructing a number of composite variables that will be used later in hypotheses testing and which are considered here as the independent variables. The dependent variable, "attitude toward cooperation", is also a composite variable which is an index composed of eleven statements measuring different aspects of fishermen's participation in collective action. The chapter then describes hypotheses testing to determine the factors that influence the emergence of collective action. As the main theme of this thesis is to evaluate the scope for collective action among fishermen in South Al-Batinah, this chapter tests a number of hypotheses which were advanced for this purpose and which were derived directly from the literature review presented in Chapter Three. General discussions and comparison with the findings of other studies are highlighted at the end of each section.

9.2 Awareness of Resource Exploitation Problems

The purpose of this section is devoted to evaluate fishermen's awareness of the overall status of the fishery, the causes of overfishing and its consequences and the awareness of the problem of externality created by their harvesting activities. As the main theme of this thesis is to evaluate the scope for collective action, the section investigates whether fishermen in the three towns under review have similar views regarding their use of the resource. Sharing similar awareness and perceptions about harvesting activities by some users may create the necessary consensus to drive enough resource users to adopt a cooperative behaviour. The following subsections present the procedures followed to calculate the composite variable score value for the multi-item Likert scale to determine the four composite variables that test fishermen's perceptions and awareness towards the resource exploitation problems which will be used later for hypotheses testing. They also present the univariate analysis of fishermen's responses to the four issues of resources exploitation problems.

9.2.1 Awareness of resource status

To assess fishermen's awareness of the status of the fish resource the researcher used five statements and presented them to the interviewed fishermen. These statements are designed to assess different aspect of resource status (Table 9.1). Responses to the statements were measured on a Likert scale where fishermen had to choose between "Agree", "Indifference" and "Disagree" to represent the most appropriate answer to their views. The three responses were assigned numerical scores of three, two and one respectively. The results indicated that there is a consensus of responses indicating an overexploited fishery as indicated by the responses of the sampled fishermen. This can be seen in Table 9.1 where around 94 percent of the respondents agreed with the first two statements (E19 and E20) in Table 9.1. Fishermen who agreed with the third (E21) and fourth (E22) were 166 (85.5 %) and 174 (89.7 %) respectively. Lack of consensus is seen with regard to the last statement (E23) in Table 9.1 with regard to the presence of trash fish. Fishermen's opinions were divided here; half of them agreed with the statement, whereas the other half were either not sure about their answer (22.1 %) or completely disagreed with it (27.8 %). The lack of agreed responses to the last statement was anticipated, because in a multi-species fishery, like the one in South Al-Batinah, the problem of trash fish predominates in the trap fishery more than in the drift net fishery. The presence of catfish (*Arius thalassinus*) and other non-marketable demersal species in the catch of fishermen is more often cited by trap fishermen, whereas most of the pelagic species caught by drift net are marketable.

Rather than treat the items in Table 9.1 as separate measures, it is preferable and reasonable to combine them into one index or scale which is defined as a composite variable (Nachmias and Nachmias, 1996; Bryman and Cramer 1997; Oppenheim, 1992). To do this, the score of individual responses are aggregated and then the total score is divide by the number of statements in the scale to obtain the mean score value for that particular scale. The new composite variable computed from Table 9.1 is referred to here as "Awareness of Resource Status" and has a scale similar to that of individual statements ranging from a score of three (perfect agreement) to a score of one (perfect disagreement).

It is clear that the measure of individual items in Table 9.1 is an ordinal measure. This poses problems for researchers since the inability to treat such a variable as an interval measure means that methods such as correlation and regression which are powerful and popular cannot be used (Bryman and Cramer, 1997; p. 57). However, multi-item scales or the composite measures like the one computed from Table 9.1 have the advantage of having the quality of interval variables because they permit a large number of categories to be stipulated (ibid.). The multi-item scale that measures "Awareness of Resources Status" is then treated here as an interval variable and this permits correlation and regression to be used. Furthermore, the desirability of composite variables lies in the fact that a single statement for measuring attitudes not only yields insufficient information, but also is subject to random response error. If only one statement is used to measure an attitude, there is a chance that it will yield an inaccurate reflection of the subject's response. However, if many statements are used, the effect of some kind of error in responding to one statement will have less effect on the accuracy of the total attitude score.

The same procedure described above to calculate a composite variable score value for a multi-item scale will be followed to determine the other three composite variables that test fishermen's perceptions and awareness towards: the factors that cause overfishing, the consequences of overfishing and externality in coastal fisheries.

Table 9.1 Awareness of Resources Status (N=194)

	The items	Responses		
		Agree	Indifference	Disagree
E19	Your fish catch per trip declines	183 94.4 %	2 1 %	9 4.6 %
E20	Your target species is difficult to catch	182 93.8 %	3 1.6 %	9 4.6 %
E21	The large fish are difficult to find or catch	166 85.6 %	9 4.6 %	19 9.8 %
E22	We need to spend longer hours looking for fish then we used to	174 89.7 %	3 1.5 %	17 8.8 %
E23	The percentage of trash fish in your daily catch has increased	97 50 %	43 22.2 %	54 27.8 %

Following the procedure discussed in the above section, a new variable "Awareness of Resource Status" is calculated. The mean score for this variable is 2.72 with a standard deviation of 0.43. The score is closer to perfect agreement (score three) than to disagreement (score one). The above figure reflects the consensus of views which enables us to conclude here that fishermen in the area are aware of the ongoing processes of resource depletion and of the extent of damage done. Possession of such information about the status of the resource is vital for the emergence of collective action, as this will reduce the transaction cost of allowing agreements of cooperative behaviour to take place. It is argued here that when fishermen are aware of the resources problem, they will be interested in participating in local conservation efforts.

Before proceeding to use the scale in correlation and regression analysis, it was evaluated for reliability by calculating Cronbach's alpha. The results presented in Chapter Six (Section 6.8.1) indicate that alpha of 0.76 is achieved by the scale suggesting that the scale is reliable, based on the recommendation of Nachmias and Nachmias (1996), Bryman and Cramer (1997) and Bagozzi (1994) that an alpha of 0.70 is a reasonable standard for reliability.

9.2.2 Awareness of the causes of overfishing

Factors that are thought to be responsible for causing resource depletion, as seen by fishermen in the area, were investigated in Chapter Eight using an open-ended question. The majority of fishermen (82.4 %) reported overfishing as the main factor causing the fishery to deplete, while the remaining fishermen (17.6 %) indicated causes other than overfishing. In this section the analysis will focus on fishermen's awareness of the causes of overfishing.

In order to assess fishermen awareness of the causes of overfishing, the researcher devised a multi-item scale and administered it to the sampled fishermen. These items were devised to measure fishing effort from different dimensions so they can be safely aggregated to form a composite variable instead of treating each item individually. Fishermen's responses to individual statements are presented in Table 9.2 which shows that the majority of fishermen agreed that large numbers of vessels, large numbers of units of fishing gear, new technology and increased fishing time per trip are causing their fishery to be depleted. Many excluded two factors, vessel size and high horse-powered engines as causing fish resources to decline. For example, only 45.4 percent and 21.1 percent were agreed that larger vessels and high horse-powered engines respectively would cause the resource to decline. It was made clear to the respondents that the meaning of larger vessels in statement F25 is not industrial trawlers or bigger vessels, but rather larger vessels of the same type used by the traditional fishermen in the study area. Regarding engine horse-power, fishermen indicated that in their fishery, engine horse-power does not influence the amount of catch directly, simply because fishing is carried out while the engine is off.

Following the procedure discussed in Section 9.2.1, a new variable, "Awareness of the Causes of Overfishing", is calculated. The mean score for this variable is 2.4 with a standard deviation of 0.53. The score is closer to 3 (agree) than to 1 (disagree). This suggests that fishermen in the study area are aware of their harvesting activities and can determine those components of their harvesting effort that are directly responsible for the degradation of the resources. They formed a correct idea about their own responsibilities for a decline of fish catches. The results presented in Chapter Six (Section 6.8.1) yield a Cronbach's alpha of 0.76. This shows that the scale is reliable, based on the recommendation of Nachmias and Nachmias (1996), Bryman and Cramer (1997) and Bagozzi (1994).

Table 9.2 Awareness of the Causes of Overfishing (N=194)

The items	Responses		
	Agree	Indifference	Disagree
F24 Fish resources decline if too many vessels are operating in the same area	154 79.4 %	6 3.1 %	34 17.5 %
F25 Fish resources decline if all vessels are large in size	88 45.4 %	20 10.3 %	86 44.3 %
F26 Fish resources decline if all vessels use high horse-powered engines	41 21.1 %	48 24.8	105 54.1 %
F27 Fish resources decline if all vessels employ large no. of nets	169 87.1 %	4 2.1 %	21 10.8 %
F28 Fish resources decline if fishermen use encircling gear	166 87.1 %	3 1.5 %	25 12.9 %
F29 Fish resources decline if fishermen increase their fishing time per trip	141 72.7 %	7 3.6 %	46 23.7 %

9.2.3 Fishermen's perception of the consequences of overfishing

In the previous sections it was found that fishermen in the study are aware of the current status of their fishery and of the factors that led to this deteriorating situation. In this section, fishermen's perception of the consequences of having a depleted fishery are discussed. To test their perception, a multi-item scale of six statements was administered to them and the responses are presented in Table 9.3. In general, a direct result of having a depleted fishery is a declining catch and an increase in fishing costs (Alessi, 1997). The statements in Table 9.3 were devised to measure these consequences from different dimensions.

The results indicated that 84 percent of the sampled fishermen agreed that they have to search for fishing grounds away from their villages and 85 percent agreed that because of declining state of their fishery they have to extend their fishing hours to catch the same amount (Table 9.3). Almost 96 percent agreed that their fuel consumption has increased and they have to use more fishing nets to catch a profitable amount. Those who indicated that many fishing areas close to their villages are barren due to overfishing represent 89 percent of the sampled fishermen. The majority of respondents (97 percent) said that because of overfishing, income has declined. The mean score for the composite variable "The Consequences of Overfishing" is 2.8 with a standard deviation of 0.35. The mean scale value is just below 3 (perfect agreement) which suggests that fishermen in the area are aware of the consequences of their harvesting activities on their fishery. Cronbach's alpha which tests the reliability of the scale was 0.79, highly reliable for most purposes (Nachmias and Nachmias, 1996, Bryman and Cramer, 1997 and Bagozzi, 1994).

Table 9.3 The Consequences of Overfishing (N=194)

	The items	Responses		
		Agree	Indifference	Disagree
G30	Your fishing area becomes further away from your village	163 84 %	4 2.1 %	27 13.9 %
G31	Your fishing hours become longer	165 85.1 %	8 4.1 %	21 10.8 %
G32	Your fuel consumption increases	186 95.9 %	1 0.5 %	7 3.6 %
G33	Many fishing areas are barren	173 89.2 %	8 4.1 %	13 6.7 %
G34	You have to use more fishing gears to catch fish	186 95.9 %	3 1.5 %	5 2.6 %
G35	Your income declines	188 96.9 %	1 0.5 %	5 2.6 %

9.2.4 Externalities in coastal fisheries

To elicit information about fishermen's awareness of the presence of negative externalities in their fishery, they were asked to choose the answers that best represent their views of five statements included in Table 9.4. The resulting outcome can be indicated by loss of catch, loss of fishing gears and the results of conflicts erupting between fishermen in the fishing grounds. To test fishermen's attitude towards these sup-optimal outcomes, five statements were presented to them; their responses are shown in Table 9.4. The majority of fishermen agreed with the statement concerning congestion externalities, such as facing difficulties in fishing if too many vessels operate in a small area (80 percent), the problem of net entanglement (81.9 percent) and the problems of increased violence between fishermen at sea (87.6 percent). The majority (94.3 percent) also agreed that they lost catch when fishing in areas recently fished by others. Out of the five statements presented in Table 9.4, a composite variable was calculated following the procedure discussed in Section 9.2.1. The mean scale value is 2.8 with a standard deviation of 0.45. The results indicate fishermen have a consensus agreement about the negative externalities as caused by their misuse of the fishery. Cronbach's alpha for this scale was 0.77 which indicates that the scale has high internal consistency (Nachmias and Nachmias, 1996, Bryman and Cramer, 1997 and Bagozzi, 1994).

Table 9.4 Externalities in Coastal Fisheries (N=194)

The items		Responses		
		Agree	Indifference	Disagree
H36	You may face some difficulty in fishing if too many vessels operate in a small area	155 79.9 %	3 1.5 %	36 18.6 %
H37	Net entanglement problems often occur if too many vessels operate in the same area	159 81.9 %	4 2.1 %	31 16 %
H38	You cannot fish in the area where many colleagues are fishing	181 93.3 %	4 2.1 %	9 4.6 %
H39	Less catch is expected if you operate in the area which has just been fished by many colleagues	183 94.3 %	1 0.5 %	10 5.2 %
H40	Conflicts among fishermen at sea are rising	170 87.6 %	2 1 %	22 11.4 %

9.3 Attitude Toward Cooperation

The dependent variable for this study, willingness to cooperate to manage fish resources, was measured as an index. Cooperation was operationalised as fishermen's obeying the group rules and participating in collective efforts to manage the resources. Ideally, cooperation should be measured as fishermen's self restraint in harvesting the resources when it is depleted, but measuring such a concept, either directly or indirectly, proved difficult. Therefore, the researcher measured fishermen's willingness to cooperate from different dimensions. Although the index contains items describing activities not related explicitly to harvesting behaviour (or resource use), the researcher decided to include all because each item could be viewed as a demonstration of cooperation to manage the fishery and to support the local management institution (Senat Al-Bahar).

The index contains 11 statements, which were administered to the respondents. Respondents were asked to choose the answer that best represented their feeling about each statement. They could either choose "yes" which had a score value of one or "no" which had a score value of zero. Fishermen's responses to the 11 items in the index are presented in Table 9.5. Then the scores of individual responses for the statements were aggregated to find the total score value for the index. The Cronbach's alpha coefficient for the eleven items is 0.80, suggesting high internal consistency for the index (Nachmias and Nachmias, 1996; Bryman and Cramer, 1997 and Bagozzi, 1994).

Table 9.5 Index of Fishermen's Cooperation

The items		Responses	
		Yes	No
N88	You returned under-sized fish into the sea when caught in your net	177 91.2 %	17 8.8 %
N89	Set your nets at a distance from other fishermen gears	178 91.8 %	16 8.2 %
N90	Inform on colleague who break the fishing rules	90 46.4 %	104 53.6 %
N91	Attend workshops arranged by the Ministry of Agriculture and Fisheries	79 40.7 %	115 59.3 %
N92	Renew your fishing licence and boat licence	136 70.1 %	58 29.9 %
N93	Speak to the head of the tribe about the problem of your fishery	131 67.5 %	63 32.5 %
N94	Discuss fishing problems frequently with more than one fisherman	164 84.5 %	30 15.5 %
N95	Participate in a group to resolve conflicts in fishing	90 46.4 %	104 53.6 %
N96	Persuades others to follow fishing rules	125 64.4 %	69 35.6 %
N97	Visit the Governor office to raise a case against rules violators	68 35.1 %	126 64.9 %
N98	Oppose catching sardine with purse seine nets	157 80.9 %	37 19.1 %

The univariate statistics of the index of the dependent variable "cooperation" indicated that the mean level of cooperation was 7.19 with a standard deviation of 2.75 and a range of 0 to 11. The index was an interval measure ranged between a score of 0 (no cooperation) to a score of 11 (maximum cooperation). Because the multi-item index that measures "cooperation" is treated here as an interval variable, analysis such as correlation and regression can be used (Bryman and Cramer, 1997; p. 57). Visual inspection of the shape of the distribution for this index indicated that responses are close to being normally distributed and, therefore, it is safe to apply parametric tests such as Pearson's r, t-test, analysis of variance (ANOVA) and regression which assume that the population scores are normally distributed (Bryman and Cramer, 1997; p. 117).

9.4 Treatment of Hypotheses

The following sections examine factors that are hypothesised to be influential in fishermen's decisions to adopt cooperative behaviour. The dependent variable for the analysis is fishermen's cooperation, which is tested against a number of independent variables. Results of hypotheses are presented here and those factors which are influential in fishermen decision to cooperate are identified.

9.4.1. Economic dependence on the fishery

In the study of collective action, the notion that economic dependence on a common pool natural resource as a source of livelihood promotes the emergence of collective action has received considerable support in the literature. Many researchers argue that the more the user group depends on the resource as a source of livelihood the more likely they will achieve endogenous solutions to the commons problems (Runge, 1986; Wade, 1987). Consequently, economic dependence on fishing is hypothesised to have positive influence on cooperation (Table 9.6). The independent variable "economic dependence" was operationalised as the relative importance of respondent's income from fishing to the overall household income. For the purpose of this study, net income earned directly from fish sales by individual vessel owners was only counted as fishing income. Therefore, "household dependence on respondent's fishing income" (RED) was calculated as the respondent's annual income from fishing divided by total household income (fishing and non-fishing income earned by the respondent and other members of the household).

$$\text{RED} = \frac{\text{respondent's annual income from fishing}}{\text{total household income}}$$

Another factor, which is hypothesised to be inversely related to fishermen's decision to cooperate in the commons, is the respondent's economic dependence on non-fishing income. The study anticipated that those who are less dependent on their fishery would show less inclination toward cooperation. Therefore, the concept "economic independence" was operationalised as the relative importance of respondent's non-fishing income to the overall household income. The variable "respondent's economic independence" (REI) was therefore calculated as the respondent's annual non-fishing income divided by total household income (fishing and non-fishing income earned by the respondent and other members of the household) as shown in the following equation.

$$\text{REI} = \frac{\text{respondent's non - fishing income}}{\text{total household income}}$$

Visual inspection of the scatter diagram shows that the relationship between the dependent variables and "respondent's economic independence" (REI) is more likely to be curvilinear than linear which makes the use of the Pearson's r correlation irrelevant. Therefore, the variable was collapsed into two groups and the t-test technique was used instead.

Table 9.6 Operationalization and Measurement of Association for Economic Dependence with Attitude Toward Cooperation.

Dependent variable (Interval variable)	Independent variables		Test
	Indicators	Type	
Cooperation	RED[1]	Ratio	Pearson's r
	REI[2]	Nominal	t-test

The univariate statistics of the variable "respondent's economic dependence on fishing" indicated the mean dependent on income from fishing was 51.6 percent with a standard deviation of 35 percent and the median of 41.8 percent. It was found that at least 30 percent of the respondents were 100 percent economically dependent on fishing and 22 percent were dependent on fishing for 40 to 80 percent of their income. Only 8 percent of the respondents were dependent on fishing for less than 10 percent of their total income. These results suggested that fishermen's households in the three towns are still highly dependent on income from fishing. To investigate if there is a relationship between respondent's economic dependence on the fishery and their attitude toward cooperation, the two variables were correlated to test the following hypothesis:

Hypothesis one: *There is a statistically significant correlation between fishermen's economic dependence on the fishery and their attitude toward cooperation.*

[1] RED means household dependence on respondent's income from fishing

[2] REI means household dependence on non-fishing income

A null hypothesis of no relationship between the two variables was therefore derived from hypothesis one. The null hypothesis will be rejected if the p-value (probability distribution) of the Pearson's r is less than 0.05.

Testing the above null hypothesis shows that there is a significant correlation between fishermen's economic dependence on the fishery and their willingness to cooperate. Therefore, the null hypothesis of no correlation was rejected based on a Pearson's r-value of 0.23, which was significant at the 0.001 level (Table 9.7). Therefore, the result of this test provides support for hypothesis one.

Table 9.7 Pearson Correlation between Respondents' Economic Dependence on Fishing and their Attitude Toward Cooperation (N=194)

Test	r-value	Decision
Pearson's r	0.23 $P < 0.001$	Reject H_0

Although the correlation is somewhat weak, it provides support for earlier findings by Runge (1986) and Wade (1987) of a positive relationship between economic dependence on the common property resources and individual decisions to cooperate in managing the commons. In the same vein, Baland and Platteau have stated: "*the more vital the resource for survival the greater the chances of successful collective action*" (Baland and Platteau, 1996; p. 287). Therefore, the positive relationship between economic dependence and cooperation was expected, and confirmed the findings of the above authors from which hypothesis one was derived. MacDonald (1993) also achieved similar results when studying the economic dependence on fishing of fishermen in Lake Chapala, Mexico. Her results also produced a small positive correlation ($r = 0.32$) between economic dependence on fishing and fishermen's cooperation in the management of their fishery. This low correlation reflects appropriately the correlation value of 0.23 calculated in this study for economic dependence on the fishery.

Overall, the results suggest that economic dependence on the resource has a positive effect on cooperation as demonstrated by the correlation discussed above. Therefore, it can be stated here that those fishermen who are more economically dependent on fishing show more willingness to cooperate in solving their common problem. Fishermen not dependent on the fishery become detached from the village, since they are no longer bound by the condition of mutual vulnerability now because they have alternative sources of income. To some extent it can be said that for those who are less dependent on the fishery for their income, loss of reputation (when caught catching immature fish, for example) is not a threatening factor to deter them from doing so.

In contrast to economic dependence on the fishery, it is interesting to examine the difference between cooperation mean scores for those fishermen who are economically dependent on non-fishing income and those who are less dependent on non-fishing income. Table 9.8 indicates that the t-test value (2.57; $p < 0.05$) which shows that the difference in means between those who are dependent on non-fishing income and those who are less dependent on non-fishing income is statistically significant. Based on the result presented in Table 9.8, the null hypothesis was also rejected. From Table 9.8 it can be seen that those who are dependent on non-fishing income had a lower cooperation mean (5.42) compared to that of those who are less dependent on non-fishing income (6.39). The inverse relationship, therefore, confirms our earlier suggestion that the more the fishermen depend on non-fishing income, the less effort they will exert toward its maintenance. These results provide more support for the economic dependence hypothesis (H_1).

Table 9.8 Unrelated t-test Comparing Attitude Toward Cooperation of those who are Dependent on Non-fishing Income and those who are Not Dependent on Non-fishing Income (N=194)

Groups	N	Mean	SD	Df	t- value[3]
Dependence on non-fishing income	62	5.42	2.30	192	2.57; $P < 0.05$
Not dependence on non-fishing income	132	6.39	2.53		

9.4.2. Social identity as a fisherman

Another basic hypothesis is that fishermen who have strong social identity as fishermen will pursue cooperative behaviour more than those who have weak social identity as fishermen (H_2). Three indicators: fisherman's family involvement in fishing,

3 The variances of the both groups are not statistically different since the p-value of the Levene's test is 0.69. Consequently, a t-value based on an equal variances estimate is employed for this test.

his principal work, and his experience in fishing were devised to measure social identity of individual fisherman (Table 9.9).

The first indicator of social identity was operationalized in terms of family involvement in fishing. It is assumed here that fishermen with more family involvement in fishing have a strong social identity as fishermen. Fishermen were asked if any of the five kin relations included in the questionnaire were engaged in fishing. To measure this variable a value of one was given for each kin relation involved in fishing. The measure ranged from weak social identity, a value of zero where no other member of his family is involved in fishing, to strong social identity, a value of five, where the respondent's father, brothers, sons, uncles and cousins were identified as fishermen. Cousins and uncles were included in the index because the extended family is characteristic of the Omani culture.

The second indicator of social identity is operationalized as the number of years the respondent has spent working as a fisherman (fishing experience)[4]. The more years the respondent has spent in fishing the stronger might his social identity be. The researcher anticipated a positive relationship between the number of years the respondent has spent in fishing and his willingness to cooperate.

The third indicator of social identity was the respondent's principal work. A value of one is given to a fisherman citing only fishing as the main occupation. Fishermen reporting non-fishing occupations as their main occupations were given a value of zero. This was based on the assumption that a fisherman engaged in other occupation besides fishing has lower social identity as a fisherman, whereas those who stick to their occupation has high social identity. The analysis will treat the three indicators separately; Pearson's r correlation is used to find a correlation between the first two indicators and the dependent variable "attitude toward cooperation", and a t-test is used to determine if the mean scores of fishermen with different principal work is significantly different (Table 9.9).

[4] Childhood fishing (the first 14 years of adult life) was excluded because it was found that respondents included their childhood fishing in their responses. In the study area, it was observed that children at the age of ten go fishing with their fathers.

Table 9.9 Operationalization and Measurement of Association for Social Identity with Attitude Toward Cooperation.

Dependent variable	Independent variables		Test
(Interval variable)	Indicators	Type	
	Social identity		
Cooperation	a. Family involvement	Interval	Pearson's r
	b. Experience	Interval	Pearson's r
	c. Principal work	Nominal	t-test

As described above, three indicators were used to measure social identity (family involvement in fishing, number of years spend in fishing and principal work). Family involvement in fishing is the first indicator of social identity, which had a mean value of 3.4 members with a standard deviation of 1.4 members and a range between 0 and 5. The results indicate that most respondents have a strong social identity; more than two-thirds (67 percent) of the respondents have 3 or more members of their family engaged in fishing.

When social identity as a fisherman was measured using fishermen's experience in fishing (number of years spent fishing), the univariate statistics indicated that the mean number of years spent fishing by fishermen was 27.90 years with a standard deviation of 9.95 years. The minimum number of years a fisherman was engaged in fishing was 4 years and the maximum was 55 years.

The third indicator of social identity was fishermen's principal work, which separates the group into those who reported fishing as their principal work and those who reported another occupation as their principal work. The univariate statistics indicated that most respondents have strong social identities as fishermen when reporting their principal work. More than two-thirds (69.6 percent) reported fishing as their principal work. The remaining 30.4 percent of the respondents reported something other than fishing as their principal work.

Hypothesis tests were conducted by measure of association, namely "Pearson's r" when both variables are interval or ratio measures and t-test when the independent variables are nominal as shown in Table 9.9. The aim here is to determine the influence of social identity on fishermen's individual decision to participate in collective action. Therefore, these tests were selected to explore the extent and direction of the relationships between the dependent variable "attitude towards cooperation" and the independent variables. The following hypothesis was tested.

Hypothesis two: *there is a statistically significant correlation between respondents' social identity as fishermen and their attitude toward cooperation to manage their fishery.*

To test hypothesis two, a null hypothesis of no relationship was tested. The result of testing the null hypothesis for the three indicators of social identity and attitude toward cooperation supported the hypothesis that those respondents who identify themselves more strongly as fishermen will cooperate more in the commons than those who do not identify themselves strongly as fishermen. Table 9.10 shows the measurement of association (Pearson's r), which indicates a fair degree of support for this hypothesis using number of years spent fishing, but lack of support using family involvement.

Table 9.10 Pearson Correlation between Family Involvement and Number of Years Fishing and the Dependent Variable Attitude Toward Cooperation (N=194)

Test	Family involvement	Years fishing
Pearson's r	0.08 $P > .05$	0.17* $P < 0.05$
Decision	Accept H_0	Reject H_0

(*) Indicate significant correlation at the 0.05 level

To test the third indicator of social identity (principal work), the t-test technique was used to determine the influence of fishermen's principal work on their attitude toward cooperation in the commons. Table 9.11 indicates that the t-test value of fishermen's cooperation (-2.46; $P < 0.05$) is statistically significant, and there is a significant difference between fishermen's willingness to cooperate, according to their principal work. Table 9.11 indicated that fishermen who reported fishing as their main occupation had a higher cooperation mean (6.37) than that of those who combined fishing and another occupation (5.42). Therefore, the significant difference between the mean scores of the two groups indicate that fishermen who reported fishing as their main occupation had more positive willingness to cooperate in the commons than those who reported non-fishing occupations. The results presented in Table 9.11 give more support for our hypothesis (H_2) that those respondents who identify themselves more strongly as fishermen will cooperate more in the commons than those who do not identify themselves strongly as fishermen

Table 9.11 Independent Sample t-test Comparing Attitude Toward Cooperation according to fishermen's principal work (N=194).

Principal work	N	Mean	SD	DF	t-value[5]
Fishing	135	6.37	2.52	192	- 2.46; P < 0.05
Non-fishing	59	5.42	2.34		

Therefore, Hypothesis two was supported when social identity as a fisherman was operationalised as principal work and number of years spent fishing, but was not supported when family involvement was correlated with attitude toward cooperation. As shown by the results in Table 9.10, a statistically significant correlation between number of years a fisherman spent fishing and the dependent variable attitude toward cooperation was discovered. Although the correlation was somewhat weak ($r = 0.17$), nevertheless it was positive and significant ($p < 0.05$) which means that there is a tendency for fishermen who have more fishing experience to show more willingness to cooperate to manage their fishery.

9.4.3 Perception of resource exploitation problems

Also tested was the relationship between attitude toward cooperation and the fishermen's awareness of resource exploitation problems. A number of hypotheses were devised for this purpose and Pearson's r was used again to carry out the test, the results of which are presented in Table 9.12. Visual inspection of the scatter diagram shows that the relationship between the dependent variable and the independent variables appears to be approximately linear. Therefore, it is safe to use the Pearson's r correlation to test the strength and direction of the relationship between the above variables (Cramer and Bryman, 1997; p. 177).

[5] The variances of the both groups are not statistically different since the p-value of the Levene's test is 0.84. Consequently, a t-value based on equal variances estimate is employed for this test

Hypothesis three: *there is a statistically significant correlation between the attitude toward cooperation and fishermen's perception of the status of the resource.*

The null hypothesis is that there is no significant correlation between attitude toward cooperation and fishermen's perception of the status of the resource. The results of testing this hypothesis indicate that there is a significant correlation between attitude toward cooperation and fishermen's perception of the status of the resources. This means that the higher the perception of resource users about the status of their resources, the higher would be their attitude to cooperate in solving its problems. The Pearson's r value for this test was 0.2 ($P < 0.05$) which allows us to reject the above null hypothesis (Table 9.12).

Hypothesis four: *there is a statistically significant correlation between the attitude toward cooperation and fishermen's awareness of the causes of overfishing.*

Table 9.12 shows that there is a positive statistically significant correlation between attitude toward cooperation and fishermen's awareness of the causes of overfishing. The Pearson's r resulting from this test was 0.32, which is significant at the 0.05 level, allowing the rejection of the null hypothesis and providoing support for hypothesis four. This moderate correlation suggested that those fishermen who have high awareness of the likely factors that cause the resource to deplete show more willingness to cooperate to avoid further damage to their fishery.

Hypothesis five: *there is a statistically significant correlation between the attitude toward cooperation and fishermen's awareness of the consequence of overfishing.*

The test of hypothesis five revealed a statistically significant correlation between attitude toward cooperation and fishermen's awareness of the consequences of overfishing. This is clearly shown in Table 9.12 by the Pearson's r-value of 0.15 which was significant at the 0.05 level. The null hypothesis of no significant relationship is therefore rejected. Hence, fishermen who are aware of the consequences of overfishing shows more willingness to cooperate.

Hypothesis six: *there is a statistically significant correlation between the attitude toward cooperation and fishermen's awareness of externality in coastal fisheries.*

Among hypotheses concerning the resource exploitation problems, the test failed to reject the null hypothesis which was derived from hypothesis six. The correlation between attitude toward cooperation and fishermen's awareness of externalities in their coastal fishery was non-significant. The calculated r coefficient was 0.12 and the P-value was greater than the 0.05 significance level. Therefore, the test has failed to reject the null hypothesis (Table 9.12).

Table 9.12 Pearson's Correlation between Fishermen's Perception of Resource Exploitation Problems and their Attitude Toward Cooperation (N = 194)

Hypothesis	Technique used	The results	
		Value	Decision
H3	Pearson's r	0.2; $P < 0.05$	reject H_0
H4	Pearson's r	0.32; $P < 0.05$	reject H_0
H5	Pearson's r	0.15; $P < 0.05$	reject H_0
H6	Pearson's r	0.12; $P > 0.05$	accept H_0

The results presented above show that three of the four indicators of the fishermen's awareness of their resource exploitation problems were correlated significantly with the dependent variable "attitude toward cooperation". The strongest correlation was found between awareness of the causes of overfishing and cooperation and indicates that the more the fishermen are aware of the impact of their harvesting activities, the more they will cooperate to manage the fishery. As anticipated in Section 9.2, possession of information about the status of the resource is vital for the emergence of collective action, as this will reduce the transaction cost of allowing agreements of cooperative behaviour to take place. It is proved here that when fishermen are aware of the resource problem, they will be interested in participating in local conservation efforts.

The findings in this study suggested that resource scarcity supplies an incentive for cooperation. We are reminded by Baland and Platteau that awareness of resource depletion will be more detectable when the impact of overexpolitation on the resource stock is more visible and when the connection between user behaviour and the level of this stock is more evident and predictable (Baland and Platteau, 1996; p. 228). However, there may be some optimal degree of resource depletion that will give the right incentive for fishermen to cooperate to restrict their take from the fishery. An abundant fish resource obviates the need to conserve, while an exhausted one makes it useless to do so, but a middling scarcity offers enough to reward conservation efforts (Arnold and Campbell, 1986: cited from Blair, 1996; p. 493). We have seen from fishermen's income that the fishery is still generating some net income which suggests that the fishery is not exhausted. This level of scarcity seems to give the right incentive to cooperate as suggested by Arnold and Campbell. This was proved by the positive correlations between the three indicators of the resource exploitation problems and cooperation, which were statistically significant at the 0.05 level. Similarly, Baland and Platteau (1996) emphasized that for corporate management of CPRs to be effective, an essential prerequisite is that resource users correctly perceive the benefits of collective action, which requires that they are well informed not only about the status of the resource but also about the possible impact of use behaviour on stocks (p. 290).

In an attempt to investigate the combined affect of the four indicators together, the researcher developed a composite variable, "awareness of resource exploitation problems". The four indicators were combined into one index (Nachmias and Nachmias, 1996; Bryman and Cramer 1997; Oppenheim, 1992). The resource exploitation indicator equalled the sum of the four indicators divided by four (the number of indicators) to form an interval variable. The Cronbach's alpha for the indicator was 0.70, which indicates high reliability (Nachmias and Nachmias, 1996). When this indicator was correlated with the dependent variable "cooperation", the resulting Pearson's r (0.30; p = 000) indicated a positive correlation which was statistically significant at the 0.001 level. This means that the more the fishermen are aware of the resource exploitation problems, the higher would be their willingness to cooperate.

9.4.4 Social and demographic variables.

In the study of collective action, the notion that resource user's profile (for example, age, education, household size, etc.,) promotes or hamper the emergence of collective action has not received enough attention in the literature. Although demographic variables may not have a crucial deterministic effect on the success or failure of collective action, some of these variables such as age, education and household size are expected to have some influence on fishermen's decision to participate on collective action. Due to the long-run nature of productivity benefits from resource conservation, long planning horizons are expected to influence positively fishermen's decision to participate in managing their resources (Kalaitzandonakes and Monson, 1993; p. 202). Younger fishermen are thus more likely to participate in collective effort than older fishermen. Similarly, fishermen with higher education are expected to devote greater participation to conserve their fishery. This is because higher education is associated with grater information on the productivity implications of overfishing and the benefits of various collective conservation efforts. Therefore, it is hypothesised here that there is significant correlation between fishermen's demographic variables and their willingness to cooperate in the commons.

In this section the investigation will proceed to determine whether fishermen's profiles have an influence on the level of cooperation or effort they will put to manage their coastal fishery. Because both variables (dependent and independent) were measured on the interval scale, Pearson's r correlation appears to be very appropriate to determine if a significant correlation does exist between fishermen's profiles and the dependent variable attitude toward cooperation.

Hypothesis seven: *there is a statistically significant correlation between fishermen's profiles and their willingness to cooperate in the commons.*

The test will be used to reject the null hypothesis of no significant correlation between the dependent variable and the three independent variables. The null hypothesis will be rejected if the p-value (probability distribution) of the Pearson's r is less than 0.05.

It was found that there is no statistical significant correlation between respondent's age and household size and their willingness to cooperate. The p-values for these variables are greater than 0.05. Hence, the null hypothesis should be accepted (Table 9.13). The only statistical significant correlation was found between education attainment and the dependent variable attitude toward cooperation. The calculated Pearson's coefficient was -0.144 with a p-value of less than 0.05, which indicates that the null hypothesis in this case only should be rejected.

Table 9.13 Pearson's Correlation between Fishermen's Profiles and their Attitude Toward Cooperation (N=194)

Variables	The results	
	Value	Decision
Age	0.138; $p > 0.05$	Accept H_0
Family size	-0.025; $P > 0.05$	Accept H_0
Education attainment	-0.144; $P < 0.05$	Reject H_0

As it can be seen from the negative value of the Pearson's r, fishermen's education is inversely related to attitude toward cooperation. Surprisingly, this means that those fishermen who have high education seem to cooperate less to manage their fishery. One would expect that educated fishermen would take the lead to initiate collective action to manage their coastal fishery. But this study has proved the opposite. There must be an explanation for this finding. It is interesting to find that the more educated the fisherman, the better his chances of finding a job in the civil services. To prove this, an independent t-test was carried out to determine whether or not there is any significant difference between the mean values of education attainment of those who have jobs in the civil services and those who do not. The results shown in Table 9.14 indicated that the t-value of this test (3.45; $p < 0.05$) is statistically significant, and there is a difference in educational attainment between those who are employed and those who do not have alternative work opportunities. As can be seen from Table 9.14 the mean education attainment for working fishermen (mean education attainment = 2.24) is higher than for pure fishermen (mean educational attainment = 0.60).

Table 9.14 Independent t-test Comparing Education Attainment and Working Status (N=194).

Groups	N	Mean	SD	df	t- value[6]
Fishermen with another job	59	2.24	3.42	192	3.45; $P < 0.05$
Fishermen without another job	135	0.60	1.93		

[6] The variances of the both groups are statistically different since the p-value of the Levene's test is less than 0.05. Consequently, a t-value based on unequal variances estimate is employed for this test.

In Chapter Seven, the findings indicated a significant association between respondent's age, education and working in non-fishing occupations. Because the high educational attainment a fisherman has the better his chance to find a job outside the fishing sector, this can explain why fishermen's education attainment is inversely related to their willingness to cooperate in managing their fishery. Furthermore, it was found in Chapter Seven that work opportunities outside the fishing sector are likely to attract younger fishermen. Beside their exit opportunities, it is expected that those young respondents have less knowledge about the problems associated with the fishery compared to the older fishermen.

The results obtained here provide more support for the hypothesis that resource management is most effective among homogenous groups of people (Scott, 1993; Taylor, and Singleton, 1993; Johnson and Libecap, 1982). As in many real-world setting, groups may not be homogeneous in all respects. In this case the group is not homogeneous in terms of their dependence on the fishery. We have observed from the above discussion that the fishermen behave differently because they do not all value similarly the benefit they receive from a healthy fishery. Those who have secured jobs outside the fishery sector are better off and their subjection toward discount rate might be different (higher in this case) than that of those who depend on the fishery for their livelihood. Therefore, their low level of cooperation to manage the coastal fishery is expected based on the above findings. In game-theoretic terms, it can be said that players are heterogeneous where different type of players have to deal with each other. Such a situation is one where players with the payoff characteristic of the assurance game face players with the payoff structure characteristic of the prisoner's dilemma (Baland and Platteau, 1996; p. 88).

Therefore, the above findings indicate that demographic variables do not have crucial deterministic effect on the success or failure of collective action. The hypothesis of significant relationships between demographic variables and fishermen's decision to participate in collective action was not supported using age and household size. The findings indicate that the hypothesis was supported using education as an independent variable, though the relationship was negative.

9.4.5. Vessel characteristics

It is interesting to examine the difference in fishermen's attitude to management of the fishery between fishermen of different technology. One would expect that the characteristics of the vessels would have some influence on the respondents' decision to cooperate or defect. Among vessel characteristics, vessel size and engine horsepower were chosen in this study to examine the influence of vessel characteristics on fishermen's level of cooperation. The emergence of collective action is seriously hampered by the existence of different interests, notably between users of different technology, for example the conflicts between fishermen operating bigger vessels equipped with bigger engines and fishermen with smaller vessels equipped with smaller engines. The former can exploit new fishing grounds outside the continental shelf, and so increase their profits. Therefore, they may be less concerned about conservation of fish resources in the coastal areas than those who are constrained by the low level of the technology they own whose subsistence depends on the state of the resource in the vicinity of their village owing to the lack of alternative income opportunities. For example, Johnson and Libecap found that fishermen's willingness to organise with others was made difficult because they are equipped with different fishing techniques (Johnson and Libecap, 1982). The following hypothesis will be tested:

Hypothesis eight: *there is a statistically significant correlation between vessel characteristics and attitude toward cooperation.*

The null hypothesis to be tested here is that there is no relationship between vessel characteristics and fishermen's attitude toward cooperation. Pearson's r was used again to test the strength and direction of the above relationship. The null hypothesis will be rejected if the p-value (probability distribution) of the Pearson's r is less than 0.05. The results presented in Table 9.15 indicate that there is no statistically significant correlation between vessel size and attitude toward cooperation. When the correlation was tested for engine horsepower, the results indicated that the correlation was not statistically significant as well (Table 9.15). Therefore, the null hypothesis of no statistical significant correlation between vessels characteristics and fishermen's attitude toward cooperation was accepted. The result of the above test was anticipated because in Chapter Seven it was found that fishermen in the study area are using vessels of more or less similar characteristics in terms of hull type (fibreglass), size and engine horsepower. Similar results were found by Salim (1996).

Table 9.15 Pearson's Correlation between Vessels Characteristics and Fishermen's Attitude Toward Cooperation (N=194)

Test	Vessel characteristics	
	Vessels size	Engine horsepower
Pearson's r	0.05 $P > 0.05$	0.06 $P > 0.05$
Decision	Accept H_0	Accept H_0

9.4.6 Risk perceptions

In game theory, high risk and uncertainty play a crucial role in a player's decision to take a particular strategy. Many researchers argue that the perception of increased risk inhibits cooperation (Fernandez-Cornejo *et al.*, 1994). In general, when a fisherman faces a situation of high risk and uncertainty, cooperation becomes a decision problem. Risk is believed to be particularly critical in the decision for individual fishermen to cooperate in managing their fishery because of the danger of subsequent loss due to free riders and their becoming suckers if a cooperative strategy is followed.

As presented in Chapter Five (section 5.2.1.2), in this study risk aversion is expected to be positively associated with higher willingness to participate in collective action. To operationalize the concept of risk perceptions, the study considered two factors generally associated with fishermen's risk attitudes. The first is debt to asset ratio (D/A) which measures financial risk. Fishermen with a high D/A ratio are likely to be less risk-averse (or they have a greater willingness to accept some risk). Therefore, fishermen with a large D/A ratio may be willing to accept greater business risks, and therefore they may be less willing to cooperate in managing their fishery.

The second indicator used to measure perception of risk is the total number of fishing gear types owned by vessel owners. This indicator is used as a proxy for a fisherman's willingness to take risk. When fishermen own many types of fishing gears, they are willing to accept some risk. Thus, fishermen who own more types of fishing gears have a less risk-averse attitude and they are less likely to show a high level of cooperation in commons (see section 5.2.1.2).

Hypothesis nine: *there is a positive statistically significant relationship between risk aversion and attitudes toward cooperation.*

A null hypothesis of no positive statistical significant relationship was derived from hypothesis nine. Pearson's r was used again to test the strength and direction of the above relationship. The null hypothesis will be rejected if the p-value (probability distribution) of the Pearson's r is less than 0.05.

The results presented in Table 9.16 indicate that among the factors related to risk, the correlation between debt to asset ratio and cooperation was statistically significant and negative only in Suwaiq. The calculated Pearson's coefficient was -0.330 with a p-value (0.004) of less than 0.05, which indicates that the null hypothesis should be rejected, at least in Suwaiq. Therefore, the higher the D/A ratio (less risk averse), the lower the fishermen's willingness to cooperate. This can be observed in the situation of an open access fishery or when the institution that governs the users' harvesting activities is weakened, for example, by government intervention, as in the case of the fishery described in this study. In such situations, a fisherman with a high debt to asset ratio will not take the offer of a cooperating game, as there is no guarantee that others will not defect and make him a "sucker". When the correlation was tested for the three towns, the null hypothesis was accepted, as there was no statistically significant correlation at the five-percent level ($P > 0.05$). The results for Barka and Masn'a may be due to the fact that this variable is influenced by other factors; for example the availability of alternative job opportunities outside the fishery sector, especially in Barka, which gives fishermen access to creditors to obtain loans for purposes other than fishing.

The second indicator used to measure the perception of risk is the number of fishing gear types owned by the individual vessel owner. The Pearson's r coefficient is negative and statistically significant in all three towns. As presented in Table 9.16, there is a moderate negative correlation between perception of risk and the attitude toward cooperation (- 0.30) which is statistically significant with a p-value (0.000) of less than 0.05. Thus, the null hypothesis of no significant correlation should be rejected. In any case, considering the overall effect of the two indicators of risk aversion, the hypothesis that risk preferences have no influence on a fisherman's attitude toward cooperation is rejected.

Table 9.16 Pearson's Correlation between Fishermen's Risk Preference and their Attitude Toward Cooperation (N=194)

Test	Risk preferences	
	D A ratio[7]	No. of fishing gears owned
Pearson's r	- 0.330* $P < 0.05$	- 0.300* $P < 0.05$
Decision	Reject H_0	Reject H_0

(*) Indicate significant correlation at the 0.05 level

9.4.7 Group size

In the study of collective action, the relationship between group size and the success of collective action has received considerable attention in both the theoretical and experimental literatures. Based on the literature review, it is hypothesised in this study that group size has no effect on the resource users' level of participation on collective action (Sandler, 1992; Barry and Hardin, 1982; Chamberlin, 1974; Wade, 1988 and Baland and Platteau, 1996).

The first stage of the analysis will be to take the three towns (Barka, Masn'a and Suwaiq) separately. The purpose here is to determine if there is a difference in fishermen's attitude toward cooperation among fishermen from the three towns included in this study. In fact, the total number of fishermen inhabiting each town is different; there are 343 fishermen in Barka, 236 in Masn'a and 383 fishermen in Suwaiq.

Hypothesis ten: *there is a statistically significant difference among fishermen f the three towns in attitude toward cooperation.*

To compare the attitude toward cooperation of the respondents from the three towns, one-way analysis of variance was used to test the null hypothesis of no significant difference in the mean scores of the three groups. The result of this test is displayed in Table 9.17. The F-ratio, which is the between-group means divided by the within-groups one (3.709/7.584 = 0.489), is non-significant. Consequently, there is no significant difference in attitude toward cooperation between respondents from the three

[7] The result (Pearson's r) shown here is for Suwaiq only. The resulted Pearson s r was no statistical significant for Barka and Masn'a.

towns. The result of the test has failed to reject the null hypothesis. Hence, it can be concluded that fishermen in the study area have a similar attitude toward cooperation.

Table 9.17. A One-way Analysis of Variance of Attitude Toward Cooperation (N=194)

	DF	Sum of Squares	Mean Square	F-ratio
Between groups	2	7.42	3.71	
Within groups	191	1448.53	7.60	0,489; P > 0.05
Total	193	1455.94		

The second stage is to take the total number of fishermen in each village as the independent variable. The independent variable "group size" was therefore operationalized as the total number of fishermen in each village. In this study, fishermen from 27 villages were included in the sample. The group sizes of these villages vary; the smallest has only 10 fishermen, whereas the largest has a total of 160 fishermen living together. It is interesting to examine the difference between fishermen's cooperation mean scores for those who live in villages of small user groups and that of large user groups. For the purpose of the analysis, the 27 villages included in the survey were divided into two groups: small and large. The small group includes villages inhabited by 40 fishermen or less and the large group includes villages with more than 40 fishermen living in them. A t-test technique was used to determine the influence of group size on fishermen's attitude to cooperate in the commons. The results presented in Table 9.18 indicates that the t-test value of fishermen's cooperation (1.01; P > 0.05) is not statistically significant. Hence, there is no significant difference between fishermen's willingness to cooperate according to their group size, i.e., fishermen inhabiting villages of large group size or small group size.

It can be seen from Table 9.18 that fishermen's cooperation mean scores for those who come from small villages (6.28) is slightly higher than the mean scores for those who come from large villages (5.91), though the difference is not statistically significant. Again, the results of the test failed to reject the null hypothesis of no statistical significant relationship between group size and fishermen willingness to cooperate.

Table 9.18 Independent Sample t-test Comparing Attitude Toward Cooperation of Fishermen Living in Small and Large Village Size (N=194).

Group size	N	Mean	SD	DF	t- value[8]
Small group	90	6.28	2.15	192	1.01; $P > 0.05$
Large group	104	5.91	2.77		

It is true that in some cases, members of a small group have better chances to organise and form collective action than those of a large group. The reason for this is that because when groups are small, members tend to have more personalised encounters in the village and they therefore have a strong incentive to consider the future consequences of their strategies instead of paying attention to immediate costs and benefits. But small groups have disadvantages as well. For example, during the field survey, the researcher was told by a group of fishermen from a small village that they could do nothing to stop fishermen from a neighbouring village using certain gears such as the Tadwerah and Tahweta, which are responsible for resource depletion. They stated that the members of their village are too few to face the large numbers of fishermen from the neighbouring village. They added that they could not even lobby the local authority to make fishermen from other villages obey the local fishing rules (Senat Al-Bahar) when fishing in front of their village. In fact, as will be shown below, large groups become like small groups when their members share common norms (homogenous group). In another small village (Al-Break in Masn'a) in which ten fishermen are living, the researcher found that the mean scores for cooperation was only one (the mean for the whole sample is 7.19). The researcher observed that 50 percent of the fishermen in this village were using gears such as Tadwerah and Tahweta. The other fishermen in the village stated that they could not oppose the action of their colleagues because of the size of their group.

We have seen that the group of fishermen surveyed in the present study is homogenous in term of their ethnic origin, culture and language, whereas groups of similar size studied by Salim (1996) in Malaysia were not homogenous because group members had different ethnic origins, languages and cultures (Chinese and Malay). Therefore, having a small user group does not eliminate cultural, ethnical and other

[8] The variances of the two groups are not statistically different since the p-value of the Levene's test is 0.84. Consequently, a t-value based on equal variances estimate is employed for this test.

differences among group members, and so it does not guarantee the homogeneity of the group.

It is true that for many authors one of the conditions for successful collective action is that user groups are small in size. This notion goes back to 1965 when Mancur Olson in his book "The logic of collective action" argued that "*provision of public goods depends largely on group size*" (Olson, 1965). Olson suggested that small groups would provide public goods; as the size of the group increases, individuals will not provide themselves with the public good required (ibid.). However, there are many others who expressed strong disagreement with Olson's view with respect to the connection between user groups size and participation in collective action. For example, Barry and Hardin stated that Olson's logic can only concern whether groups are privileged or latent, not whether they are large or small (Barry and Hardin, 1982). Sandler (1992) has also ruled out the direct effect of group size as the main predictor of the success or failure of collective action. In Chamberlin's view, the relationship between group size and the provision of collective goods is more complex than Olson asserts and, in many cases, it is the opposite of that suggested by Olson (Chamberlin, 1974; p. 707).

Another example from a real world setting is the findings of Wade in Andra Pradesh (India) when he stated that small size is not a necessary condition of success in collective action (Wade, 1988; p. 213-14). Similar to Wade's conclusion is the finding of Baland and Platteau after they had reviewed many cases of collective action from communities of different group sizes. They reached the following conclusion: "*The lesson from these examples seems to be that there is some sense in saying that large groups are made more like small groups when their members share common norms possibly enforced by a well-recognized authority*" (Baland and Platteau, 1996; p. 300). Therefore, the finding of this study, which ruled out the direct effect of group size on the success or failure of collective action, is consistent with the findings of Baland and Platteau (1996); Wade (1988); Chamberlin (1974); Barry and Hardin (1982); Salim (1996) and Sandler (1992).

9.4.8 Group heterogeneity

Of fundamental relevance to the study of collective action is the relationship between group heterogeneity and the success of collective action. Based on the literature review, three sources of heterogeneity that hamper the capacity of resource users to participate in collective action were identified. These sources are originated from the following: (a) ethnic, racial, or other kinds of cultural divisions; (b) differences in the nature of interests various individuals may have in a particular collective action and (c) inter-individual variations in some critical endowments, that are reflected in varying intensities of interest (Baland and Plateau 1996; p. 302). Baland and Platteau (1996, 1997a and 1997b) further asserted that while the first two are considered as causing a strong obstruction to collective action, the same cannot be said of the third case.

Regarding the first source of heterogeneity, ethnical, social and other cultural difference may have a negative impact on the ability of resource users to form collective action. As presented in Chapter Seven, fishermen in the study area were found to have a common language, share the same religious belief and originate from the same race. Therefore, the first source of heterogeneity (ethnic, racial, or other kinds of cultural divisions) was not used as an explanatory socioeconomic variable. Because the group is homogenous with respect to the first source of heterogeneity, fishermen seem likely to establish or maintain institutions to manage fish resources at low cost. Homogeneity coupled with high interdependence among the fishermen makes social ostracism strong enough to induce compliance with institutional rules.

When these ethnic, racial and cultural differences are minimized, they tend to eliminate the difference in interpreting the rules of the game as well as the social conventions and norms that support cooperation. However, ethnic and racial differences should not be assumed to be the cause of every collective failure. For example, Salim (1996) in his study of the coastal trawl fishery of Malaysia found that Chinese and Malay fishermen organized collective action to reduce overfishing in their fishery. Thus, their ethnic differences were no impediment to collective action.

The second source of heterogeneity (heterogeneity of interests or objectives) is a strong impediment to collective action as argued by Baland and Platteau (1996). To elicit information about the second source of heterogeneity, the fishermen were asked to report their fishing status, i.e., full-time or part-time. Part-time fisherman are those who are working full-time outside the fishing sector, and so have alternative income-earning opportunities. Based on the above discussion, the following hypothesis was tested:

Hypothesis eleven: *there is a statistically significant difference in willingness to cooperate between fishermen with different objectives concerning the use of the fishery.*

To compare the willingness to cooperate to manage the fishery of fishermen with different objectives or interest (fishing status as the explanatory variable), a t-test was used to test the null hypothesis of no significant difference. The results of this test are presented in Table 9.19. It is interesting to examine the difference between fishermen's cooperation mean scores for those who are full-time and that of part-time fishermen. The results presented in Table 9.19 indicate that the t-test value of fishermen's cooperation (- 2.85; $p < 0.05$) is statistically significant, and therefore, there is a statistical difference between fishermen's willingness to cooperate according to their fishing status, i.e., full-time and part-time.

Table 9.19 Independent Sample t-test Comparing Willingness to Cooperate of Full-time and Part-time Fishermen (N = 194)

Fishing status	N	Mean	SD[9]	DF[10]	t-value[11]
Part-time	59	6.36	2.68	192	- 2.85; $p < 0.05$
Full-time	135	7.56	2.70		

Therefore, the null hypothesis was rejected based on the results presented in Table 9.19. The result of the test clearly shows that full-time fishermen have a higher willingness to cooperate mean score (7.56) than part-time fishermen (6.36). This indicates that full-time fishermen have a more positive willingness to cooperate to manage their resources, owing to their high interest in the resources, than part-time fishermen.

In the context of coastal fisheries, for example, collective action is threatened when some fishermen have alternative income-earning opportunities. Resources management is undermined by the existence of different interests, most notably between full-time and part-time fishermen. In the case of fishing status, part-time fishermen having secured another source of income feel much less concerned about conservation

[9] SD = Standard Deviation.
[10] DF = Degree of Freedom.
[11] The variances of both groups are not statistically different since the p-value of the Levene's test is 0.84. Consequently, a t-value based on equal variances estimate is employed for this test.

of fish resources, than full-time fishermen whom subsistence crucially depends upon the state of these resources, owing to lack of alternative income opportunities (Platteau, 1989b; p. 645).

The intuition behind this hypothesis is that when two groups with different objectives appropriate the resource, the management of the resource is threatened. In such a situation, the first group (full-time fishermen) use the resource with a long-term objective; thus they will be much more concerned about its sustainability. The other group (part-time fishermen), owing to their alternative sources of income, will appropriate the resource with a short-term objective (higher subjective discount rate); thus they are much less concerned about resource management and will free ride on the efforts of the other groups. It has been suggested that heterogeneity of preferences amounts to transaction costs, and thereby impedes cooperation as cooperation requires shared values (Dasgupta, 1996; p. 403). The same can be said about industrial fishing where there are sometimes many exit possibilities, because fishermen can move their fleets to other fishing grounds (Platteau, 1989b; p. 645). Cases of this type are found in developing countries, where industrial fishing has been given concessions to exploit fish resources (Lim *et al.*, 1995; Baland and Platteau, 1996 and Ostrom, 1990), thus expanding the options open to skippers.

Based on the literature review presented in Chapter Three, the third cause of heterogeneity originates from differences in skills, assets, income and access to credit markets. Olson (1965) advanced the exploitation hypothesis in which he argued that agents with high stakes in a public good are more willing to bear a large share of the costs of its production (see also Guttman, 1978; p. 254). Some evidence from CPRs supports Olson's argument where the costs of regulation are often born by the economic elite (Wade, 1988; p. 190 and Ostrom and Gardner, 1993; p. 105). In an example provided by Baland and Platteau (1997a; p. 461) it was found also that rural cooperatives in the Netherlands were often created by better-off farmers who took the initiatives to start the cooperatives and contributed the bulk of the initial share capital. Another successful example was the case of Saudi Arabia which for many years produced less than its quota of oil to subsidize OPEC in its effort to reduce excess production by other members (Heckathorn, 1993, cited in Baland and Platteau, 1997b; p. 3). This pattern conforms well to the exploitation hypothesis advanced by Olson (1965) that the large is exploited by the small. Based on the literature review, the study will test Olson's (1965) exploitation hypothesis. Thus, it is hypothesised here that higher income inequality will lead to optimal provision of the collective goods as asserted by Olson (1965). The following hypothesis will be tested:

Hypothesis twelve: *there is a statistically significant relationship between income inequality and individual fishermen's willingness to cooperate.*

Therefore, the third indicator of heterogeneity was income inequality. A frequently used measure of the distribution of income is the Gini Coefficient, which was estimated for the three towns in Section7.8. The aim here is to determine the effect of income inequality on fishermen's individual decision to participate in collective action. Table 9.20 presents the Gini coefficients, and mean score for willingness to cooperate for the three towns included in this study.

Table 9.20 Gini Coefficient and Towns Mean Score of Cooperation.

Towns	Gini coefficient	Mean willingness to cooperate
Barka	0.34	7.48
Masn'a	0.37	7.02
Suwaiq	0.40	7.10
Average	0.39	7.19

From Table 9.20, it can be seen that Barka has the lowest income inequality (0.34) and the highest mean score for individual willingness to cooperate (7.48), while Suwaiq has the highest income inequality (0.40) and its mean level of cooperation was lower than that for Barka (7.10). The figures in Table 9.20 seem not to support Olson's exploitation hypothesis. To test the null hypothesis statistically, one-way analysis of variance was used, the results of which are presented in Table 9.21. Although variation in income inequality was observed between the three towns, statistical analysis does not show a statistically significant difference in the mean score of cooperation for the three towns (Table 9.21). The F-ratio is very small ($F = 0.489$ and $P > 0.05$); thus, it is non-significant. The results of the test failed to reject our null hypothesis that "there is no relationship between income inequality and individual fishermen's willingness to cooperate". Therefore, the findings of this study give no support for the exploitation hypothesis advanced by Olson (1965).

Table 9.21 A One-way Analysis of Variance of Attitude Toward Cooperation (N=194)

	DF	Sum of Squares	Mean Square	F-ratio
Between groups	2	7.42	3.71	
Within groups	191	1448.53	7.60	0.489; $P > 0.05$
Total	193	1455.94		

In an attempt to investigate further the influence of income inequality on individual willingness to cooperate, Gini coefficients were calculated for each village. In the three towns selected for this study, there are 27 fishing villages. These villages are used here as the unit of analysis and comparison was made between Gini coefficients in each village and its mean score for cooperation. Therefore, the study tested the relationship between income inequality and the level of cooperation in the 27 villages. Pearson's r was used to test the strength and direction of the above relationship (Table 9.22). The results presented in Table 9.22 indicate that there is no statistically significant correlation between income inequality and mean level of cooperation.

Table 9.22 Pearson Correlation between Income Inequality in each Village and its Mean Level of Cooperation (N = 27 villages)

Test	r-value	Decision
Pearson's r	0.059 $P > 0.05$	Accept H_0

The results of the correlation test have failed to reject the null hypothesis, and therefore Olson's exploitation hypothesis is rejected based on the results presented in Table 9.21 and 9.22. The findings of this study ruled out the effect of income inequality on the fishermen's ability to participate in collective action, similar to the findings of Baland and Platteau (1997a; p. 461 and 1997b; p. 3).

As argued by Baland and Platteau (1997a; p. 461 and 1997b; p. 3), the exploitation hypothesis should not be taken to mean that if the distribution of wealth were made more egalitarian, individual contribution would fall. In the case of OPEC, it just happened that the wealth of Saudi Arabia was overwhelmingly greater than that of other members of OPEC; thus, it attached a higher value to any improvement in oil prices, which made it rich enough to bear the greater share of the reduction of excess production. Further, Cornes and Sandler (1985; p. 113) argue that the optimal provision of a public good in a community of a given size is independent of income distribution (see also Cornes, 1993; p. 265). In communities where wealth is made more equal, the cost of initiating regulatory tasks would be shared more equally among agents, whereas greater inequality makes some agents big enough to bear a greater share of the costs on a voluntary basis, while others are too small or attach too little value to their resource endowments (Baland and Platteau, 1997b; p. 3).

In many instances from marine fisheries, wealth is associated with better availability of outside economic opportunities. Thus, a large elite, even though they attach greater value to their resource endowment, chooses to sacrifice conservation effort in order to derive quick gains in the present. In the context of coastal fisheries, for example, conservation effort may be seriously undermined by the presence of more endowed members. As their assets increase, they start to acquire bigger vessels and stronger engines, which allow them to exploit new fishing grounds away from their base village. Owing to this exit opportunity, they feel less concerned about conservation of local fish resources. Therefore, more inequality does not necessary lead to more efficient use of natural resources (Baland and Platteau, 1996; chap. 12; 1997a; p. 461 and 1997b; p. 3); thus, Olson's (1965) conjecture (the equilibrium in public-goods game often has small members free-riding more than large members) might not hold true in the case of CPRs.

To conclude this section, the study findings indicated that while the first two sources of heterogeneity (ethical and difference in objectives and interests) are considered as causing an obstruction to collective action, the same cannot be said about the difference in the distribution of income. More inequality does not necessarily lead to more efficient use of natural resources

9.5 Regression Analysis

In the above sections, fishermen's willingness to cooperate was found to be explained by a number of independent variables. The remainder of this chapter is devoted to illustrate the use of regression analysis to build a linear regression model to test these relationships further and to enable us to make prediction of the likely value of the dependent variable, "cooperation".

Regression analysis, in the form of multiple regression, is regarded as the most widely used and powerful tools for summarizing the relationship between variables and for prediction of the dependent variable (Bryman and Cramer, 1997; p. 256). The main theme of this section is to examine the possible contributions of the independent variables to fishermen's willingness to cooperate. The relative importance of the independent variables to the dependent variables is measured by R^2 (the coefficient of determination), which represents the proportion of the variation in the dependent variable accounted for by the variation of the independent variables (Kennedy, 1998; p. 13). It is often used as an indication of how well the model implied by the regression equation fits the data. For example, if R^2 of the regression model is 0.49, it can be said that the independent variables entered into the regression equation are providing an explanation of 49 percent of the variation in the dependent variable. The linear regression model chosen to test the relationship was:

$$y = \text{constant} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_n X_n$$

Where: β_1 to β_n are the regression coefficients

X_1 to X_n are the independent variables entered into the regression equation.

In the computation of the multiple-regression equation, the researcher employed a *stepwise* procedure to decide the sequence of the entry of variables into the equation. The *stepwise* selection of independent variables is the most commonly used method in testing regression (Norusis, 1993; p. 350, Bryman and Cramer, 1997; p. 267). It is a combination of forward and backward selection. With this procedure, variables are entered in steps, with the variable that exhibits the highest correlation with the dependent variable being entered at the first step, followed by the variable that exhibits the next highest correlation with the dependent variable; and so on, until the regression procedure terminates. The procedure terminates when independent variables fail to conform to the criteria for inclusion[12] operated by the stepwise procedure (Bryman and Cramer, 1997).

Before considering the results of the regression model, the F-ratio test should be inspected first. This test is used to examine the null hypothesis that *the multiple*

[12] Criteria for entry is set at $P = 0.05$. Therefore, any variable with p-value greater than 0.05 will be excluded from the regression equation.

correlation is zero in the population from which the sample was drawn[13]. The multiple regression analysis demonstrates that the correlation between the dependent variable "cooperation" and all the independent variables (awareness of resource problems, perception of risk, economic dependence on fishing and social identity) are significant in all the four steps of model building, as shown by the F-values in Table 9.23. Therefore, it is improbable that R in the population is zero; thus, the above null hypothesis is rejected.

Table 9.23 Steps of the Multiple Regression Results (N=194)

Predictors	Steps	R	R^2	F
Awareness of resources exploitation problems	1	0.31	0.09	19.77 $P<0.05$
Perception of Risk	2	0.39	0.14	16.76 $P<0.05$
Economic dependence on fishing	3	0.46	0.21	16.92 $P<0.05$
Social identity	4	0.48	0.24	14.48 $P<0.05$

Table 9.23 provides information about what happens as each variable is entered in the equation which is demonstrated by the steps from 1 to 4. As it can be seen, the multiple R (R^2) was 0.09 when only awareness of resources problems was included in the regression equation. When perception of risk was entered, the R^2 became 0.14, suggesting that this variable added 0.05 (0.14-0.09) to R^2. The variable economic dependence on fishing added another 0.07 (0.21-0.14) to R^2, and the variable social identity added a further 0.03 (0.24 -0.21) to R^2. The procedure was terminated after step 4. Step 4 provides the final figures for the equation as a whole. This shows, for example, that R^2 once awareness of resource problems, perception of risk, economic dependence on fishing and social identity are entered into the equation is 0.24, suggesting that around one quarter (24 %) of the variance in cooperation is explained by these four variables alone. Independent variables such as respondent's age, education and many others did not enter the regression equation because they failed to conform to the criteria for inclusion set by the stepwise procedure. Although these variables were statistically significantly associated with the dependent variable "cooperation", when the four variables (awareness of resource problems, perception of risk, economic

[13] This means that the multiple R (correlation between the dependent variable and the independent

dependence on fishing and social identity) are controlled, they do not have enough impact on cooperation to escape the program's exclusion criteria. In any case, if these variables were forced into the equation, their contribution to explain the dependent variable "cooperation" would be close to zero (Bryman and Cramer, 1997).

Another important statistical test that should be consulted in regression analysis is the t-value produced in Table 9.24, which indicates the statistical significance of individual regression coefficients (Beta). As can be seen from Table 9.24, the coefficients of the four independent variables in the model were statistically significant (P-values less than 0.05). This suggests that the calculated coefficients (Beta) for each of the four independent variables are unlikely to be zero in the population.

Table 9.24 Stepwise Multiple Regression Results at the Last Step (N=194)

Predictors	β	Beta*	T	tolerance
Awareness of resources problems	0.243	0.281	4.37 $P<0.05$	0.979
Perception of Risk	-0.731	-0.257	-3.99 $P<0.05$	0.978
Economic dependence on fishing	0.014	0.181	2.60 $P<0.05$	0.836
Social identity	2.37	0.169	2.42 $P<0.05$	0.835
(Constant)	2.94	-	2.43 $P<0.05$	-

*** Standardised Beta coefficients**

The last column (tolerance) in Table 9.24 provides information about multicollinearity, which refers to the situation in which there is a high multiple correlation when one independent variables is regressed on the others (intercorrelation among independent variables) (Kennedy, 1998 and Norusis, 1993). If two independent variables are intercorrelated, they provide very similar information, and it is difficult to determine the contributions of each variable on the dependent variable. The tolerance of a variable is a commonly used measure of multicollinearity (Norusis, 1993; p. 355). When the tolerance is low (close to zero), the multiple correlation is high and there is the possibility of multicollinearity which renders the results untrustworthy (Bryman and Cramer, 1997; Norusis, 1993). The tolerance for the four independent variables included

variables produced by the regression analysis) is equal to zero.

in the model of this study is high (close to one), ranging from 0.84 to 0.98, suggesting that multicollinearity is unlikely and the results are trustworthy.

Because the variables in the regression equation are derived from different units of measurement which makes the derived betas (β) non-comparable, standardised regression coefficients (Beta) should be used when interpreting the results to obtain the relative importance of each independent variable to the dependent variable (Kinnear and Gray, 1995; p. 183). Table 9.24 provides the final figures for the equation as a whole.

The multiple regression equation estimated in Table 9.24 suggests several findings. Fishermen's awareness of resource exploitation problems appears to be the best predictor of cooperation (standardised Beta = 0.281). Perception of risk also appears to be important (Beta = -0.257). Less risk averse fishermen show less cooperation, since the sign of the coefficient is negative. Economic dependence on fishing (Beta = 0.181) came in third place, followed by social identity (Beta = 0.169) as fishermen; the sign of both these coefficients is positive. Thus, the standarised beta for perception of resource problems means that for each one unit change of perception of resource problems, there is a standard deviation change in cooperation of 0.281, with the effect of the other three variables in the equation controlled. The final linear regression model obtained in this study to predict the dependent variable "cooperation" is as follows:

$$\begin{aligned}\text{Cooperation} = 2.94 &+ 0.24 \times \text{awareness of resources problems} - \\ &0.73 \times \text{perception of risk} + 0.014 \times \text{economic dependence on fishing} \\ &+ 2.4 \times \text{social identity}\end{aligned}$$

9.6 Conclusion

The results of this chapter provide some insight into the factors that influence the emergence of collective action to manage coastal fisheries. The factors highlighted in this chapter can be generalised to predict the success and failure of collective action in similar fishing communities. In particular, the analysis indicates that there is a positive relationship between economic dependence on the common property resources and individual decisions to adopt a cooperative strategy. The higher the economic dependence on the fishery, the higher the effort one would provide to manage the fishery. The negative influence of outside income may be related to the ability to mitigate risk of community punishment because fishermen not dependent on the fishery become detached from the village, since they are no longer bound by the condition of mutual vulnerability, because they have alternative sources of income.

Social identity as a fisherman appears to predict fishermen's willingness to cooperate to manage their fishery. Family involvement in fishing did not appear to be related to the fishermen's cooperation, but cooperation was associated with fishermen's experience (number of years fishing) and principal work. These results suggested that those who migrate to the fishing communities to start fishing would show a relatively lower level of cooperation to manage the fishery.

The findings in this study suggest that resource scarcity gives an incentive for cooperation. Possession of information about the status of the resource is vital for the emergence of collective action. The results indicate that three of the four indicators of the fishermen's awareness of their resource exploitation problems were correlated significantly with the dependent variable "attitude toward cooperation". The strongest correlation was found between awareness of the causes of overfishing and cooperation, suggesting that when fishermen are aware of a resource problem, they will be interested in participating in local conservation efforts.

Fishermen's profiles did not appear to influence their choice to cooperate or to defect. Only educational attainment was found to be significantly correlated with the individual's willingness to cooperate, though the correlation was negative. The negative relationship was explained by the high correlation between education attainment and fishermen's ability to find work outside the fishing sector. At the same time, vessel characteristics do not appear to influence fishermen's decision to manage the fishery. This can be explained by the fact that fishermen in the area are using more or less similar technology.

The results indicated that there is a significant negative relationship between perception of risk and fishermen's adoption of a cooperative strategy. When debt to asset ratio was used to predict perception of risk, the relationship was statistically significant in Suwaiq only. The non-significant correlation for Barka and Masn'a may be due to the interference of other variables. The result of the hypothesis test using the second indicator of risk perception (the number of fishing gear types owned) indicated that there is a significant negative relationship between perception of risk and fishermen's attitude toward cooperation.

Regarding group size, it is true that for many authors, one of the conditions for successful collective action is that user groups have a small size. The results presented in this chapter oppose this hypothesis. The results strongly suggest that group size does not have any significant influence on fishermen willingness to cooperate to manage their fishery. Indeed, a large group is made like a small group when the users share common norms. Therefore, the finding of this study ruled out the direct effect of group size on the success or failure of collective action, which is consistent with the findings of Baland and Platteau (1996), Wade (1988), Chamberlin (1974), Barry and Hardin (1982), Salim (1996) and Sandler (1992).

The study also considers the relationship between group heterogeneity and the success of collective action. Three indicators of group heterogeneity were included in hypothesis testing (ethnic, racial, or other kinds of cultural divisions; differences in the nature of interests various individuals may have in a particular collective action and inter-individual variations in some critical attributes, that are reflected in varying intensities of interest). The study findings indicated that while the first two sources of heterogeneity (cultural division and difference in objectives and interests) are considered as causing a strong obstruction to collective action, the same cannot be said about the difference in the distribution of income. More inequality does not necessarily lead to more efficient use of natural resources. Thus, Olson's (1965) exploitation hypothesis was ruled out.

CHAPTER TEN

ANALYSIS OF FISHERMEN'S DECISION CHOICE USING GAME THEORY

10.1 Introduction

This chapter uses game theory to analyse the decision choice of the fishermen included in this study. The chapter will provide an understanding of why fishermen in South Al-Batinah have succeeded in initiating collective action to solve some of their common problems but failed in others. In Chapter Nine, fishermen's willingness to cooperate was explained and shown to be determined by a number of factors. Some of these factors seem responsible for influencing the incentives facing individuals in a game, which in turn determine the game outcome. In this chapter, therefore, these factors are used to support the analysis of fishermen's behaviour using game theory. The chapter begins by illustrating different forms of game theory and its application to the analysis of coastal fisheries. Then it explores a number of provision problems facing fishermen in South Al-Batinah. Important appropriation problems facing the traditional fishermen in their use of the fishery are also explored. The section before the last explores the overall level of cooperation in the study area, while the chapter conclusion is presented in the last section.

10.2 Game Theory

Individual decision choice when concerned with the management of common property resources can be analysed using game theory (Palfreman, 1999; p. 41). As argued by Child and Faulkner (1998; p. 26) "*Game theory is concerned with the strategies adopted by the players to a game and the effects these have on the game's outcome*". Similarly, Nalebuff and Brandenburger (1996; p. 40) argue that "*game theory provides a systematic way to develop strategies when one person's fate depends on what other people do*".

There are different forms of game. These differences arise from the difference in: the number of players (two-person vs. n-person), interest of the players (conflict or coincide), knowledge about the other party's decision (perfect vs. incomplete), number of times the game is played and communication (ibid.). Furthermore, games may be cooperative or non-cooperative. As argued by Cornes and Sandler (1996, p 18), cooperative games refers to the formation of coalitions in which participants work together to maximize a payoff, which will later be divided among members Some examples of cooperating games are the privileged game, the game of Chicken and the Assurance game. On the other hand, non-cooperative games refer to situations where competition prevails among players who are seeking to maximise their own benefits and ignore the side effects they create on each other and ignore the benefits they will receive had they cooperated. A classic case of a non-cooperative game is the so-called Prisoner's Dilemma[1] (PD) which is a simple game in which the ultimate outcomes will be disastrous for all participants if no intervention from outside the group occurs; thus, the equilibrium is Pareto- inferior to the mutual cooperation outcome.

Unfortunately non-cooperative game theory has been widely used by many scholars to explain situations facing users of common property resources, thus implicitly prejudging the outcomes (Hardin, 1968 and Wade, 1987). The conclusion reached is that when people are in a situation where they could mutually benefit if all of them restrained their use of a common-pool resource, they will not do so unless an external agency enforces a suitable rule. Accordingly, common property resources can only be managed through centralized coordination and control (see for example Hardin, 1968 and Wade, 1987). On the contrary many authors (Baland and Platteau, 1996, Baticados *et al.*, 1998; Dasgupta and Maler, 1994; Ostrom, 1990; and Runge, 1986 argue that the above claim does not hold true for many common property resources surveyed by the above authors. Also, the findings of this thesis suggest that situations of common property use should not be represented as a non-cooperative game such as the PD game. In their reply to the findings of Wade (1987) who concluded that common property resources can only be managed through centralized coordination and control, Dasgupta and Maler (1994; p. 330) argued that "*the theory of games has unraveled the variety of institutional mechanisms (ranging from taxes to quantity controls which can in principle support desirable allocations of common property resources. The theory makes clear, and has made clear for quite some time, that enforcement of the agreed-upon allocation can be carried out by the users themselves. In many cases this may well be the most desirable option*".

[1] A game is non-cooperative if it is impossible for players to communicate or collaborate in any way (Nash, 1953, p 35)

The findings of Chapters Eight and Nine suggest that modelling the fishermen's behaviour in South Al-Batinah using the Prisoner's Dilemma (PD) game seems unrealistic as this game poses an obvious problem. This problem arises because the stable outcome of the PD game in such situations is non-cooperation, which contradicts the findings of this thesis. Let us imagine for a moment that the fishing practices in South Al-Batinah are devoid of collective action and that the situation can be represented by a PD game. In this case, the invasion of industrial fishing fleet into the traditional fishing zone of the Al-Batinah coast would have remained unchallenged, ruining the livelihood of thousand of fishermen in the area[2]. Furthermore, the indigenous management institution (Senat Al-Bahar) would not have been evolved to manage and restrain the take of fish from the resource and to control the activities of fishermen on land and at sea. It would also be possible for fishermen to use destructive technology to catch fish such as dynamite and we would have seen new fishing gears that might deplete the resource entering the area without obstruction[3]. However, field observation and the results found in this study indicated that collective action has evolved to overcome some (but not all) of the problems mentioned above.

To take a few examples of successful collective action from the study area, let us consider the case of the fishermen in Al-Qurha village (Suwaiq). Fishermen in this village successfully organized and forced industrial trawlers out of their fishing grounds (full description of the case can be found in Chapter Eight). The collective action in this case is when fishermen collectively participated and won the battle against a common enemy, an activity which improves their collective well-being. In this case the payoff structure of the gains from the fishermen's action in the above village does not look like the payoff structure of the PD game. Therefore, if the situation in South Al-Batinah fishing cannot be appropriately represented by the PD game, then other game forms that may be more relevant in this respect should be discussed. The results presented in Chapter Eight strongly suggest that fishermen in the study area initiated collective action on numerous occasions. We have seen strong opposition by fishermen in the area to the use of more destructive fishing gears such as Monofilament gill nets, Tadwerah and Tahweta, which are seen by them as causing resource depletion. Many of them successfully organized to lobby the local authority and the Ministry of Agriculture and

[2] This is a provisional problem analysed in Section 10.3
[3] This is an appropriation problem analysed in Section 10.5

Fisheries to stop such innovations and to penalize those using them. In the following sections the thesis analyses fishermen's behaviour using the theory of games.

10.3 Provision Problems

To illustrate cases of successful collective action in the study area, let us first consider the case of the fishermen's decision problem in Al-Qurha (Suwaiq) when industrial trawlers invaded their fishing grounds. This is a typical provision problem, which can be represented, for simplicity, by a two-fisherman game whose fishing grounds are invaded by a demersal trawler. Let us assume that the catches of each individual fisherman presently are 10 kilograms per day. However, to maintain present catches, they need to stop the trawler invading their fishing ground. Let us also assume that they can collectively pay a number of villagers to go with them to the sea to destroy the gear of the trawler or to catch the captain and his crew (which is the public good to be provided). Further, assume that the total cost of producing the public good amounts to the value of 4 kilograms of fish catch. If both fishermen cooperate, i.e., they both agree to share the cost of paying the villagers to force the trawler out of their area, their individual net catch will be 8 kilograms (10 kilograms minus 2 kilograms). However, if both defect, i.e., neither of them challenges the trawler, then the outcome is disastrous as their fishery will be overexploited and their individual catch will soon come down to 3 kilograms (not enough catch to justify the effort involved). If, however, one fisherman contributes, the non-contributor (the free-rider) receives the benefits of catching 10 kilograms (without any cost), while the contributor (the active fisherman or the "sucker") receives a net catch of 6 kilograms only after the cost of hiring the villagers (4 kilograms) is deducted.

As illustrated in Figure 10.1, forcing the trawler out of the fishing ground is so rewarding that one fisherman can bear the entire cost himself and still retain a net catch of 6 kilograms. The best payoff results for the fisherman who escaped the participation in the collective action, while forcing the other fishermen to take full responsibility (i.e., being the sucker). The interesting feature of this game structure is that mutual cooperation (8 , 8) yields a benefit below the best payoff (10 kg.) but above that associated with taking full responsibility alone (6 kg.).

Fisherman A

Fisherman B	Strategy	Cooperate	Defect
	Cooperate	8,8	6,10
	Defect	10,6	3,3

Figure 10.1 The Payoff Structure of the Collective Choice of Defending a Common Fishing Ground Against an Industrial Trawler.

In the above game, both fishermen have no dominant strategies in this game. However, as can be seen from Figure 10.1, there are two Nash[4] equilibria in pure strategy, in which one fisherman takes full responsibility to challenge the trawler (cooperate) while the other free-rides (defects) (Sandler, 1992; p. 40; Baland and Platteau, 1996; p. 80)[5]. The averting of the encroachments of an industrial trawler into a traditional fishing-zone corresponds to the game of Chicken, since the status quo of no action will result in significant consequences. The action of fisherman A depends on what he thinks fisherman B will do. Looking at the payoff structure of Figure 10.1, it can be clearly seen that each fisherman prefers the other to bear the cost of providing the collective good while he refrains from contributing, since he will receive the highest payoff. Contrary to the PD game, in this game at least one fisherman must undertake full responsibility to challenge the trawler if both are to avoid the disastrous outcome (depleted fishery). To further his own interests, if not to protect himself as in the PD, each fisherman has a sufficient reason to provide the collective good alone, whatever the other does. In such a situation, possession of information about the status of the fish resource is vital for the emergence of collective action. Awareness of the causes of overfishing, coupled with lack of alternative fishing grounds, are the main factors that induce fishermen in the case of the above village to initiate the collective action. As

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[4] Nash equilibrium results when an agent chooses his or her best or optimizing choice for one (or more) variables, given that the other players have chosen their optimizing or best responses for this (or these) variables. However, it should be noted here that when the public good is impure (exclusion is possible for example as in club goods), Nash behaviour need not imply sub-optimality (Sandler, 1992; p. 16).

[5] There is also a mixed-strategy equilibrium in which each fisherman randomizes his strategy. In this Nash equilibrium each fisherman chooses his probability based on the best probability choice of the other fishermen (Sandler, 1992; p. 41; Baland and Platteau, 1996; p. 81 and Cornes and Sandler, 1996; p. 308). For Figure 10.1, each fishermen cooperate with probability 3/5 and defects with probability 2/5.The expected utility for each is therefore equal to 3/5(3/5*8+2/5*6) + 2/5(3/5*10+2/5*3) =7.2. In this thesis the discussions only focus on pure strategies.

shown in Chapter Nine, there is a statistically significant correlation between awareness of the causes of overfishing and the provision of collective good (cooperation).

There is one obvious problem with the above game in the long run. It is true that either of the fishermen would undertake the provision of public good if the other did not (it is better to be a 'sucker' and get 6 kg of fish catch than not be a 'sucker' and get only 3 kg). However, one would not like to undertake the full responsibility (being a 'sucker') forever, while the other fisherman free rides on his effort. A plan of action which must be agreed upon by both fishermen and self-enforcing (Baland and Platteau, 1996; p. 81) is needed if the collective action is to be sustained. This is because encroachments of industrial trawlers into the traditional fishing-zone can occur in the future; thus, once more the public good needs to be provided. Both fishermen, therefore, can benefit from sitting together to coordinate their actions in the sense that one of them might choose to cooperate in the first round and defect in the next round[6] (this plan is known in game theory as a correlated equilibrium). As argued by Baland and Platteau "*under a correlated equilibrium, agents endogenously and non-cooperatively generate a coordinated solution which gives them the assurance that collective action will take place: one of them will have to undertake it, but under a scenario agreed on by everybody*" (Baland and Platteau, 1996; p. 81).

To coordinate their action, fishermen in Al-Qurha village asked the master of the Senat Al-Bahar to call all fishermen in the village for a meeting. In the meeting, twenty fishermen voluntarily decided to bear the cost of challenging the trawler on the fishing ground. The fishermen in this village successfully initiated collective action and the trawler was forced out of the fishing grounds. As can be seen from the payoff structure illustrated in Figure 10.1, the collective action in this case is self-enforcing where fishermen collectively participated and won the battle against a common enemy, an activity which improves their collective well-being. Forcing the trawler out of the fishing ground is so rewarding that a few fisherman can bear the entire cost themselves and still retain a profit. This case clearly demonstrates that the payoff structure of the gains to the fishermen's action in the above village looks like the payoff structure of the Chicken game. It is the role of the institution (Senat Al-Bahar) that makes fishermen sufficiently well organised to initiate collective action. Therefore, the institutional rule

[6] A systematic procedure can be implemented in this case to determine the sequence of individual action. Tossing a coin or drawing a lottery are examples of such systematic procedures

has changed the payoff structure of the game from a PD to a cooperative game. High awareness about the status of the fishery coupled with high economic dependence on fishing induced fishermen to work collectively to further their well-being. It can be concluded here that the indigenous management institution (Senat Al-Bahar) provides incentives, tipping the scales in favour of cooperation.

10.4. Appropriation Problems

The provision problem described above was conceptualised as a game of Chicken. Chicken games can also be used to model a number of appropriation problems in the study area. First, let us consider the assignment of rights to fishing spots when fishermen compete for limited fishing spots; the case of the beach seine fishery will be considered later to highlight another example of an appropriation problem in coastal fisheries. In the trap fishery, for example, there are many situations where the number of fishermen exceeds the number of productive fishing spots. If two fishermen locate their traps in a single fishing spot, the share of the catch of each individual fisherman will be too small to cover the cost of the fishing trip. In order to avoid conflicts among fishermen in such communities, fishing rules must be implemented. In South Al-Batinah, the fishing communities solved such problems by implementing the rule "the first to arrive has the right to fish" in the spot. To analyse such a situation using game theory let us consider a single fishing spot which is fished by two fishermen. Assume that when one fisherman fishes in the spot he can produce 20 kilograms of fish every day. If both fishermen fish in the same spot simultaneously, conflicts will arise leading to a disastrous outcome (-1, -1). However, if one fisherman arrives first in the spot (his right to fish is recognized), he will catch the whole 20 kilograms while the other fisherman gets nothing (Figure 10.2).

Fisherman A

	Strategy	Enter	Wait
Fisherman B	Enter	-1,-1	20,0
	Wait	0,20	0,0

Figure 10.2 The Payoff Structure of the Collective Choice of Assigning Fishing Spots Between two Fishermen.

It is clearly shown in Figure 10.2 that both fishermen have no dominant strategy, but there are two Nash equilibria in pure strategy, in which one fisherman waits ashore, goes to a less productive fishing spot or use different fishing gear such as handline and catches pelagic species, for example (cooperates), whilst the other goes to the fishing spot. The payoff structure depicted is that each fisherman prefers the other to stay on shore while he goes fishing alone and gets the maximum payoff. At the same time, both avoid being on the fishing spot at the same time in order to avoid incurring a loss, which is the worst payoff in this case. If they can communicate with each other they can coordinate their actions, for example, by implementing the rule devised by Senat Al-Bahar: "first entrant into the fishing spot has the right to fish". If fisherman A notices that fisherman B has gone to the spot, he should avoid going to the same spot on that particular day to avoid the worst outcome (conflicts and loss of catch).

One might argue that the above situation might induce a fisherman to get up earlier and earlier to be in the fishing spot before his neighbour. However, it should be remembered that fishermen's decision to cooperate is influenced by the physical attributes of the fishery. As was observed by the researcher, fishermen in the area help each other to beach their fishing vessels. For example, a fisherman needs the help of at least four others to beach his fishing vessel at the beginning and end of any fishing operation. In the above case of assigning fishing spots to fishermen, if one fisherman acts self-interestedly by going to the productive spot every day (without coordination with his neighbour), he will lose the cooperation of his neighbours to help him with beaching his fishing vessel. In small villages like the one described here, examples of individuals' cooperation in their daily activities on land are legion. Therefore, fishermen's fear of lose of cooperation of other members in the village induces fishermen to cooperate with each other. The cost imposed on those who breach the rules laid down by the group may not be offset by the possible benefits gained from free riding. Furthermore, the interdependent nature of the activities in the fishing village is all necessary in the fishermen's daily activities. One might gain more benefits in the fishing grounds by breaching the rules, but he is likely to lose a good deal in the village.

In some communities, assignments of fishing rights to fishermen when the number of fishermen exceeds the number of productive fishing spots are carried out using a lottery (e.g., Alanya fishery in Turkey; for more details see: Ostrom, 1990; pp. 18 - 20). In communities where the users of a common resource design institutional rules to coordinate their fishing activities, these rules are seen to provide the proper incentives, thereby tipping the scales in favour of cooperation (Sandler, 1992; p. 47). In this example, the discussion demonstrates how the institutional rules have changed the payoff structure from a non-cooperative game (PD) to a game of Chicken and the resource users have coordinated their actions.

To take another appropriation problem, let us consider the beach seine fishery. In this case, problems arise as who should cast his net first. Let us assume first that there are two fishermen in a fishing village using beach seines to catch sardine. As the school of sardine approaches the village, if both encircle the school of sardine at the same time, the nets will get entangled, leading to a disastrous outcome (-x,-x)[7]. Similarly, if both do not encircle the sardine, both will receive nothing and the school of sardine will be caught in the next village. It can be seen from Figure 10.3 that the best outcome in this case is for one fisherman to cast his net and catch the sardine (receiving the maximum benefit of 100 sacks), while the others waits (being the "chicken" and receiving 0) until another school of sardine approaches the village. Unlike the PD game, in this game at least one fisherman must wait until his colleague has completed casting his beach seine if both are to avoid the disastrous outcome (entangled beach seines).

To understand how beach seine fishermen have avoided the worst outcome, the researcher interviewed a number of beach seine operators. It was found that owners of beach seines coordinated their action to avoid their nets being entangled. The plan of action is as follows: as the school of sardine moves across the coast from east to west or vice versa, a fisherman can cast his beach seine only when the school of sardine has just approached his location[8]. If fisherman A fails to encircle the net (the school of sardine dives under his net or they are faster than his boat), he has to pull his net out of the sea and dry it before he can start the next fishing operation, which may take him half a day. In this case the right to catch the sardine is transferred now to fisherman B. If fisherman B observes that fisherman A has failed to encircle the school of sardine, he can enter the sea and cast his beach seine. This plan of action (known as a correlated equilibrium in game theory) is in fact the product of the indigenous management institution (Senat Al-Bahar). The plan has been agreed upon by all concerned fishermen to coordinate the sequence of beach seine fishing; thus, it is self-enforcing. The aim of this plan is to give

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[7] The cost of a beach seine is approximately RO 3000 ($ 7812.5). $ 1 = RO 0.384.

[8] Each individual beach seine owner has a typical location, which is normally in front of his house. The casting of the net starts from this point.

every beach seine operator equal chances in terms of access to the sea as well as income opportunities. Off course the rule of Senat Al-Bahar is sustained by the feelings of embarrassment, anxiety, guilt and shame that a person suffers at prospect of violating them. In Weligalle (South Sri Lanka), a more or less similar arrangement to coordinate the operation of beach seine nets, known as Net Sequences, is employed by fishermen to maximize their overall benefits (Amarasinghe, 1989; p. 704).

It can be clearly observed in this game, that both fishermen have no dominant strategies, but there are two Nash equilibria in pure strategy and in each of these one fisherman cooperates (waits) while the other defects (encircles the school of sardine). At any of the two Nash equilibria, neither fisherman would unilaterally change his strategy. By changing strategy, fisherman A's payoff would drop from zero to -x (his beach seine may be damaged), while fisherman B's payoff would drop from 100 sacks to zero. Therefore, the payoff structure that results from solving the above problem is corresponding to the payoff structure of a Chicken game as illustrated in Figure 10.3.

Fisherman A

	Strategy	Enter	Wait
Fisherman B	Enter	-x,-x	100,0
	Wait	0,100	0,0

Figure 10.3 The Payoff Structure of the Collective Choice of Assigning the Right of Fishing to Beach Seine Fishermen.

It can be clearly seen in the above game that institutional rules have changed the payoff structure from universal defection (PD game) to a coordinated equilibrium (privileged group) in which the collective action has been initiated to avoid the worst outcome. As argued by Sandler, "*Nature-imposed sanctions attached to the status quo can assist groups to Pareto-optimal outcomes*" (Sandler, 1992; p.44). In natural world settings, at least some collective goods might be provided with some form of coordination among participants. The institutional setting in place plays a crucial role in avoiding the worst outcome.

Generalizing the above Chicken games to N-fishermen situations is straightforward. Let us return to the beach seine fishery, but now assume that, instead of two fishermen, there are 10 fishermen in this village and all own beach seine nets. The right to cast first is determined by the institutional rule devised by Senat Al-Bahar, by which all the ten fishermen have agreed on to coordinate their action. Assume that the school of sardine approaches the village from the east. When the school of fish approaches the location of the first fisherman, he casts his beach seine, while the others wait until he completes the operation. If the school passes the first fisherman, the right to cast is transferred directly to the fisherman next to him, while other fishermen must wait, and so on. Normally, schools of sardine are very large and move in small patches so that one beach seine cannot take the whole school; thus, everyone in the village gets a share of the catch if they follow what they had agreed upon (the coordinated equilibrium). In any case, the fisherman who casts his net, whether or not he is successful, needs several hours to pull his net out of the sea and dry it (for half a day) before he can cast again. Another constraining factor of consideration is the availability of drying grounds. The catch of beach seines is dried under the sun and then packed in sacks, a process which may take from seven to ten days. Therefore, if a fisherman catches a big school of sardine in a particular day, he is unlikely to fish again for several days, even if more schools of sardine approach the village, if his drying ground is full.

There is no dominant strategy in this game, but there are ten Nash equilibria in pure strategy; in each of them, a single fisherman casts his beach seine net while the others wait their turn. Since the operators of beach seines in this case maximize their benefits in the above game as they coordinate their action, the group should be privileged, regardless of the number of fishermen (Sandler, 1992; p. 40).

10.5 Modelling Cases where Assurance is Needed

The above account gives a few examples of both provision and appropriation problems that fishermen in the study area are encountering. However, there are many other appropriation problems in which participation of a few fishermen will not lead to the provision of the public good; thus, efforts of all fishermen are needed for any benefit to be obtained. For instance, the use of monfilament gill nets and efficient fishing gears such as Tadwerah and Tahweta which are operated by encircling the fish are all technical options, which are available to fishermen to receive an immediate gain. These techniques are employed in inshore waters to harvest large quantities of fish, including immature fish. Whether the fish resource is depleted or not hinges upon the number of fishermen who are willing to refrain from using such fishing gear. If only a few of them abstain, the beneficial impact of their action is likely to be insignificant. It is obvious that the cooperation of everybody is needed to eliminate such techniques from the fishery in order to avoid resource depletion. As a matter of fact, conflicts arise occasionally between fishermen of coastal villages in the study area regarding the techniques mentioned above. Some villages have adopted a conservative approached by forbidding the use of such techniques among their members, whilst other villages make no such restriction. First, the section will present the payoff structure facing individual fishermen in a fishing village when they have the option of using the Tahweta (sardine encircling nets) to make immediate gains. Then the section will analyse a game where two neighbouring fishing villages have banned such gear.

To illustrate cases of successful collective action in the study area, let us first consider the case of the fishermen's decision problem in Al-Greem (Masn'a) when the new fishing gear (Tahweta) appeared in their fishery to catch sardine. According to the norm of Senat Al-Bahar, sardine caught by cast nets is used as bait, and the catches of beach seines are dried and fed to live stocks, whereas, only the catch from gill nets can be sold in the market. This seems logical as a conservation measure to protect the sardine fishery. The cast net can be used from the shore and also has very small meshes; thus, if its catch were to go to the market, sardine resources in the vicinity of these coastal villages might be depleted. Beach seines, on the other hand, are restricted to their location and operated close to the shore; thus, they only catch schools of sardine close to the shore. Gill nets[9], owing to their selectivity characteristics (if an appropriate mesh size is used) allow small sardine to pass through to grow and breed. However, the new gear (Tahweta) can be operated at any depth with the use of two fishing vessels, thus catching big quantities of sardine and those who use it can make big profits compared to those who use gill nets. Owning Tahwetas is extremely expensive compared to other fishing gears. Thus, only the big elite can afford to buy them.

In Al-Greem village, two fishermen received an offer to operate a sardine seine net (Tahweta) owned by a rich trader from Barka who deals with fishing gears and accessories. The owner of the net would receive half of the profits as part of his capital

[9] The rules of Senat Al-Bahar only allow fishermen to use gill nets of a certain mesh size to catch sardine.

cost, whilst the two fishermen would share the other half. The two fishermen had two options; either to accept the offer or reject it.

Now consider the case of any individual fishermen in the above village who has one of two options. The first option is to cooperate by rejecting the rich man's offer to use Tahweta and stick to his gill net, a strategy, which is advantageous to all fishermen in the village, thus protecting the fishery. Alternatively the fisherman may accept the offer (defect) and start operating Tahweta, an option which, while advantageous to him, harms all the fishermen in the village by causing overfishing. To illustrate the situation facing a fisherman in this village, a two fishermen game is presented below to analyse the incentives each individual faces in this game. Let us assume that their payoffs for the various possible outcomes are as given in Figure 10.4.

		Fisherman A	
	Strategy	Reject the offer	Accept the offer
Fisherman B	Reject the offer	4, 4	- 2, 6
	Accept the offer	6, - 2	0, 0

Figure 10.4 The Payoff Structure of the Collective Choice of Avoiding a Public Bad.

The important point to note from Figure 10.4 is that the net payoff accruing to a fisherman when he accepts the offer (6 units) is higher than the payoff he would receive by rejecting the offer (4 units). If, say, both fishermen reject the offer and stick to their gill net, then each fisherman receives a net profit of 4 units. Looking at the matrix of this game it appears that the payoff structure encourages defection, because one is always better off (with a gain of 6 or 0) defecting, regardless of the strategy of the other fisherman. Although if both fishermen reject the offer, the highest (4 + 4 = 8) aggregate payoff is achieved, because the game is played only once, there is always a risk of the fisherman who rejects the offer receiving the lowest payoff (-2 or being a "sucker") if the other defects. The resulting game is a Prisoner's Dilemma, because the dominant strategy is to defect; hence, the group remains latent unless other considerations (local accords or norms) are included (Sandler, 1992; pp. 38 - 40 and Cornes and Sandler, 1996; p. 310).

Returning to the case of the above village, speaking to the two fishermen who operate the Tahweta, they state that they only used the gear twice. Other fishermen in the villages threatened them to burn their gear if they continued to use such gear to catch sardine, as their action was seen by the others as violating the rules and norms of Senat Al-Bahar (the local management institution).

Now let us see what will happen to the structure of the game after the community threatens the violating fishermen. In such a situation the violating fishermen not only lose their gear, but also they feel embarrassment, anxiety, guilt and shame for their action. Taking the same game presented above, but this time with a cost imposed on the fisherman who accepts the rich trader's offer to operate the banned gear (the defector), let us assume that if the community carries out its threat against the defector, he will lose his gear, as a result of which he is assumed to incur a cost of 8 units of benefits. The payoff structure is presented in Figure 10.5.

Fisherman A

	Strategy	Reject the offer	Accept the offer
Fisherman B	Reject the offer	4, 4	- 2, (6 - 8 = - 2)
	Accept the offer	(6 - 8 = - 2), - 2	0, 0

Figure 10.5 The Payoff Structure of the Collective Choice of Avoiding a Collective Bad.

From Figure 10.5, it is clearly shown that the resulting payoffs encourage cooperation. Both fishermen are better off cooperating as this strategy yields them the highest payoff possible. Therefore, the resulting game is fully privileged, because universal cooperation is the most preferred outcome. In fact, speaking to the researcher during the field work, the two fishermen who accepted the offer of the trader to operate Tahweta in Al-Greem subsequently complied with the group rules and abandoned their new gear. Thus, this village represents a privileged group where the number of fishermen in the village has no effect whatsoever on the final outcome, as argued by Sandler (1992; p. 40). The local management institution in the study area (Senat Al-Bahar) plays a crucial rule to coordinate individuals' expectations so as to enable them to avoid the public bad.

Now fishermen in Al-Greem have complied with the local accords, but they complain about fishermen from a neighbouring village who use Tahweta and Tadwerah, thus generating immediate gains and causing the fishery to deplete. In this case, it is appropriate to use a two-village game for analysing the decision problem in such a situation. Assume, for instance, that the heads of the tribe in each village can persuade fishermen in their communities to abandon such fishing gear. In order to achieve the preferred results, the efforts of all fishermen are needed to aid the heads of their tribes to fulfil their obligation.

Catches of villages A and B before introduction of the new techniques are 10 tonnes each. It is assumed that fishermen in the two villages can succeed in banning the use of the destructive fishing gears from their fishery, provided that they help the head of the tribe to persuade those who use such fishing gear to abandon these gears (the public good to be provided). The cost involved in banning the Tadwerah and Tahweta by each village is equivalent to the value of 2 tonnes of fish assigned to the provider. If the use of Tadwerah and Tahweta continues in the fishery (even by a few fishermen from one village), the fishery will not recover and the effects of such gear will soon bring landings in each village down to a mere 2 tonnes. Therefore, both villages must contribute to receive any benefits from their own action.

The decision problem of both villages is analysed using a two-village game as shown in Figure 10.6. If the destructive fishing gears are eliminated completely from the fishery (mutual cooperation), landings will return to their previous normal level of 10 tonnes each. Therefore, mutual cooperation will yield net benefits of 8 tonnes (20 tonnes of catch minus 4 tonnes of cost) for each village. If only one village provides the public good (the head of the tribe in one village fails to persuade owners of the destructive gear in his village), then the fishery will not recover (status quo landings are 2 tonnes each). In this case the provider will bear the cost of his provision (his payoff is 0 tonnes), (which is 2 tonnes catch minus 2 tonnes of provision cost), while the free-rider catches the 2 tonnes (no provision cost). If neither of them contribute, the status quo will remain and each village will catch 2 tonnes. Therefore, the payoff structure here is similar to that of the assurance game.

Village A

	Strategy	Cooperate	Defect
Village B	Cooperate	8,8	0,2
	Defect	2,0	2,2

Figure 10.6 The Payoff Structure of the Decision Problem of two Villages to Ban Destructive Fishing Gears.

As it can be seen from Figure 10.6, both villages have no dominant strategy, but there are three possible equilibria, two in pure strategies (mutual cooperation or universal defection) and one in mixed strategy[10]. The mutual cooperation equilibrium Pareto dominates the universal equilibrium, but may not be the outcome unless the players can rely on one another (Sandler, 1992; p. 42). In this case, contrary to the PD, the net payoff received by a village when it free-rides on the provision of the other village (2 tonnes) is smaller than the net payoff the village would receive by cooperating (8 tonnes). Figure 10.6 also depicts that mismatch of actions is the least preferred by both villages taken together. The mixed strategy is the third Nash equilibrium in which the fishermen randomize over their strategies. In this equilibrium, each fisherman chooses his strategy with a certain predetermined probability (Baland and Platteau, 1996; p. 81 and Cornes and Sandler, 1996; p. 308). The way the mixed strategy payoff is obtained was presented in footnote 5.

In assurance situations, if village A fulfils a promise to enforce the common rule, the contract is self-enforcing, since village B has strong incentives to enforce the rule. If it did otherwise, village B would receive 2 tonnes of catch instead of 8 tonnes. As argued by Sandler, *"even without an enforcement mechanism, contracting can overcome collective failure in an assurance situation"* (Sandler, 1992; p. 42). Therefore, the best strategy for village A depends on its expectations of village B. In fact, the best choice for village A, for example, is to enforce the common rule if the probability that village B will do the same is assessed by village A to be more than 1/4, and its optimal choice is not to enforce the common rule if this probability is less than 1/4. If we denote p to be the probability that the other village enforces the rule, the value of p (which is

[10] See footnote 5.

1/4 as shown above) is obtained for Figure 10.6 from the following equation which is provided by Baland and Platteau (1996; p. 91):

$$8p + 0(1\text{-}p) = 2p + 2(1\text{-}p)$$

Solving the above equation for p, it was found that the equilibrium in mixed strategy is obtained when each village enforces the rule with a probability 1/4 and does not enforce the rule with probability of 3/4.

Although there is no guarantee that the game will equilibrate at the more preferred points of the three Nash equilibrium because the concerned villages might not trust each other, in real world settings cooperation can be achieved. This is because in situations of two neighbouring villages, the heads of the tribes as well as fishermen from both villages are interacting with each other continuously (cheap talk allowed), thus signals sent regarding one's intention to cooperate are interpretable in an unambiguous way. In this case, as argued by Baland and Platteau (1996), cooperation is much more likely to arise because all concerned parties (heads of the tribes in both villages) can reassure each other and form optimistic expectations about their mutual behaviours. The local management institution in the study area (<u>Senat Al-Bahar</u>) plays a crucial rule to coordinate individuals expectations so as to enable them to cooperate. When the two villages have agreed on rules to improve their well-being, the rule must be sustained by the feelings of embarrassment, anxiety, guilt and shame that a person suffers if he violates these rules. It is the responsibility of the master of <u>Senat Al-Bahar</u> to ensure that the agreed upon rules are enforced and those who violate them must be sanctioned. As argued by Runge (1986; p. 630), "*it is precisely the role of village level conventions, including common property institutions, to reinforce expectations of collective behaviour leading a critical mass of individuals to adopt such a solution as a cooperative strategy*".

The assurance game used above to analyse the decision problem of two neighbouring villages can be expanded to model a situation where many villages (N-villages game) is involved. Similarly, there will be no dominant strategy in this multi-village game, but there will be a number of Nash equlibria (the number of equilibria equals the number of village involved) in pure strategy and one in mixed strategy[11]. Again, a critical mass of cooperating villages are needed if the cooperation equilibrium is to hold. For example, the gain from cooperation for each village depends on the proportion of villages that actually adopt a cooperative strategy in the entire group. As the proportion of cooperating villages increases, the problem of free riding becomes easier to overcome. This is because if the number of cooperating villages is large, the free riding village "feels bad" about defecting (Baland and Platteau, 1996; p. 109). However, for cooperation to prevail in this situation, the majority of villages who wants to cooperate must feel confident that their willingness to cooperate is shared by many others as well (Runge, 1986). Local management institutions (Senat Al-Bahar) in the study area, if functioning optimally, can provide the assurance that a critical mass (Runge, 1986) of others will obey the rule (free riders might be sanctioned); thus, everyone has an interest to do likewise, since this outcome is preferred. This holds even more true when the groups are culturally homogenous, a characteristic of the study population as identified in previous chapters.

10.6 The Overall Level of Cooperation

Up until now, the collective action decisions of a number of selected cases were conceptualized using game theory. Collective action decisions have been treated as a discrete variable; either cooperate or defect. In what follows, the fishermen's overall level of cooperation will be considered as a multi-person game to illustrate the type of game played by fishermen in the study area. Information gathered through questionnaire, personal interview and observation were used to analyse the decision problems facing fishermen in the study area.

As presented in Chapter Nine, the dependent variable "cooperation" was measured using an index containing 11 statements. The statements were then aggregated to construct a composite variable in order to determine the level of cooperation for individual fishermen. Therefore, the level of cooperation is a continuous variable ranging from zero (no cooperation) to 11 (maximum cooperation). The results for the 194 fishermen included in the study indicated that the average level of cooperation was 7.19 with a standard deviation of 2.71; thus, a relatively high level of cooperation has

[11]There is also a mixed strategy Nash equilibria in which the fishermen randomize over their strategies. In each of these equilibria each fisherman choose his strategies with a certain predetermined probability (see footnote 5 above) (Baland and Platteau, 1996; p. 81 and Cornes and Sandler, 1996; p. 308)

been achieved. For the purpose of the following discussion, the cooperation scale is converted into a proportion. Thus, the scale ranges now from zero to 100 percent. In this case the mean level of cooperation achieved is 65.4 percent. Therefore, the collective good is continuous and a summation technology characterises public supply; thus, the choice of a level of contribution is permitted. This means that individual effort to conserve the fishery is aggregated to find the total amount of collective good provided.

What is striking in the above findings is that the dominant free riding of the PD seems to be implausible in the case of the fishermen included in this study (average cooperation = 65.4 percent). Therefore, if the situation in South Al-Batinah fishery cannot be appropriately represented by the PD game, then other game forms that may be more relevant in this respect should be discussed. Several authors have argued that situations of common property resources in developing economies can best be represented by an assurance game (see Baland and Platteau, 1996; p. 90 and also Runge, 1986; p. 628). One of the characteristics of the assurance game is the absence of dominant strategies (neither cooperation nor defection represents a strictly dominant strategy) (Cortazar, 1997; p. 46). This seems to fit most closely the situation of the fishermen's decision problems to manage their fishery in the study area because, as appeared from the univariate analysis of the dependent variable (cooperation), a relatively high level of cooperation has been achieved in the group. In cases where there are no dominant strategies in the decision making, alternative outcomes that depend on optimistic expectations about mutual behaviours of everyone in the group are possible. Therefore, the decision to conserve or deplete the fishery depends on the expected decision of others. For example, if a fisherman expects others in the group to cooperate, he will do likewise to achieve the preferred outcome because his payoffs when he cooperates with the rest of the fishermen would be higher than if he defects while many cooperate. In many common property resource settings and particularly in the case of the fishery in South Al-Batinah, what makes fishermen hold optimistic expectations about the behaviours of others is the presence of a local management institution by which individual fishermen's decision making are coordinated.

In an assurance game, each member of the group is, objectively, an essential contributor, in the sense that without his contribution the collective good cannot be provided (Cortazar, 1997; p. 46). To illustrate the structure of payoffs facing individual fisherman in this case, let us assume that the utility of fisherman "i" is Fi (x, z), where "z" corresponds to the strategy of the rest of the members. In such a situation Fi (C, C) > Fi (D, C) because the contribution of fisherman "i" is essential for the provision of the collective goods. Similarly, Fi (D, D) > (C, D), because since the rest do not contribute, the collective good is not produced, and fisherman "i" bears the cost of his contribution. Therefore, the two Nash equilibria of this game are (C, C) and (D, D), bearing in mind that there is no dominant strategy. In this case, if a fisherman believes that his contribution toward the collective good is necessary, a rational strategy for him is to participate in the collective good, though his best choice is contingent on the choice of the rest of the fishermen.

As indicated above, a game with multiple equilibria and the absence of dominant strategies can better approximate the actual decision problems of the fishermen in the study area. To carry out the analysis it is necessary to produce an appropriate graphical representation of the situation facing the fishermen to provide a way of visualising the changes of the payoffs as the number of those who decide to cooperate in the group increases or decreases. Figure 10.7 is a graphical representation (adopted from Runge, 1986 with modification) in which two linear payoff curves are drawn to represent the benefits of cooperation and defection for the fishermen in the study area. "D" denotes the dominant defection curve, while "C" denotes the dominant cooperation curve. Both curves begin at the left end at the point of open access where rent from the fishery is driven to zero, and then both curves rise to the right as the proportion of fishermen deciding to cooperate increases.

As can be seen from Figure 10.7, there is no dominant strategy. However, there are two Nash equilibria in pure strategy; one is universal defection represented by point "o" in which no fishermen cooperate (open access equilibrium) and the other is universal cooperation at point "q" where the Nash equilibrium is Pareto-superior. The proportion of fishermen deciding to cooperate to manage the fishery varies from 0 to 100 percent as represented by the horizontal axis, whereas the benefit (payoff) accruing to individual fishermen is denoted by the vertical axis.

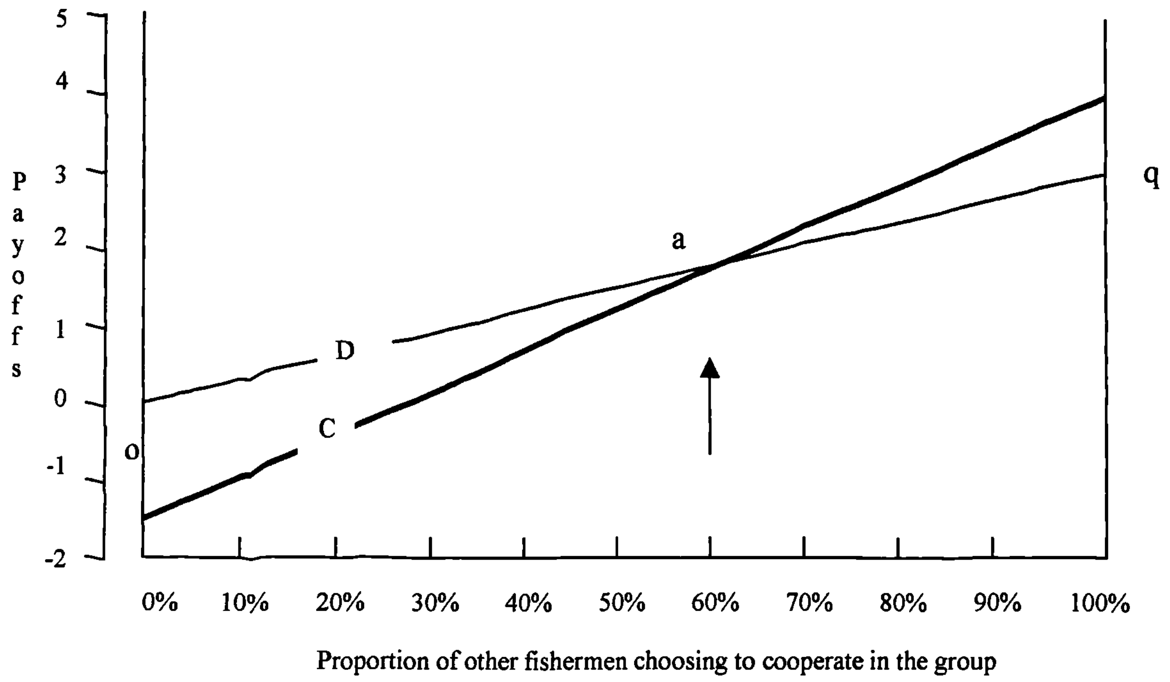

Figure 10.7 Payoffs to a Fisherman in an Assurance Game According to the Proportion of Cooperators in the Group.

Starting at point "o", the defection curve dominates the cooperation curve until point "a", after which the cooperation curve dominates the defection curve as the number of fishermen who decide to cooperate increases. It is clearly shown that the gains from cooperation for individual fishermen depend on the proportion of cooperating fishermen in the group. To achieve the Pareto-superior equilibrium at point q, a "critical mass" of other fishermen must send clear messages to everybody regarding their intention to conserve the fish resources. Similarly, signals sent to others in the group must be interpreted in an unambiguous way. This is not difficult to achieve, especially when fishermen in their daily activities are interacting with each other and depending on each other continuously. Hence, it can be argued here that the long-term interaction that characterises much of the daily life in any fishing village gives rise to the possibility of voluntary participation because it change the payoff structure of the PD into an assurance game. It is immediately apparent from Figure 10.7 that individual fishermen's strategies will obviously depend on their expectations of the behaviour of the other fishermen in the area (Cortazar, 1997; p. 46).

The coordination game described by the Assurance Problem (AP) described above suggests that there are incentives to develop and maintain institutions characterized by rules which make voluntary contribution to public goods a utility-maximizing strategy (Runge, 1984; p. 155). When institutions exist to facilitate the coordination of behaviours by providing information regarding the expectations of others, they provide assurance, which makes cooperation to the group actions more attractive than free riding.

As illustrated by Figure 10.7, the cooperation curve crosses the defection curve at point "a" where the proportion of fishermen who decide to cooperate equals 60 percent of all fishermen (the critical mass is reached according to Runge). After the switch point "a" (i.e., enough fishermen in the group decide to cooperate), cooperation will dominate leading to the superior equilibrium at q. As argued by Baland and Platteau (1996; p. 110) "*agents will choose to cooperate if they expect more than 60 percent of the group members to cooperate, otherwise they will defect*". In fact, for the case of the present study, the level of cooperation achieved was 65.4 percent; thus, a critical mass of fishermen in the study area are willing to cooperate to conserve their fishery which should, if the theory is correct, induce the rest to cooperate as well. In this coordination game there exists a threshold level for the number of fishermen willing to cooperate to manage the resource beyond which it is profitable for all fishermen to cooperate, and below which no individual fishermen has an interest in doing so (Baland and Platteau, 1997c; p. 204).

For the Pareto-superior equilibrium point (q) to hold, the cooperation of the significant majority of fishermen (60 percent or more) alone is not enough, but it must be the case that these people have assurance that their willingness to cooperate is shared by many others. The kind of assurance needed here which will make everyone in the group feel that their expectation about others willingness to cooperate is unmistakable can only be found in a situation where fishermen have devised a local institution to coordinate their actions. As quoted above, Runge has stated that "*it is precisely the role of village level conventions, including common property institutions, to reinforce expectations of collective behaviour leading a critical mass of individual to adopt such a solution as a cooperative strategy*" (Runge, 1986; p. 630).

To provide further insights on the graphic representation used above to describe how fishermen's collective choice to avoid the public bad might be achieved in a two-fishermen assurance game, an alternative cardinal representation is presented in Figure 10.8. In the context of the study area, assume that if one unit of cooperation yields 6 units to each and every fishermen provided that the other fisherman contributed as well. Further assume that the cost of individual provision (obeying the rule of the local institution or restrain his take from the fishery) amounts to 8 units. This is because in the assurance game both fishermen must contribute a unit of the public good for them to receive any benefits (unilateral action yields insignificant results). If both fishermen provide a unit, then each receives a net benefit of 4 units. This is equal to the difference between the total benefits of 24 units (2 x 12 = 24) and the total cost of 16 units. If, however, only one fisherman contributes, then he will incur a loss of his provision cost (- 8) but receive nothing, as for any benefits to be gained both fishermen must cooperate (Figure 10.8).

Fisherman A

	Strategy	Cooperate	Defect
Fisherman B	Cooperate	4, 4	- 8, 0
	Defect	0, - 8	0, 0

Figure 10.8 The payoff Structure of Analysing the Overall Level of Cooperation.

From Figure 10.8, it is clear that the game has no dominant strategy, but possesses two pure-strategy Nash equilibria, in which no one contributes or both fishermen contribute. In cases where there are no dominant strategies in the decision making, alternative outcomes that depend on optimistic expectations about mutual behaviours of everyone in the group are possible. Therefore, the decision to conserve the fishery depends on the expected decision of others. For example, if a fisherman expects others in the group to cooperate, he will do likewise to achieve the preferred outcome because his payoffs when he cooperates with the rest of the fishermen will be higher than if he defects while many cooperate, as shown by the payoff structure presented in Figure 10.8. As argued above by Baland and Platteau (1996) and Runge (1986), cooperation of the majority of resource users the "critical mass", will induce others in the group to do likewise.

Returning to the case of the South Al-Batinah fishery, as was illustrated in Chapter Eight, fishermen's actions are coordinated by a local management institution known locally as Senat Al-Bahar. The institution devised rules to coordinate the use of the fishery; thus, it provides the enforcement mechanism needed to organize a change in fishermen's behaviour. If Senat Al-Bahar functions optimally, it can reinforce expectations of collective behaviour which is the incentive required for a critical mass of fishermen to adopt cooperation as the dominant strategy. Other researcher have argued that the strategy Tit-for-Tat may be seen as an adequate mechanism of coordination to attain the Pareto superior Nash equilibrium of the assurance game (Cortazar, 1997; p. 47).

In the context of a small fishing village, for example, if all fishermen are far-sighted, a credible threat by others that they will impose sanctions on those who break the rules will be sufficient to achieve compliance. Tit-for-tat appears to be a robust strategy which resists challenge from other strategies where a player cooperate unless another defect. However, the trouble with Tit-for-Tat is that in the real world the first defection often leads to breakdown (Child and Faulkner, 1998; p. 29). Ridley (1996; cited in Child and Faulkner, 1998) suggests two alternative strategies that have been found to be more effective than Tit-for-Tat. They are Pavlov and Firm-but-Fair. In Pavlov, players stick to their strategy if they win on that strategy and if they lose try another strategy. Ridley claims this to be the basis of both dog-training and child-rearing. In this context, individuals are trained to do things that are rewarded and stop doing things that are punished. The strategy of Firm-but-Fair seems more effective than Tit-for-Tat and Pavlov. According to Child and Faulkner (1998; p. 29) "*in the firm-but fair, players act successively and can communicate (unlike the PD game) which leads them to cooperate with cooperators, return to cooperation after mutual defection, and punish defectors by further defection, but assumes that they continue to cooperate after being a sucker in the previous round*".

In the case of the fishery under study, the lack of a dominant strategy for each fisherman means that the final outcome also depends on many other factors beside the advantage of having a coordination mechanism (the local institution). The results presented in Chapter Nine revealed that fishermen's willingness to cooperate was explained by a number of independent variables. Furthermore, the regression analysis shows that four factors (awareness of resources problems, perception of risk, economic dependence on fishing and social identity) explain around one quarter (24 percent) of the variance in cooperation. Therefore, the unexplained variance in this case is 76 percent, which can be attributed to other factors. It can be argued here that part of the unexplained variance in cooperation in the regression analysis can be attributed to the presence of Senat Al-Bahar which provides security of expectation for all fishermen, thus encouraging them to adopt a cooperative attitude.

To highlight the importance of local level institutions in promoting collective action let us return to the findings presented in Chapter Four. We have seen that small changes brought about by institutions can change the *incentive structure facing* individual fishermen. It was shown that changing the way the catch is shared among resource users has resulted in a more efficient exploitation of the commons. It was found that the proportional-sharing rule leads to higher effort, which is higher than the level required for efficient exploitation of the commons. However, when the output is shared equally among participants (equal-sharing rules applied) the dominant strategy of individual fishermen changes to universal cooperation, thus a more efficient exploitation of the commons has been achieved. This is similar to changing the rules of the game in which the Prisoners' Dilemma is transformed into a fully privileged game by changing the way the game is played (see Sandler, 1992). The results obtained from equal shares rule reverse the overexploitation of the fishery commonly found under the proportional-sharing rule. An application of such an arrangement was found in the informal lobster territories in Maine (Acheson, 1989). One of the interesting features of the Maine lobster case is that gang members have instituted an equal sharing rule by limiting the number of traps individual fishermen may use. The outcome achieved by this sharing rule is a more efficient exploitation of the lobster resource in Maine. This leads us to conclude that small changes brought about by institutions can change the *incentive structure* facing individual fishermen. Therefore, the presence of a local management institution is vital to reinforce expectations of collective behaviour, inducing fishermen to adopt a cooperative strategy.

In her analysis of long term and successful collective action institutions, Ostrom (1990) states that the success of these institutions depends also on credible sanctions. Fishermen must believe that their misuse of the fishery will be caught and punished. Such disincentives induce fishermen to participate in collective action to manage the fishery, thus providing the needed assurance, especially for those who have already decided to participate in collective action (the critical mass) that their willingness to cooperate will be followed by the rest of the fishermen. In the study area and particularly at the village level multiple, sanctions are an effective device to foster participation in collective action. Fishermen's fear of the retribution from the sea, loss of reputation in the market (especially the credit market) and lose of cooperation of other members in the village are all necessary in their daily activities. For example, a fisherman needs the help of at least four others to beach his fishing vessel at the beginning and end of any fishing operation; more help is needed, of course, at low tides. It appears that the cost imposed on those who breach the rules laid down by Senat Al-Bahar might not be offset by the possible benefits gained from free riding.

10.7 Conclusion

The above account shows that conceptualizing the fishery in South Al-Batinah using the theory of games produces an outcome opposite to that characterized by Hardin (1968) as the tragedy of the commons. In contrast to the results of the PD, free riding is no longer the strictly dominant strategy.

The findings of this study strongly suggested that fishermen in South Al-Batinah have been initiating collective action to overcome some of the problems they face in their fishery. For example, strong opposition by fishermen in the area was observed to the use of the more destructive fishing gears.

To illustrate cases of successful collective action in the study area, many provisional and appropriation problems were conceptualised using game theory. The results of analysing two fishermen games strongly suggested that free riding is no longer the strictly dominant strategy. There was no dominant strategy in these games, but there were two Nash equilibria (for each game) in pure strategy in which one fisherman cooperates while the other defects. The payoff structure (similar to that of a Chicken game) is such that each fisherman prefers the other to cooperate while he defects. At the same time, at least one fisherman must take full responsibility to provide the public good if both are to avoid the disastrous outcome. Therefore, both maximize their benefit by coordinating their actions. To maximize their benefits and to avoid the worst outcome, fishermen were seen to depend heavily on the rules devised by the local institution (Senat Al-Bahar). Rules such as "first entrant into the fishing spot has the right to fish" and the "distance rule" were amply used to coordinate fishermen's actions to solve common dilemmas. The findings of this study strongly suggest that the presence of a local management institution to coordinate the fishermen's activities in the study area is the key factor in avoiding the worst outcome (universal defection). The game structure has been changed from a Prisoner's Dilemma to a Privileged game or a game of Chicken where the benefits from cooperation are maximized.

The study also found that high awareness of resource exploitation and the potential benefits of cooperation, coupled with high dependence on fishing, induced fishermen to work collectively to further their well-being. As rational individuals, fishermen will not choose a mutual defection strategy that may lower their individuals, and collective benefits.

The discussion clearly demonstrates how institutional rules have changed the payoff structure from a Prisoner's Dilemma to a game of Chicken or an Assurance game and the fishermen have coordinated their actions.

The study found that in some cases, participation of a few fishermen does not yield the public good needed. In such a case, a critical mass of other individuals is needed to participate in collective action for the cooperation equilibrium to hold (this is a typical assurance game). However, those who what to cooperate must feel that their willingness to cooperate is shared by many others. It was found that the local management institution provides the necessary assurance for those who want to cooperate that others will obey the rules (free riders might be sanctioned), encouraging everybody to participate in local collective action since the outcome is preferred. Therefore, individual fishermen's strategies depend on their expectations of the behaviour of other fishermen in the area.

CHAPTER ELEVEN

OVERALL CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FURTHER RESEARCH ARISING FROM THE STUDY

11.1 Introduction

This chapter is devoted to summarizing the study and to highlighting its findings and implications for the Omani fishery. The chapter begins by presenting the important findings of this research. The chapter will proceed then to present the implications of the study. Finally, the chapter evaluates the limitation of this study and presents guidance for future research.

11.2 Background Summary

The coastal fisheries of the Sultanate of Oman are a vital part of the livelihoods of large sections of the population in the country, and the issue of how to prevent their over-exploitation as demand for fish grows is of great importance for development policy in Oman. The inshore fisheries resources have witnessed the symptoms of overfishing especially the high value commercial species. Overexploitation of fish resources in South Al-Batinah results from unrestrained access to the fishery leading to a steady increase in the number of fishermen and fishing vessels over the years. This has been coupled with a relatively lower input prices for fishing vessels and gear which are available secondhand, making access to the fishery simple. On the other hand, traditional conventions and informal social sanctions relating to the use of fish resources have been replaced by unenforceable legal and administrative measures. This has marginalized the fishermen's initiatives to coordinate their usage pattern and to exclude outsiders from entering their communities.

Overexploitation of fish resources in Oman and particularly in South Al-Batinah result from a number of reasons. One reason is the rapid change in the institutional setting in Oman. The traditional fisheries laws (Senat Al-Bahar or the local fisheries management institution) which were governed by Islamic rules as well as customary rules (established practices) have been changed. Historically, the laws of Senat Al-Bahar were used to govern the fish resources in the country. The objective is always to define responsibilities, conserve the fishery and limiting personal and communal disputes. With modern fisheries management, the government has declared all fish resources to be a national resource and thus it empowers the relevant governmental agencies to develop and protect these resources according to laws declared by Royal Decree. The result of the new fisheries management institutions has been a need for more coordination of policies between the various governmental agencies involved with fisheries management. Each agency currently designs and implements policies aimed at achieving each agency's objectives. Different of interest and some duplication of effort has occurred.

The fisheries sector, particularly the traditional sector, is a significant sector in the Omani economy. It provides substantial employment opportunities for coastal inhabitants in addition to its contribution to the national GDP, foreign exchange and the provision of an important source of animal protein. The traditional fishery constitutes the most important sub-sector, accounting for around 80 percent of the total fish landings during the last twenty years. However, as indicated in the Chapter Two, the landings of the traditional fishery have showed declining trends for several years since 1980s. The decline in the landings of this sub-sector can be attributed to overfishing in inshore waters.

Given the failures of the current state management institution to address the problem of overfishing and to protect the livelihoods of the fishermen, it is important to search for an alternative solution. Cooperation among resource users to manage their resources has been regarded as an alternative to the expensive and often inappropriate management by the state. It is the aim of the present study to examine the factors that influence fishermen's decisions to participate in collective action.

A theoretical framework was developed for this study based on the theory of common property resources, concepts of institutional analysis, the theory of public goods and game theory. The framework was essential for examining how institutions and individuals and other physical and village attributes account for the failure or success of collective action among fishermen to manage their fishery. Data collected from a cross-sectional survey on 194 vessels' owners in South Al-Batinah (Sultanate of Oman) were used to examine the propositions and hypotheses derived from the literature review.

11.3 Summary of Results by Objective

The four objectives presented in Chapter One provide the foundation for the study of collective action among fishermen in South Al-Batinah. These objectives covers: (a) the assessment of the structure, standard of living and other activities of fishermen in the study area, and to assess fishermen's awareness of the status of the resources; (b) investigation of institutional characteristics which may enhance fishermen's effort to participate in collective action to coordinate resource use; (c) investigation of the factors which are influential on individual fishermen's decisions to cooperate and (d) investigation of the influence of group size and group homogeneity on individual fishermen's collective decisions to manage their fishery. Results related to these objectives are presented here.

(a) Objective One

Fishermen in the study area were found to have a common language, to share the same religious belief and originate from the same race; thus, they are more or less homogeneous with respect to the above factors. In such groups, rules are easier to formulate and enforce because fishermen's behaviour tends to be more predictable, thus it seems likely that they will be able to establish institutions to manage the resources at low cost. Homogeneity coupled with high interdependence between fishermen in their daily lives in those small villages makes social ostracism enough to induce compliance with the rules.

The fishermen's average age was 44.4 years, and they have a relatively low level of educational attainment. The low level of education coupled with lack of skills make them highly dependent on the fishery. Regarding family size, the results indicate that the household size is relatively large resulting from a relatively high population growth in the country (3.5 percent in 1993). Large household size coupled with a shortage of employment opportunities in South Al-Batinah at present could accelerate the pressure on fish resources in coastal areas.

To diversify the household income, fishermen in the study area are undertaking supplementary occupations beside their fishing occupation. It was found that 29 percent of the sampled fishermen have jobs that provide a secure and sustainable source of income; thus, 71 percent of the sampled vessel owners are economically dependent on incomes derived from fishing. Furthermore, income from fishing accounts for a substantial amount of the total individual vessel owner's income, indicating a high economic dependence on the fish resources. It was found that income from fishing accounted for 74 percent of the total vessel owner's income, while non-fishing income represent 26 percent only. The extent of the coastal fishery as a proportion of the total household income was also examined. The findings of this study indicate that fish resources are very prominent to the livelihoods of coastal inhabitance. Among the households included in this study, the proportion of income based directly on the fishery was 40 percent, representing significant contributions.

The results indicate that the average income of boat owners from fishing is higher than the national minimum wage but slightly lower than the national GDP per capita and the fisheries GDP per capita. The analysis of income distribution using the Lorenz curve and Gini coefficient indicate that there is a great disparity in income distribution between fishermen. It was found that the income of the top 20 percent is around nine times higher than the incomes of the bottom 20 percent. The results of the Gini coefficient analysis show that the highest income inequality is in Suwaiq, while the lowest is in Barka.

The study found that fishermen use a variety of fishing gear in order to diversify their income from fishing. The results prove that more fishing effort has been added into the fishery. Fishermen in the area own more or less similar fishing vessels in terms of size, hull construction and engine horsepower. Fishermen, therefore, can be considered as a homogenous group with respect to the characteristics of the fishing fleet. Therefore, obstacles to achieve collective action are unlikely to occur as agreements to restrain the take from the fishery become easier as the difference in the characteristics of the fishing vessels among owners is negligible (Johnson and Libecap, 1982).

The study suggests that fishermen in the study area are more or less homogenous in many respects. However, the higher income inequality could be an obstacle to collective action as agreements to restrain the take from the fishery become more difficult as the difference in endowments among agents increases. As argued by Libecap (1994), "*in many common pool settings where user groups are heterogeneous, change in property institutions involve the risk of being made worse off for some group members, especially those who are profitable under the status quo*".

The study also found that fishermen were in general in agreement on the status of the fishery. They perceived the problem of declining stocks in their fishery as either severe or extreme. Fishermen were also aware of the factors that cause their fishery to be depleted. High awareness of the resource exploitation problems, the factors responsible for these problems and the potential benefit from cooperation might induce fishermen in the area to work collectively to avoid their well-being been jeopardized. When individual benefits exceed individual costs and summation technology applies, the group is fully privileged and the public goods will be provided (Sandler, 1992; p. 44).

(b) Objective Two

The study found that small changes in institutions could change the incentive structure facing individual fishermen. This is proved mathematically in Chapter Four to demonstrate alternative institutional structure that may be used for mitigating the potentially disastrous consequences of completely open access or unregulated common property. Examples of communities that developed institutions for placing constraints on individuals' exploitation of the resources, thereby avoiding some of the problems of overexploitation of open access are legion, as suggested in the literature (see Baland and Platteau, 1996 and Ostrom, 1990) and demonstrated by the findings of this study. The resulting institutions to govern the resource involve neither wholly open access for everyone to an unpriced resource nor the assignment of exclusive rights to a particular group that then hires out the rights to appropriate the resource. In most of these communities, access to the resources is restricted to members of a certain community where systems for restricting individual use of the resource are imposed (Cornes and Sandler, 1996; p. 60).

In the present study, two institutional structures were compared, open access and a regulated common property. While in the former, individuals' use of the resources is not restrained (proportional-sharing rule), the latter regime adopts a system in which the total output is shared among the members at the end of any day (equal sharing rule). It was proved mathematically that the dominant strategy of individual fishermen under the proportional-sharing rule is universal defection. However, modifying the sharing rule changes the non-cooperative game into a game in which the dominant strategy of all fishermen is to cooperate. Mathematically, it is proved that the equal shares rule can produce an outcome opposite to that characterized by Hardin (1968) as the tragedy of the commons. The findings presented in Chapter Four demonstrate clearly that under the equal-sharing rule an individual's decision to devote more fishing efforts forces the negative externalities of his action back into his own incentive structure. In such a situation he has to share the consequences of his excessive fishing effort with all other fishermen. The structure of incentives is fundamentally altered by the adoption of this sharing rule.

The empirical results indicated that there is a management institution that governs the fishing activities of the fishermen in the study area. Fishermen in the area inherited an indigenous management institution, which was established hundreds of years ago. The institution addresses the problems associated with their activities in fishing and governs the use of the fishery. Many local accords were devised by the local institution to address common problems faced by fishermen, of which many are still in use. The local institutions provide the enforcement mechanism needed to regulate fishermen's behaviour. Although the local institutions in current form seem to address provision problems, there is some evidence that fishermen in the area have devised rules to conserve important fisheries from depletion (appropriation problems).

The study indicates that the capabilities of the local institution have been undermined as the result of the centralised approach to resource management by the state. The results of the thesis suggests that the modernisation process that has been taken place in the country during the last thirty years has tended to make collective action at village level to manage the fishery increasingly difficult.

The new system of fisheries management made access to the fishery simple and encouraged many non-fishermen to enter the fishery. This has transformed the fishery from a common property to an open access. Communities' ability to exclude non-fishermen was limited because legally they can no longer prevent those who hold a fishing licence from fishing. The inability by the authorities to define resource user boundaries fully, inhibited monitoring and enforcement of the local institution although it was evident that some rules were still followed. Therefore, the entry of people from outside the fishing village has eroded local collective arrangements and the dependence of the local institution on social ostracism and moral norms to preclude certain activities has been hampered.

(c) Objective Three

The study findings strongly suggest that the majority of the traditional fishermen in the study area are aware of the ongoing process of resource depletion and the extent of damage done. The study also found that they are aware that their harvesting activities are directly responsible for the degradation of their fishery, thus they have a correct idea about their own responsibilities for the current status of the fishery. The results of testing a number of hypotheses (hypothesis 3,4,5, and 6) concerning fishermen's awareness of the resources exploitation problems showed that awareness of resources exploitation problems has a significant influence on individual willingness to participate in local collective action efforts.

Other important reasons which may account for collective action succes, are a high economic dependence on the fishery and individual's social identity as fishermen. The study found a significant positive relationship between fishermen's economic dependence on the fishery and their individual decision to cooperate in managing their fishery (hypothesis 1). Therefore, the chances of successful collective action would be high in villages where income from fishing is a large share of the total household incomes. However, Jodha reminds us that when people are subject to the pressure of survival constraints and other needs they would use a high rate to discount future income, especially when markets for use rights over the resources are highly imperfect (Jodha, 1992; p. 62). Social identity, on the other hand, was found to influence individual decisions in managing the commons (hypothesis 2). This strongly suggests that in an open access situation, when people from outside the fishing village enter the fishery they will not comply with the rules of the Senat Al-Bahar. This weakens the function of the local institution and makes local collective arrangements to restrain the take from the fishery difficult to achieve. The positive significant relationship between fishermen's social identity and their willingness to cooperate indicates that those who identify themselves more strongly as fishermen would cooperate more in the commons than those who did not identify themselves strongly as fishermen. This is because fishermen inherit fishing rules and fishing knowledge from their fathers and grandfathers; thus, they tend to have strong awareness that their activities might harm their fishery compared to newcomers.

The study found that fishermen's profiles do not seem to have a significant influence on fishermen's decision to participate in collective action apart from education attainment, which emerged as causing a negative impact on fishermen's willingness to cooperate (hypothesis 7). Furthermore, the study found that vessel characteristics have no influence on fishermen's decisions to participate in collective action (hypothesis 8). This finding was not surprising, as earlier results confirmed that fishermen in the study area are using vessels of more or less similar characteristics.

Fishermen's cooperation appears to be influenced by individuals' risk aversion (hypothesis 9). The findings suggest that situation of high risk and uncertainty plays a crucial role in fishermen's decision to participate in collective action. The findings indicate that there is a significant positive relationship between risk aversion and attitude toward cooperation. However, the assumptions made regarding the relationship between perception of risk and fishermen's willingness to cooperate in managing the commons need to be explored further. Two indicators were used to measure fishermen's risk aversion: debt to asset ratio and number of fishing gears types owned. Among the two indicators used to operationalize perception of risk, one indicator (number of gear types owned) supports the hypothesis, but the other one (debt/asset ratio) does not support it (the hypothesis holds true for Suwaiq only). The results indicate that the higher the D/A ratio (less risk averse) and the more the number of fishing gear types owned (less risk averse), the lower the fishermen's willingness to cooperate[1]. In such situations, a fisherman with a less risk averse attitude will not take the offer of a cooperating game, as there is no guarantee that others will not defect and make him a "sucker". It is anticipated that when productivity benefits from collective action are considered certain, more risk-averse fishermen are likely to expend greater conservation effort in order to avoid future losses in the fishery productivity and revenue (Kalaitzandonakes and Monson, 1994 and Robison and Barry, 1987; cited from Fernandez-Cornejo *et al.*, 1994).

A linear regression model was built to predict fishermen's attitude toward cooperation. The results of the model indicated fishermen's awareness of the resources exploitation problems appears to be the best predictor of fishermen's attitude toward cooperation followed by perception of risk. Economic dependence on fishing came in

[1] As they have high investment in the fishery, they try to reduce their business risk by avoiding a cooperative strategy.

the third place, followed by social identity. The results of the regression model indicate that these four variables were statistically significant in explaining variation in the dependent variable "willingness to cooperate". The four variables alone explained 24 percent of the variation in the dependent variable.

(d) Objective Four

As indicated above, the study found that there are a number of factors that can be used to predict the success or failure of collective action. The findings of this study strongly suggested that group size does not have any significant influence on individual willingness to participate in local collective action (hypothesis 10).

The conditions for a privileged group may depend on the technology of publicness and its relationship to the underling game structure (Sandler, 1992). When individual's benefits exceed individual costs and summation technology applies, the group is fully privileged and the public goods will be provided. In this case the number of players would have no effect whatsoever on whether the good is provided; group size is irrelevant (Sandler, 1992; p. 40). If provision costs are shared among group members regardless of contributors, then individual cost will fall with group size. When individuals' costs fall with overall group size, then the fall in individuals' fraction of the group gain may be offset by the decline in cost, hence ensuring that the group is privileged. But sharing the provision costs among group members depends largely on institution rules. Sandler (1992) states that the requirement for a privileged group to form is more dependent on the underlying game structure, which, in turns depends on tastes, cost and the technology of publicness, rather than the number of players involved. The changing institutional forms challenges the influential predictions that only state or market solutions can allocate and protect common resource (Kurien, 1995). The present study also challenges the assumption that those who are caught in a "commons dilemma" would rarely invest time and money in the design and supply of institutions to conserve it.

Therefore, the finding of this study rule out the direct effect of group size on the success or failure of collective action which is consistent with the findings of Baland and Platteau (1996); Chamberlin (1974); Cornes and Sandler (1996); Salim (1996); Sandler (1992) and Wade (1988).

The study considers further the relationship between group heterogeneity and the success of collective action. Three indicators of group heterogeneity were included in hypothesis testing (ethnical divisions; differences in the nature of interests various individuals may have in a particular collective action and income inequality). The study does not test the effect of the first source of heterogeneity because the study groups are culturally homogenous and thus ethnic and cultural differences were not included as an independent variable. The study findings indicated that while the second sources of heterogeneity (difference in objectives and interests) are considered as causing a strong obstruction to collective action (hypothesis 11), the same cannot be said about the difference in the distribution of income (hypothesis 12). More inequality does not necessarily lead to more efficient use of natural resources; thus, Olson's (1965) exploitation hypothesis was ruled out.

Game theory analysis of the decision choice of individual fishermen when facing a common dilemma has made clear that enforcement of the agreed-upon rules can be carried out effectively by the users themselves. The findings of this study strongly suggest that fishermen in South Al-Batinah have initiated collective action to overcome some of the problems they are facing in their fishery. It was clearly demonstrated throughout this thesis that modelling the fishermen's behaviour in the study area using the Prisoners' Dilemma game seems unrealistic as revealed by previous theoretical and empirical studies, as well as the findings of this study, as this game does not account for the variability and complexity of resource use conditions.

To illustrate cases of successful collective action in the study area, many provisional and appropriation problems were conceptualised using game theory. The results of the analysis of the two fishermen game strongly suggests that in most of these cases fishermen have no dominant strategy, but there were two Nash equilibria in pure strategy in which one fishermen cooperates while the other defects. The payoff structure (similar to that of a Chicken game) depicts that each fisherman prefers the other to cooperate while he defects. At the same time, both avoid universal defection (the worst payoff) in which one is willing to contribute if he believes that his opponent will not. Therefore, both maximize their benefit by coordinating their actions. To maximize their benefits and to avoid the worst outcome, fishermen were seen to depend heavily on the rules devised by the local institution (Senat Al-Bahar). Rules such as "first entrant into the fishing spot has the right to fish", the "distance rule" and many others are usually used to coordinate fishermen's actions to solve commons dilemmas.

Modelling the overall level of cooperation suggests that fishermen's behaviour in the study area is best represented by an assurance game in which there is no dominant strategy, but there are two pure-strategy Nash equilibria in which no one contributes or all contribute. In this situation alternative outcomes depend largely on optimistic expectations about mutual behaviour of all fishermen in the group. The study found that what makes fishermen hold optimistic expectations about the behaviour of others is the presence of a local management institution.

Broader conclusions regarding individual cooperation in the commons may be drawn here. As suggested in the literature and demonstrated by the findings of this study, individuals using a common resource are faced by various "assurance" and "chicken" problems. In both the PD game and the Assurance game, the preferred outcome is mutual cooperation. Whereas the predicted outcome of the former is defection, however, the latter suggests the possibility that the preferred outcome (i.e., cooperation) will occur, because individuals' decisions in the commons are influenced by a complex set of factors, rather than strictly materialistic self-interest. The analysis presented in this study examined several of those factors for their influence on individual behaviour.

11.4 Theoretical Implications

As no previous attempt has been made to assess the collective choice of fishermen in Oman this study will be the first to appear on this type. An understanding of the factors influencing fishermen's decisions to provide a collective good will certainly foster the required preconditions to achieve a sustainable management of fish resources in the country.

The findings of this study rule out the direct effect of group size on the success or failure of collective action. This was confirmed by comparing the fishermen's mean level of cooperation in the three towns included in this study. Thus Olson's (1965) assumption of the relationship between the provision levels and group size was not supported. The study further ruled out the direct effect of income inequality on the efficient use of natural resources, thus Olson's (1965) exploitation hypothesis was not supported. The study further suggests that the success of collective action is very complex, involving a host of other factors. The most significant conclusion of this study is the importance of the institutional considerations in anticipating future participation in collective action. The presence of a local management institution to coordinate the fishermen activities in the study area is the key factor for the success of collective action. Game theory analysis of the decision choice of individual fishermen when facing a common dilemma has made clear that enforcement of the agreed-upon rules can be carried out effectively by the users themselves. They study shows that the presence of proper institutional rules changes the payoff structure of the game from that of the Prisoners' Dilemma to a payoff structure similar to the Privileged, Assurance or a Chicken game.

The results strongly suggest that awareness of resources exploitation problems and the potential benefits from cooperation have a significant influence on individual willingness to participate in local collective action efforts. Economic and social considerations are also important in predicting the success of collective action. Factors such as economic dependence on the fishery and perception of risk were found to dominate the decision about participation in collective action. The results further indicate that social factors such as individual identity as a fisherman was also found to influence fishermen's decision to participate in local collective efforts. Personal profile and characteristics were found to have no significant influence on fishermen's attitudes and decisions.

The traditional conventions and informal social sanctions relating to the use of fish resources have been replaced by unenforceable legal and administrative measures. This has marginalized the fishermen's initiatives to coordinate their usage pattern and to exclude outsiders from entering their communities. It was clearly demonstrated throughout this thesis that modelling the fishermen's behaviour in the study area using the Prisoners' Dilemma game seems unrealistic as revealed by previous theoretical and empirical studies and proved by the findings of this study. The results therefore challenge the influential predictions that only state or market solutions can protect common resources. Government attempts to regulate fishermen's activities proved ineffective. Furthermore, the findings of this study have made clear that enforcement of the agreed-upon rules can be carried out effectively by the users themselves. This does not mean that government support to local management should be ruled out.

Historically these local management institutions in Oman are backed up by the legal systems. Some form of co-management should be implemented where the responsibilities to regulate the fishery are shared between the state and the users. Therefore, fishermen's involvement in the management of fish resources must be considered in the Ministry's plans to manage the fishery effectively.

During his visit to the country to carry out the field work to collect the data for this study (January to April 1998), the researcher had several meetings with officials in the Ministry of Agriculture and Fishery Resources, including the Minister His Excellency Dr. Ahmed Al-Rawahi. The researcher explained the benefits of a collective action approach toward fisheries management, which received positive responses from many staff in the Ministry, including the Minister himself. Some official staff in the Ministry to whom the researcher spoke during his recent visit to Oman (April 1999), indicated that the Ministry is proposing a study to establish a Fisheries Management Council in each town. The council will include local fishermen, sheikhs (heads of tribe in each village) and some government officials in each town. The council will be involved in the management of the coastal fish resources. The traditional conventions and informal social sanctions relating to the use of fish resources (Senat Al-Bahar) will be supported. The researcher believes that his efforts in this regard have borne fruit even before the findings of his study have been made available to the Ministry's staff. Therefore, the implications of the findings of this study for the management of the Omani coastal fisheries are significant. Presenting these findings to the Ministry's officials will trigger their attitude toward a co-management approach for the management of the coastal fish resources in the country.

11.5 Management Implications

As illustrated above, the findings of this research give support for more involvement of fishermen in the management of their fishery. Certainly these findings demonstrate the need for a change in previous Government policies regarding the form of resource regulation. The Government is advised to show a quicker and stronger determination to reverse its previous policy (nationalization of the coastal fish resources) by making a radical shift towards fishermen-based fisheries management. Change of legislation can be carried out by a Royal Decree to give local communities greater responsibilities to manage their fish resources. Special district committees of fishermen (Fisheries Management Council in each town) representing different fishing villages should be established to make the rules of the fishery (e.g., allowable fishing times, which gear is allowed on which fishing grounds, etc.). In addition a public enforcement agency should be established to assure that the rules crafted by fishermen are being obeyed.

The following suggestions can serve as the bases for the nature of relationship between the Government and the fishermen in the form of a co-management regime:

(a) The Government can process crucial information on coastal fisheries and inform the fishermen of external effects they may produce as well as providing technical assistance to the fishermen by disseminating new practices aimed at ensuring preservation and optimal exploitation of the fishery (e.g., advising fishermen to use more selective fishing gears). This will help fishermen to assess the changes that have taken place as a result of their activities, and what remedial action need to be taken. The Government can also provide a legal framework by which local communities can get legally enforceable recognition of their identity and rights. The government can also improve the efficiency of local management groups by promoting competition among local management organization by forecasting information on best practices to manage the fish resource.

(b) Fishermen on the other hand can be involved in a number of issues in a co-management regime concerning the use of their resources. Users groups can inform the government of any local ecological changes like a decline in the catch of a particular fish species. Because they are well informed about their local conditions, fishing grounds and the fishery overall, they can be responsible to craft fishing rules and adjust them over time as required by local conditions. Fishermen can also be responsible for local conflict-resolution mechanisms to solve interpersonal disputes cheaply and effectively on the spot as well as conflicts arises between communities on fishing.

Of course, the extent to which socio-professional fishermen's organizations can undertake these functions is constrained by the weakness of local communities. The stronger the communities in one or several of the above functions, the more the responsibilities the Government should hand to them. For example, communities which possess strong determination to initiate collective action should perform many of the above functions. Therefore, the present study and similar studies are of paramount importance and a prerequisite before deciding on what form of fisheries regulation should be practiced and/or which users groups should be given some functions concerning the management of local fisheries.

11.6 Limitations of the Study

The primary limitations of this research can be summarized in the following points:

(a) The scope of this study is confined to fishermen of South Al-Batinah coast. However, the methodology adopted could be applied to cover all fishermen along the coastline to see if differences are likely to occur among different regions. Similar study could be carried out in a fishery of another country, especially the Arabian Gulf countries.

(b) Like any other survey research, this research may be limited by the fact that the questions may have been interpreted by the respondents differently than intended, and answers to some questions may have influenced answers to others.

(c) The findings of this study depend largely on cross-sectional data which reflect the socioeconomic conditions as well as collective decisions of those included in the sample at the time of the survey. Institutions are always changing; thus, follow up investigations would enable comparison of institutional performance over time.

11.7 Significance of the Study

This study and the formulation of its aim and objectives transcend the restricted population of fishermen in South Al-Batinah, and this has implications for the whole fisheries of Oman. As no previous attempt has been made to assess the collective choice of fishermen in Oman this study will be the first to appear on this type. An understanding of the factors influencing fishermens' collective decision to provide a collective good will certainly allow policymakers to foster the required preconditions to achieve a sustainable management of fish resources in the country. It is intended that a longer term outcome of the study will be the development of a feasible model for the management of the coastal fish resources in Oman. The Government has been exerting efforts to diversify the economy by increasing the contributions of the fisheries sector. This study aims to contribute to these efforts by raising issues that might enhance the productivity of fish resources in Oman, thus increasing their contributions to the national economy.

11.8 Directions for Further Research

The implications for further research apply to theoretical development and the methodology used for testing the emerging propositions. The study, therefore suggests the following avenues for future research:

(a) Assumptions regarding the relationship between individuals' social identity as fishermen and their willingness to cooperate in managing the commons need to be explored further. Among the three indicators used to operationalize respondents' social identity, two indicators (years fishing and principal work) supported the hypothesis, but the other one (family involvement) did not support it. The contradictory results of testing the social identity hypothesis (hypothesis 2) for the different indicators of social identity suggest the need for considering alternative operationalizations of social identity for their relevance to cooperation in the management of fish resources. The same procedure can be applied to the assumption regarding the relationship between perception of risk and fishermen's willingness to cooperate. The contradictory results of testing the risk aversion hypothesis (hypothesis 9) suggest the need for considering alternative operationalizations of risk aversion for its relevance to cooperation in the management of fish resources.

(b) This study can serve as the basis for additional research in Al-Batinah coast. Another field visit would enable comparison of the fishermen's socio-economic conditions and their collective decisions over time. Other fisheries in Oman should be studied using the same framework developed in this study in order to determine if the proposed framework is applicable elsewhere, and to determine whether the results of this research can be extended to other countries with similar cultural and socioeconomic infrastructure such as the Arabian Gulf Countries as well as other geographical areas such as Africa, South East Asia and Latin America.

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The University of Hull
Institute of Food Health Quality

Questionnaire for vessel owners on: Social and economic factors influencing collective action in a traditional fishery of South Al-Batinah, Oman

Dear fisherman,

My name is Hamed Al-Oufi, an assistant lecturer at Sultan Qaboos University, Oman, and I am currently pursuing my studies at the University of Hull, England, under the supervision of Dr. Andrew Palfreman, a senior lecturer in fisheries economics. I am carrying out a questionnaire survey to collect data about the traditional fisheries sector which will be used for a Ph.D thesis. My topic concerns the factors that may influence the collective activities in coastal communities. I am interviewing fishermen in this village and will be grateful if you can participate in this interview.

You were selected randomly from the 1995 boat census carried out by the Ministry of Agriculture and Fisheries.

The contents of this questionnaire are absolutely confidential and only be used for the purpose of this research. Information identifying you will not be disclosed under any circumstances. Your co-operation in this survey is very important for the success of this study. Under no circumstances will your name be linked to the data of this work or any related work.

Thank you very much for your time and co-operation.

Hamed Said Al-Oufi (Assistant Lecturer)
Sultan Qaboos University
College of Agriculture
Department of Fisheries Science and Technology
Al-Khod, P.O.Box 34, CN 134. OMAN

A. General information

1. Serial No. ________________
2. Time: from ______________ to ______________
3. Town ________________ Village ___________
4. Date of interview ____________________
5. Census No. _________________________

B. Fishing assets

B1. Fishing vessel/s owned

Item	Vessel I	Vessel II	Vessel III
1.Length (ft)			
2.Year acquired			
3.Cost of acquisition			
4.Method of acquisition 1. own finance 2. loan (source)			

B2.Engine

Item	Engine I	Engine II	Engine III
1.HP			
2.Year acquired			
3.Cost of acquisition			
4.Method of acquisition 1. own finance 2. loan (source)			

B3. Fishing Gears

Item	Gear I	Gear II	Gear III	Gear IV	Gear V
1. Type of gear					
2. No. of units					
3. Year acquired					
4. Fish species					
5. Depth (fm)					
6. Sale per trip					
7. Season					
8. Cost of acquisition					
9. Method of acquisition 1. own finance 2. loan (source)					

B4. Fishing Accessories and Other Assets Owned

Item	Name of accessories and other assets				
	Farm	House	Net hauler		
No. owned					

C. Fishing activities and fish marketing:

C5. Number of crew ____________________

C6. How many days per month do you fish on average? ____________________

C7. When do you normally not fish in a month? (explain) ____________________

C8. And why? ____________________

C9. Where do you sell your catch? (State the auction name and commission charged)

____

C10 How much are your fuel and lubrication costs per trip? OR____________________

C11. How much are your other costs (food, ice, etc.) per trip? OR____________________

C12. How do you share the catch? Boat____ %, Crew _____%, Owner _____%

D. Fish resources current status

D13. Do you think the fishery of your community is declining?

Yes .... **1** Not sure........ **2** No **3**

D14. How would you describe the problem of declining fishery here- No problem, Moderate, Severe, or Extreme?

No problem.................. **1** Severe.......................... **3**
Moderate .... **2** Extreme........................ **4**

D15. Have you noticed a decline in the quantity of some species in your catch compared with the past?

Yes .... **1** Not sure ....**2** No **3**

D15.1. List those species ____________________

D16. Have you noticed that a species has disappeared completely from your catch?

____

D17. What makes fishery resources decline? (Explain)

____

____

D18. As far as you know, do you think overfishing in this area could be stopped?

Yes .... **1** Not sure ....**2** No **3**

D18.1 If "Yes", how should it be done? ______________________________

D18.2. Have you personally done anything to get the community to take action to reduce overfishing in this area?

Yes .... **1** Not sure ....**2** No **3**

D18.3 If "Yes", what have you done? ______________________________

Instruction for section E, F and G

The following statements are regarding your perception towards resources status, factors that may cause resource to decline, and the consequences of resource depletion. Please use the scales below to indicate to what extent you agree or disagree with the following statements. The choice is whether you (1) Disagree (D), (2) are Indifferent (I), or (3) Agree (A) with the statement.

E. Perception of resources status

		A (3)	I (2)	D (1)
E19	Your fish catch per trip declines	☐	☐	☐
E20	Your target species per trip decline	☐	☐	☐
E21	The large fish are difficult to find or catch	☐	☐	☐
E22	We need to spend longer hours looking for fish then we used to	☐	☐	☐
E23	The percentage of trash fish in your daily catch has increased.	☐	☐	☐

F. Overfishing:

		A (3)	I (2)	D (1)
F24	Fish resources decline if too many vessels are operating in the same area	☐	☐	☐
F25	Fish resources decline if all vessel are large in size	☐	☐	☐
F26	Fish resources decline if all vessels use high horse-powered engines	☐	☐	☐
F27	Fish resources decline if all vessels employ a large number of nets	☐	☐	☐
F28	Fish resources decline if fishermen use destructive gear	☐	☐	☐
F29	Fish resources decline if fishermen increase their fishing time per trip	☐	☐	☐

G. The consequence of overfishing:

		A (3)	I (2)	D (1)
G30	Your fishing area becomes further away from your village	☐	☐	☐
G31	Your fishing hours become longer	☐	☐	☐
G32	Your fuel consumption increases	☐	☐	☐
G33	Many fishing areas are barren	☐	☐	☐
G34	You have to use more fishing gears to catch fish	☐	☐	☐
G35	Your income from fishing declines	☐	☐	☐

Instruction for section H:

The following statements are regarding your perception towards externalities. Please use the scale below to indicate to what extent you agree or disagree with the following statements. The choice is whether you (1) Disagree (D), (2) are Indifferent (I), or (3) Agree (A) with the statement.

H. Externalities in coastal fisheries

		A (3)	I (2)	D (1)
H36	You may face some difficulty in fishing if too many vessels operate in a small area	☐	☐	☐
H37	Net entanglement problems often occurs if too many vessels operate in the same area	☐	☐	☐
H38	You cannot fish in the area where many colleagues are fishing	☐	☐	☐
H39	Less catch is expected if you operate in the area which has just been fished by many colleagues	☐	☐	☐
H40	Conflicts among fishermen at sea are rising	☐	☐	☐

I. Collective activities in fishing community:

I41 Is it necessary for all fishermen, including you, to work together to prevent resource depletion?

Yes .... 1 Not sure ....2 No 3

I42. Do you go fishing in a group?

Yes .... 1 Not sure ....2 No 3

I42.1. Why or why not ? (explain)____________________________________

I43. Do you always help your group members?

Yes .... **1** Not sure ....**2** No **3**

I43.1. If I43 is yes, in what way? (Explain)______________________________

I44. Do you recognize all fishermen in your village?

Yes .... **1** Not sure ....**2** No **3**

I45. Do you have any artificial reefs?

Yes .... **1** Not sure ....**2** No **3**

I45.1. Why or why not? (Explain)______________________________

I45.2. Did some of your colleagues help you in the construction of the reefs?

Yes .... **1** Not sure ....**2** No **3**

I46. What is the method you adopt to avoid the net entanglement problem?______________________________

J. Factors that may influence collective activities:

1. Group size

J47. How many fishermen operate in the same fishing grounds where you operate?

__________People

J48. Are they from your village?

Yes .... **1** Not sure ....**2** No **3**

J49. Do you meet with them after the fishing trip?

Yes .... **1** Not sure ....**2** No **3**

J49.1 If Yes, where do you meet?

____

J49.2 Why do you meet?

____

J49.3 How many of you meet regularly? ______________________________

J50. Do you discuss fishing matters?

Yes .... **1** Not sure ....**2** No **3**

2. Fishing technology constraints:

J51. How could you improve your catch rate?

Enlarge your vessel size **1**
Increase your engine horse-power...**2**
Use a large number of nets..**3**
Increase fishing time per trip..**4**
Other (Explain)_________________________.................**5**

J52. Have you heard about the rule that bands the use of drift gill net in areas less than 30 fathoms depth?

Yes .... **1** Not sure ....**2** No **3**

J53. Do you think this rule will reduce conflicts between fishermen?

Yes .... **1** Not sure ....**2** No **3**

J53.1 Why or why not?______________________________

J54. Did all fishermen or some of them obey this rule in this village?

Yes .... **1** Not sure ....**2** No **3**

J55. Are you willing to inform the authority about fishermen who violate this rule?

Yes .... **1** Not sure ....**2** No **3**

J56. Are there fishermen use encircling gears in this village?

Yes .... **1** Not sure ....**2** No **3**

J56.1 What are the consequences of this action? ______________________________

J56.2 Are you against the use of this gear in your fishery?

Yes .... **1** Not sure ....**2** No **3**

J56.3 Have you and your colleagues done anything to stop this? ______________

<u>3 Institutional factors:</u>

J57. Do you agree that anybody who does not have a fishing licence should be banned from fishing?

Yes .... **1** Not sure ....**2** No **3**

J58. Do you agree that breakers of fisheries laws should be penalized

Yes .... **1** Not sure ....**2** No **3**

J59. Do you think that the quality of the fish resource will improve if current number of fishing vessels is reduced?

Yes .... **1** Not sure ....**2** No **3**

J60. Have some of you united to resolve conflicts in fishing?

Yes .... **1** Not sure ....**2** No **3**

J60.1 If "J60" is Yes: (a) Explain the conflicts ______________________

(b) How it was resolved______________________

J61. Are there rules by which each one knows how he should fish?

Yes .... **1** Not sure ....**2** No **3**

J62 If "J61" is Yes:

1)How you did learn of these?______________________________

2)Have anyone in your village been penalized because of rules breaking? (Please explain)________________________________

J63. Do you think that fishermen from other villages are a threat to the fishery?

Yes .... **1** Not sure ....**2** No **3**

J64. Do you agree that fishermen from other villages should not fish on your fishing ground?

(Explain)____

J65. Do you think it will be possible for you and your colleagues to limit other village's fishermen from fishing here?

Yes .... **1** Not sure ....**2** No **3**

Instruction for section 4:

The following statements are concern your perception towards the benefits of collective conservation activities. Please use the scales below to indicate to what extent you agree or disagree with the following statements. The choice is whether you (1) Disagree (D), (2) are Indifferent (I), or (3) Agree (A) with the statement

4. Benefits from Collective Conservation Activities

		A (3)	I (2)	D (1)
J66	If resources are abundant, you do not require longer fishing hours to catch the same amount	☐	☐	☐
J67	If resources are abundant, you require less fuel to catch the same amount of fish	☐	☐	☐
J68	If resources are abundant, there will be less conflicts among fishermen at sea	☐	☐	☐
J69	Your fishing income will be higher if the quality of fish resources improves	☐	☐	☐

5. Economic dependence on fishing

J70. Your age at 1st Feb. 1998. ________________ years

J71. How many people living together with you? ______________

J72. How many years of school did you complete? ________years

J73. How many people depend on your fishing activities? ____________

J74. How many people in your house have a permanent job? __________

J75. The average monthly household expenditure: (OR) _________

J76. The average monthly household income

	Income (OR)	
	Fishing	Other work
1. Respondent		
2. Others person's kin		
a)		
b)		
c)		
d)		
Total income		

6. Social identity

J77. How many years have you been a fishermen?_________ years

J78 Why do you fish?________________________________

J79. Are there others in your family who have a fisheries related job?

Yes ( )

Kin relation	Yes	No
1. Father	1	0
2. Sons	1	0
3. Brothers	1	0
4. Uncles	1	0
5. Cousins	1	0

Total score:______

No ( )

J80. Do you have any other occupation beside fishing?

Work — Time allocated

Fishing... ___________
Farming... ___________
Government or private sector............... ___________
Other_______________.................... ___________

J80.1. Why do you do this other work? ____________________________

J80.2. (if doesn't have other work), Would it be easy for you to get another job?

Yes .... **1** Not sure ....**2** No **3**

K. Attitude towards investment

K81. Are you considering another investment in fishing in the future?

	YES	NO
New boat	1	2
New motor	1	2
New gear	1	2

K82. If any item in K81 is "Yes" which of the followings will be your source of finance?

Own-saving..1
Borrowed from commercial bank 2
Both from own-saving and loan 3
Government subsidies/low interest loans 4

K83. How much is your dept at present? ____________________ (RO)

L. Clubs

L84. What are the major problems of input and services procurement?______________________________

L85. Are you in favor of developing fisheries cooperatives in your community to provide input and service supply.

Yes .... 1 Not sure ....2 No 3

L86. Are you willing to join the cooperatives if you can get fishing gears and other fishing inputs at lower prices?

Yes .... 1 Not sure ....2 No 3

L87. Do you agree that non-member should not sell their catch through the cooperative?

Yes .... 1 Not sure ....2 No 3

M. Attitude towards the willingness to cooperate

Did you in the past year (Score one unit for each "yes")

	Item	Yes	No
M88	Returned under-sized fish into the sea when caught in your net	1	0
M89	Set your nets at a distance from other fishermen gears	1	0
M90	Inform on colleagues who break the fishing rules	1	0
M91	Attend workshops arranged by the Ministry of Agriculture and Fisheries	1	0
M92	Renew your fishing licence and boat licence	1	0
M93	Speak to the head of the tribe about the problem of your fishery	1	0
M94	Discuss fishing problems frequently with more than one fisherman	1	0
M95	Participate in a group to resolve conflicts in fishing	1	0
M96	Persuade others to follow fishing rules	1	0
M97	Visit the Governor office to complain about other fishermen activities in fishing	1	0
M98	Oppose catching Sardine with encircling gears	1	0
M99	Own artificial reefs (number of reefs)	1	0

استمارة استبيان للصيادين في منطقة الباطنة

أ. معلومات عامه

1. الرقم التسلسلي__________
2. الوقت المستغرق للمقابلة من ______________ ألي ______________
3. الولاية ______________ القريه ______________ 4
4. تاريخ المقابلة ______________
5. رقم الحصر__________

ب. الأصول

ب1. قوارب الصيد المملوكة

الصنف	قارب رقم 1	قارب رقم 2	قارب رقم 3
1. الطول (قدم)			
2. عمر القارب			
3.السعر عند الشراء			
4. طريقة التمويل 1. تمويل خاص 2. قرض (مصدره)			

ب2.المحرك

الصنف	محرك 1	محرك 2	محرك 3
1. القدرة (حصان)			
2. عمر المحرك			
3. السعر عند الاقتناء			
4. طريقة التمويل 1. تمويل خاص 2. قرض (مصدره)			

ب3. معدات الصيد

الصنف	معده 1	معده 2	معده 3	معده 4	معده 5
1. نوع المعدة					
2. العدد					
3. عمر المعدة					
4. نوع الأسماك					
5. العمق (باع)					
6. الموسم					
7. قيمة الصيد/رحله(رع)					
8. السعر وقت الشراء					
9. طريقة التمويل 1. تمويل خاص 2. قرض (مصدره)					

ب4. أجهزة الصيد و الممتلكات الأخرى

	الأدوات الأخرى المستعملة في الصيد و الممتلكات الأخرى					
الصنف	منزل	مزرعة	ونش			
العدد						

ت. أنشطة الصيد وتسويق الأسماك

ت5. عـــــدد أفـــــراد الطـــــاقم (مـــــع القبطـــــان)______________________________

ت6. كم عدد معدل رحلات الصيد في الأسبوع __________________________ _____

ت7. فـــي إي وقـــت فـــــي العـــــادة لا تقـــوم بـــــالصيد خـــــلال الشـــــهر (مـــــع الإيضـــــاح)

____

ت8. و لماذا ____

ت9. أين تقوم ببيع الأسماك التي اصطدتها (أذكر اسم المدينة التـــي تتـــم فيـــها المنـــاداة مـــع العمولـــة)

____

ت10. ما هي مصروفاتك من الوَقود والزيوت في كل رحله؟ (ر ع)________________

ت11. ما هي المصاريف الأخرى (طعام, ثلج,وغيرة) في كل رحلة صيد (ر ع)_________

ت12.كيف تقسم حصة الصيد ....القارب _____% الطاقم ______% المالك _______%

ث. وضع المخزون السمكي حاليا"

ث13. هل تعتقد بان المخزون السمكي في منطقتك يتناقص؟

نعم 1.................... غير متأكد..................2 لا..................3

ث14. كيف تصف مشكلة تناقص الثروة السمكية هنا–ليست مشكله, متوسطة, شديدة, شديدة جدا؟

ليست مشكله.................1 شديدة...........................3

متوسطة ....2 شديدة جدا 4

ث15. هل لأحضت تناقص بعض أصناف الأسماك في الكمية التي تصيدها مقارنة بالأعوام السابقة؟

نعم 1.................... غير متأكد.....................2 لا.....................3

ت15.1. أذكر هذه الأصناف ____

ت16. هـــل لأحضـــــــت اختفـــــاء نـــــوع معيـــــن مـــــن الأســـــماك كليـــــا مـــــن صيـــــدك؟

____

ث17. مـــــا الـــــــذي يجعـــــل المخـــــزون الســـــــــــمكي يتنـــــــــاقص؟ (أشـــــــرح)

____.

ث18. حسب معلوماتك, هل تعتقد انه يمكن إيقاف استنزاف الثروة السمكية في هذه المنطقة؟

نعم 1.................... غير متأكد..........................2 لا 3

ث18.1 إذا كـــــــان الجـــــــواب نعـــــــم, كيـــــــف يمكـــــــن عمـــــــل ذلك؟____

ث18.2. هل قمت شخصيا بعمل ما لجعل أهالي القريه يتحركون لتخفيف حدة استنزاف الثروة السمكية؟

نعم 1.................... غير متأكد.....................2 لا 3

ث18.3 إذا كان الجواب نعم, ماذا قمت بعمله؟ ___________________________________

Appendix 2
(Continued)

إرشادات للفقرات التاليه

الجمل التالية هي بخصوص إحساسك تجاه حالة الثروة السمكية و العوامل التي قد تؤدي ألي تناقصها ونتائج استنزاف الـــثروة السمكية. لا توجد أجابه صائبة أو خاطئة. المطلوب منك اختيار الأجابه التي تمثل شعورك. الاختيار هو: هل أنت موافـــق (1)، غير مقرر (2) أو غير موافق مع الجملة (3).

ث. حالة الثروة السمكية

	الجملة	موافق	غير مقرر	غير موافق
ث19	كمية الصيد تقل في كل رحله	1	2	3
ث20	أصناف الأسماك التي تستهدفها تقل في كل رحله	1	2	3
ث21	الأسماك الكبيرة يصعب اصطيادها	1	2	3
ث22	يجب علينا قضاء ساعات طويلة للبحث عن الأسماك مقارنـــة بالماضي	1	2	3
ث23	نسبة الأسماك ذات القيمة المنخفظة تزيد في كل رحله	1	2	3

ج. استنزاف الثروة السمكية

	الجمله	موافق	غير مقرر	غير موافق
ج24	المخزون السمكي يقل إذا كان هناك عدد كبير من القـــوارب تعمل في نفس المنطقة	1	2	3
ج25	المخزون السمكي يقل إذا كانت كل القوارب ذوات أحجـــام كبيره	1	2	3
ج26	المخزون السمكي يقل إذا كانت كـــل قـــوارب الصيـــد يستعمل لها محرك ذو قدره عاليه	1	2	3
ج27	المخزون السمكي يقل إذا كانت جميـــع قـــوارب الصيـــد تستعمل أعداد كبيره من معدات الصيد	1	2	3
ج28	المخزون السمكي يقل إذا أستعمل الصيادين المعدات الضارة	1	2	3
ج29.	المخزون السمكي يقل إذا زاد الصيادين فترة صيدهم فـــي كل رحله	1	2	3

ح . نتائج استنزاف الثروة السمكية

	الجملة	موافق	غير مقرر	غير موافق
ح30	منطقة صيدك أصبحت بعيده عن قريتك	1	2	3
ح31	الساعات التي تقضيها في الصيد أصبحت أطول	1	2	3
ح32	زادت مصروفاتك من الوقود في كل رحلة	1	2	3
ح33	العديد من مناطق الصيد أصبحت خالية من الأسماك	1	2	3
ح34	يجب أن تستخدم معدات صيد كثيرة لكي تصيد كميه مـــن الصيد	1	2	3
ح35	دخلك من الصيد يقل	1	2	3

خ. المشاكل الناتجة عن الصيد

	الجملة	موافق	غير مقرر	غير موافق
خ36	قد تواجه بعض الصعوبة في الصيد إذا كانت هناك عدد كبير من السفن تصيد معك في منطقة صغيره	1	2	3
خ37	مشكلة تشابك معدات الصيد تظهر إذا كانت هناك العديد من السفن تصيد في نفس المنطقة	1	2	3
خ38	لا تستطيع الصيد في منطقة يصطاد فيها مجموعه من رفاقك	1	2	3
خ39	تتوقع القليل من الصيد إذا صدت في منطقه قد صاد فيها مجموعه من الرفاق قبل فترة وجيزة	1	2	3
خ40	النزاعات بين الصيادين في البحر في تزايد مستمر	1	2	3

د. النشاط الجماعي في المجتمعات السمكية

د41 هل من الضروري لجميع الصيادين بما فيهم أنت ليعملوا معا لإيقاف استنزاف الثروة السمكية؟

نعم .... 1 غير متأكد .... 2 لا 3

د42 هل تذهب للصيد مع مجموعه من الصيادين؟

نعم .... 1 غير متأكد .... 2 لا 3

د42.1 لماذا أو لماذا لا (مع الإيضاح) ____

د43 هل تقوم بمساعدة رفاقك في المجموعة باستمرار

نعم .... 1 غير متأكد .... 2 لا 3

د43.1 إذا كان 43 "نعم", في أي الأشكال (مع الإيضاح)

____

د44 هل تستطيع تمييز جميع الصيادين في قريتك؟

نعم .... 1 غير متأكد .... 2 لا 3

د45 هل يوجد لديك شعب مرجانية صناعية (شدود) ؟

نعم .... 1 غير متأكد .... 2 لا 3

د45.1 لماذا أو لماذا لا (وضح) ____

د45.2. هل قام أحد الصيادين بمساعدتك في بناء هذه الشدود؟

نعم 1 .... غير متأكد 2 .... لا 3

د46. ما هو الأسلوب الذي تتبعه لتجنب مشاكل تشابك معدات الصيد؟

____

ذ العوامل التي قد تؤثر على النشاط الجماعي

1. حجم المجموعة

ذ47. , كم يبلغ عدد الصيادين الذين يصطادون في نفس منطقة صيدك ؟ ____________ أشخاص

ذ48. هل جميعهم من نفس قريتك؟

نعم .... 1 غير متأكد .... 2 لا 3

ذ49. هل تلتقي بهم بعد رحلة الصيد؟

نعم .... 1 غير متأكد .... 2 لا 3

ذ49.1. إذا كانت الإجابة نعم, أين يتم التجمع؟ ____

ذ49.2. لماذا تتجمعون؟ ____

ذ49.3. كم يكون عددكم عند التجمع ____

ذ50. هل تتناقشون في مشاكل الصيد؟

نعم .... 1 غير متأكد .... 2 لا 3

2. معوقات تقنيات الصيد

ذ51. كيف يمكنك تحسين معدل صيدك؟
زيادة حجم القارب..1
زيادة قدرة المحرك 2
استعمال عدد كبير من معدات الصيد.......................3
زيادة الوقت الذي اقضيه في الصيد في كل رحله.......4
أخرى (وضح) ________________...............5

ذ52. هل علمت عن القانون الذي يمنع استخدام الهيال في منطقة يقل عمقها عن ثلاثين باعا؟
نعم...........1 غير متأكد................2 لا.......................3

ذ53. هل تعتقد أن هذا القانون سوف يساهم في حل النزاعات بين الصيادين؟
نعم...........1 غير متأكد.................2 لا.......................3

ذ53.1. لماذا أو لماذا لا؟ ____

ذ54. هل التزم الصيادين أو بعض منهم بهذا القانون في هذه المنطقة؟
نعم...........1 غير متأكد.......................2 لا.......................3

ذ55. هل أنت على استعداد لتبليغ الوالي عن الصيادين الذين يخالفون هذا القانون؟
نعم...........1 غير متأكد ....2 لا.......................3

ذ56. هل هناك صيادين يستعملون شباك التنويره في هذه المنطقة؟
نعم...........1 غير متأكد ....2 لا.......................3

ذ56.1. ما هي النتائج المترتبة عن ذلك؟ ____

ذ56.2. هل أنت ضد استعمال هذه المعدة؟
نعم..............1 غير متأكد ....2 لا................3

ذ56.3. هــــل قمـــــت ورفــــاقك بعمـــــل مـــــا بــــهذا الخصـــــوص
____

3. عوامل المؤسسة

ذ57. هل توافق على إن أي شخص لا يحمل رخصة مزاولة الصيد يجب منعه عن الصيد؟
نعم.................1 غير متأكد ....2 لا 3

ذ58. هل توافق على أن مخالفي قوانين تنظيم الثروة السمكية أو سنة البحر يجب معاقبتهم؟
نعم.................1 غير متأكد ....2 لا 3

ذ59. هل تعتقد بأن حالة الثروة السمكية سوف تتحسن إذا خفضت عدد قوارب الصيد الحالية؟
نعم.................1 غير متأكد ....2 لا....................3

ذ60.هل قامت مجموعة منكم بالاتحاد لحل نزاع بين الصيادين في الصيد؟
نعم.................1 غير متأكد ....2 لا 3

ذ60.1.إذا كانت الإجابة "نعم"
أ. اشرح نوع النزاع ________________________________
ب. كيف تم حل هذا النزاع ______________________________________

ذ61.هل هناك قوانين تحدد كيف يمكن للفرد أن يصيد؟
نعم.................1 غير متأكد ....2 لا 3

ذ62.إذا كانت الإجابة "نعم"
1. كيف تعلمت هذه القوانين؟ ______________________________________

2. هــل تمــت معاقبــة أي صيــاد فــي قريتــك بســبب مخالفتــه لـــهذه القوانيـــن؟
(اشرح)____

ذ63.هل تعتقد أن الصيادين من القرى الأخرى خطر على الثروة السمكية؟

نعم.................1 غير متأكد ....2 لا...........................3

ذ64.هل توافق على أن الصيادين من القرى الأخرى يجب عليهم عدم الصيد في مناطق صيدكم؟

نعم.................1 غير متأكد ....2 لا............................3

ذ65.هل تعتقد انه بإمكانك ورفاقك منع الصيادين من القرى الأخرى من الصيد في منطقتكم؟

نعم.................1 غير متأكد ....2 لا.......................3

إرشادات للفقرة (ذ4)

الجمل التالية هي بخصوص إحساسك تجاه فائدة الأنشط الجماعية للمحا فضة على الموارد السمكية. لا توجد أجابه صائبة أو خاطئة. المطلوب منك اختيار الأجابه التي تمثل شعورك. الاختيار هو: هل أنت **موافق** (1), **غير مقرر** (2) أو **غير موافق مع الجملة** (3).

4. الفائدة من الأنشطة الجماعية للمحا فضة على الموارد السمكية

	الجملة	موافق	غير مقرر	غير موافق
ذ66	إذا كانت الموارد السمكية متوفرة بكثرة, لن تحتاج إلى وقت طويل لصيد نفس الكمية	1	2	3
ذ67	إذا كانت الموارد السمكية متوفرة بكثرة, تحتاج إلى كمية اقل من الوقود لصيد نفس الكمية	1	2	3
ذ68	إذا كانت الموارد السمكية متوفرة بكثرة ستكون النزاعات بين الصيادين أقل في البحر	1	2	3
ذ69	دخلك من الصيد سيكون أعلى إذا زاد حجم الموارد السمكية	1	2	3

5. الاعتماد الاقتصادي على الصيد

ذ70. كم يكون عمرك في الأول من مارس 1998 ______________سنوات

ذ71. كم عدد الأشخاص الذين يسكنون معك؟ ________________________

ذ72.كم سنة دراسية أكملت؟ ________________سنوات

ذ73.كم فرد يعتمدون على دخلك من الصيد؟ ____

ذ74.كم عدد الأشخاص الذين يقيمون معك ولديهم عمل دائم؟ ______________________

ذ75.معدل الدخل الشهري للأسرة

	الدخل (ريال عماني)	
	من مهنة الصيد	من أعمال أخرى
1. المجيب في المقابلة		
2. الأقارب		
ا)		
ب)		
ت)		
ث)		

ذ76. كم تبلغ المصروفات الشهرية لأسرتك؟ __________________

6. الانتماء الاجتماعي

ذ77.كم عدد السنوات التي مارست فيها مهنة الصيد؟ __________________ سنوات

ذ78.لماذا تقوم بمزاولة مهنة الصيد؟ ____

ذ79.هل هناك آخرين من أقربائك يزاولون مهنة الصيد؟

Appendix 2
(Continued)

نعم (   )

صلة القرابة	نعم	لا
1. الأب	1	0
2. الأولاد	1	0
3. الأخوة	1	0
4. الأعمام	1	0
5. أولاد العم أو الخال	1	0

لا (   )

ذ80.هل لديك أي عمل آخر بجانب مهنة الصيد؟

<u>المهنة</u> <u>الوقت المخصص</u>
الصيد..................................... ____________
الزراعة................................... ____________
عمل حكومي أو قطاع خاص.......... ____________
أخرى ____________.............. ____________

ذ80.1.لماذا تحترف هذه المهن الأخرى؟

____

ذ80.2.(إذا لم تكن لك مهنة أخرى), هل من السهل الحصول على مهنة أخرى؟

نعم.................. 1 غير متأكد ....2 لا..................3

<u>ر. موقفك من الاستثمار</u>

ر81. هل تضع في الاعتبار توظيف أموال أخرى في مجال الصيد في المستقبل؟

	نعم	لا
قارب جديد	1	2
محرك جديد	1	2
معدات صيد جديدة	1	2

ر82.إذا كان أي فقرة في ر81 "نعم", ما هو مصدر التمويل؟

ادخار شخصي 1
اقتراض من بنك تجاري.. 2
ادخار شخصي وقرض من بنك تجاري 3
دعم حكومي أو قرض ميسر 4

ر83. كم تبلغ ديونك في الوقت الحاضر؟ ____________________________________

<u>ز. نوادي التعاون</u>

ز84. ما هي أهم المشاكل التي تواجهك في توريد المواد الأولية لرحلة الصيد, مثل الوقود مثلا, والخدمات الأخرى؟ ____________________________________

ز85. هل تؤيد أنشاء جمعية سمكية للصيادين في قريتكم لتزويدكم بالمواد الأولية لرحلة الصيد والخدمات الأخرى؟

نعم................. 1 غير متأكد .... 2 لا 3

Appendix 2
(Continued)

ز86. هل ترغب الانضمام ألي الجمعية السمكية إذا قدمت لك أدوات وشباك صيد وخدمات أخرى بأسـعار مخفضة؟

نعم.................... 1 غير متأكد ....2 لا 3

ز87. هل توافق على أن غير الأعضاء في هذه الجمعيات لا يجب أن يبيعوا صيدهم بواسطة الجمعية؟

نعم.................... 1 غير متأكد ....2 لا.................. 3

<u>س. السلوك تجاه الرغبة في التعاون</u>

هل قمت بالأتي خلال السنة المنصرمة (أعط وحدة واحدة لكل نعم)

		نعم	لا
س88	قمت بإرجاع اسماك صغيرة الحجم وجدتها في شباك الصيد	1	0
س89	نصبت شباك الصيد على بعد عن شباك الصيادين الأخرين	1	0
س90	بلغت عن زميل قام بمخالفة قوانين الصيد	1	0
س91	شاركت في الندوات التي نظمتها وزارة الزراعة والأسماك	1	0
س92	قمت بتجديد رخصة مزاولة مهنة الصيد و قارب الصيد	1	0
س93	تكلمت مع شيخ القبيلة بخصوص مشكلة الصيد في قريتك	1	0
س94	ناقشت مشاكل الصيد باستمرار مع اكثر من صياد	1	0
س95	شاركت مع مجموعة لحل نزاع بين الصيادين	1	0
س96	أقنعت الأخرين لأتباع قوانين الصيد	1	0
س97	قمت بالذهاب لمكتب الوالي لتقديم شكوى ضد الصيادين المخالفين	1	0
س98	عارضت صيد العومة بواسطة شباك التدويرة	1	0
س99	شاركت في بناء الشعب المرجانية الصناعية (الشدود) -عددها-	---	0

The Semi-structured Interview

Name: ____________________________

Age: ______________________________

Address ___________________________

Occupation:_______________________

Experience in the fisheries sector: ______________________________

1. Could you describe the condition of the fishery resources in your area?

2. Describe the technological progress of the fishery that has taken place during the last 30 years?

3. Can you talk about the factors that cause the fishery to decline?

4. What is your suggestion to improve the status of the fishery?

5. Describe the traditional customs or laws that coordinate the activities of fishermen at sea?

- Do people follow them at present?

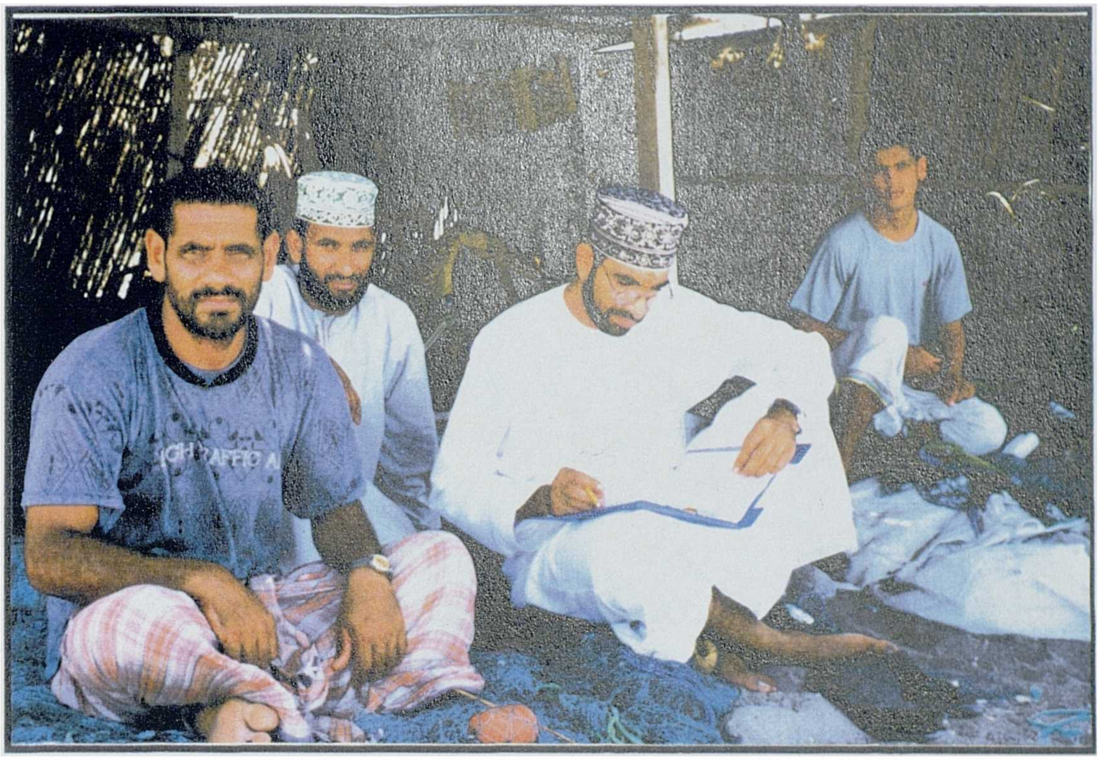
- Do you think they can be enforced and how?

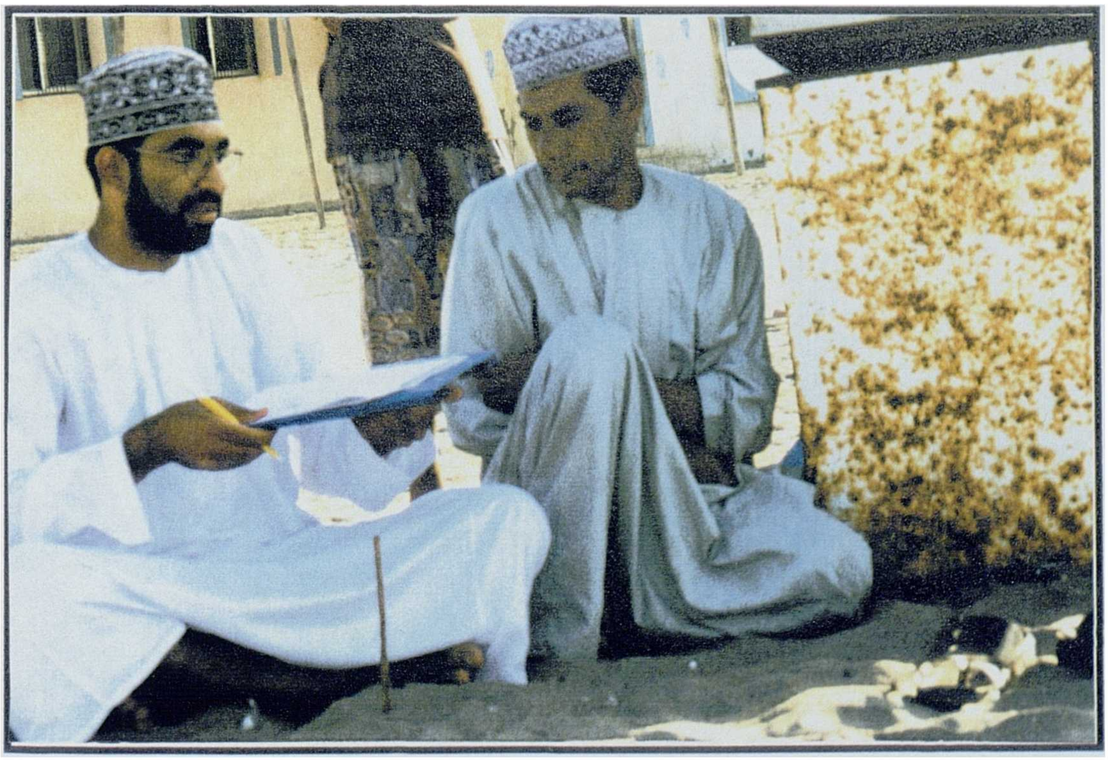
6. What is the rule of the religion to shape fishermen's behavior at sea?

7. Are there any form of collective activities taking place in your village?

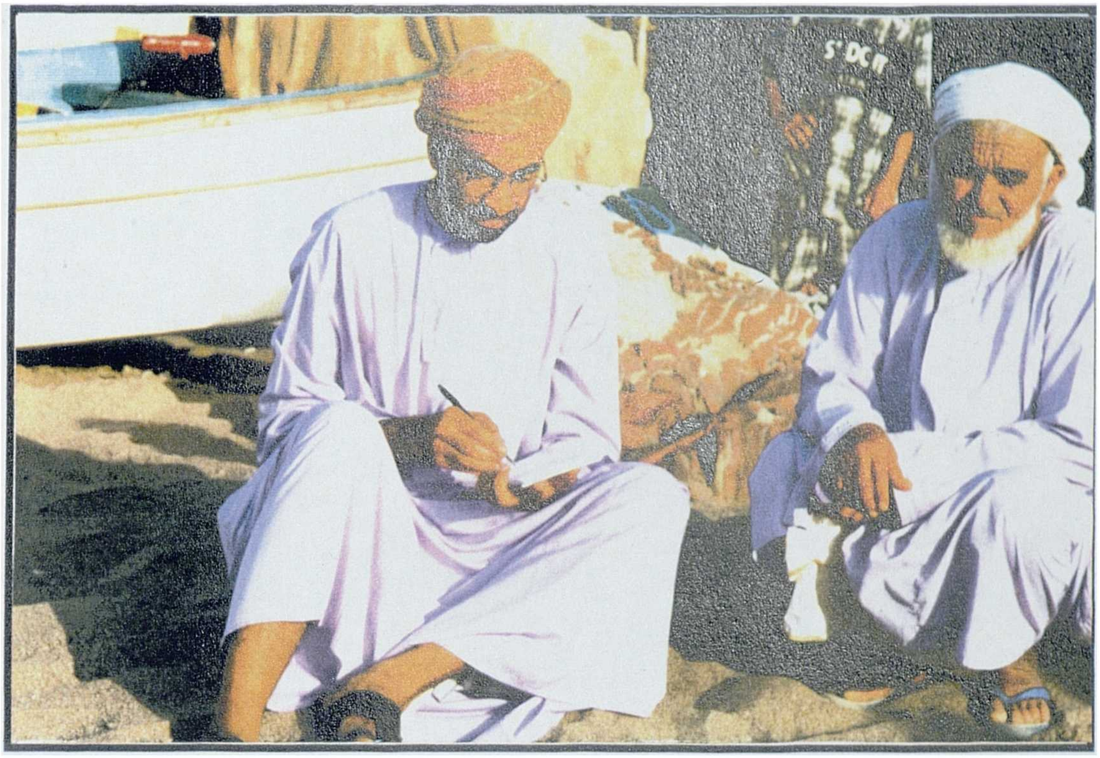
The interview process

Pictures show the researcher filling up the questionnaire schedule

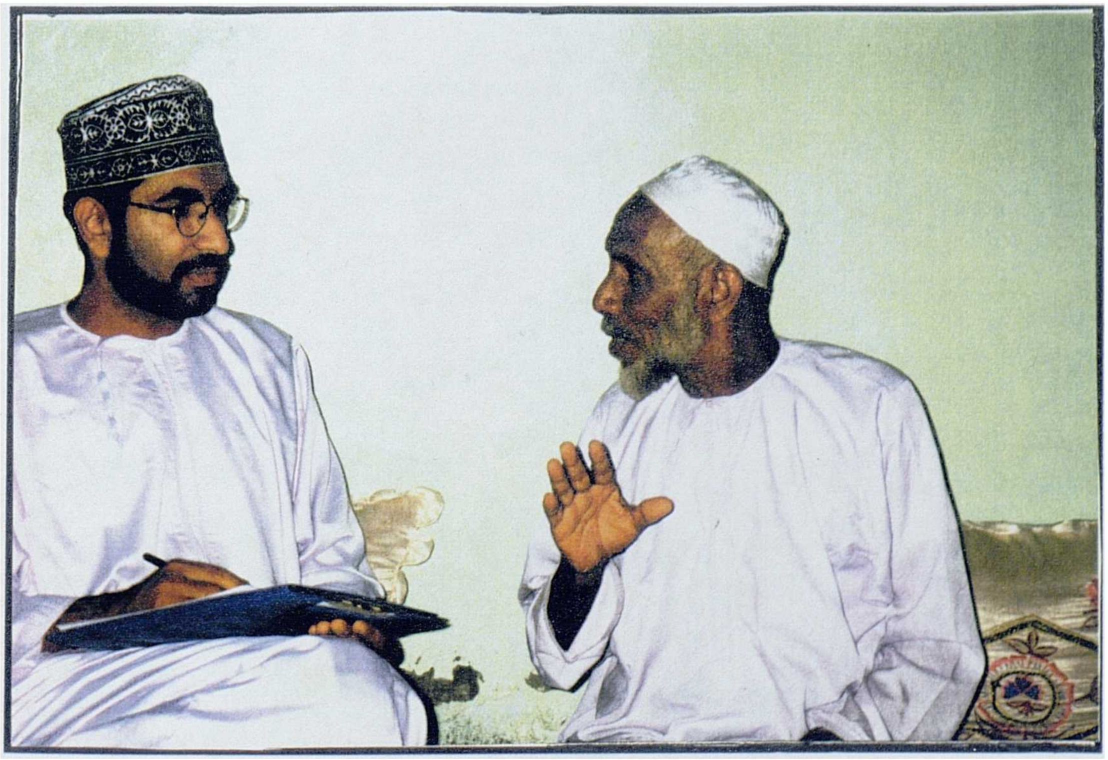




Picture show the researcher interviewing the chief of Senat Al-Bahar in Barka.



Picture show the researcher interviewing the chief of Senat Al-Bahar in Al-Masn'a



Content Validity

Dear respondent

The following scales are used in a questionnaire which will be administered to boat skippers in a traditional fishery in Oman. The main objective of the questionnaire is to identify factors that influence collective choice in a coastal fishery.

I need your help to determine the **Content Validity** of the scales below. You are asked here to give your opinion regarding each item and the scale appropriateness and their relevance to the issue of the scale. Also you are asked to list any area that are pertinent to the issue measured in the scale but not covered in the items.

Instruction for section A, B and C:

The following statements are concerning fishermen's perception towards **status of current fish resources, fishermen's perception of overfishing and the consequence of overfishing.** Please use the scale below to rate each item for appropriateness and relevance to the issue measured by each scale. You can list issues that are pertinent to the issue of the scale but not covered in the items. **Please circle one number for each line.**

A. Status of current fish resources

Statement	EA	A	M	FA	NA
1. Your fish catch per trip declines	5	4	3	2	1
2. Your target species per trip decline	5	4	3	2	1
3. The large fish are difficult to find or catch	5	4	3	2	1
4. We need to spend longer hours looking for fish then we used to.	5	4	3	2	1
5. The percentage of trash fish in your daily catch has increased.	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

B. Overfishing:

Statement	EA	A	M	FA	NA
1. Fish resources decline if too many vessels are operating in the same area	5	4	3	2	1
2. Fish resources are limited due to small area	5	4	3	2	1
3. Fish resources decline if all vessel are large in size	5	4	3	2	1
4. Fish resources decline if all vessels use high horse-powered engines	5	4	3	2	1
5. Fish resources decline if all vessels employ a large number of nets	5	4	3	2	1
6. Fish resources decline if fishermen increase their fishing time per trip	5	4	3	2	1
7. Fish resources decline if fishermen increase their fishing days per month	5	4	3	2	1
8. Fish resources decline due to pollution	5	4	3	2	1
9. Fish resources decline due to weather	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

C. The consequence of overfishing:

Statement	EA	A	M	FA	NA
1. Your catch contains a high proportion of trash fish	5	4	3	2	1
2. Your fishing area becomes further away from your village	5	4	3	2	1
3. Your fishing hours become longer	5	4	3	2	1
4. Your fuel consumption increases	5	4	3	2	1
5. Many fishing areas are barren	5	4	3	2	1
6. You have to use more fishing gears to catch fish	5	4	3	2	1
7. Your income declines	5	4	3	2	1
8. It is in God's hand how much fish remain in the sea	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

D. Benefits from collective conservation activities

The following statements are concerning **benefits from collective conservation activities.** Please use the scale below to rate each item for appropriateness and relevance to the issue of the **benefits from collective conservation activities**. You can list issues that are pertinent to **benefits from collective conservation activities** but not covered in the items. **Please circle one number for each line**

Statement	EA	A	M	FA	NA
1. You do not used to fish for long to catch a paying trip.	5	4	3	2	1
2. If fish resources are abundant, you require less fuel to catch the same amount of fish	5	4	3	2	1
3. If fish resources are abundant, there will be less conflicts among fishermen at sea	5	4	3	2	1
4. Your fishing income will be higher if the abundance of fish resources increases	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

____

E. Externalities in Coastal Fisheries

The following statements are concerning **externalities in coastal fisheries.** Please use the scale below to rate each item for appropriateness and relevance to the issue of **externalities in coastal fisheries**. Also you are asked to list issues that are pertinent to **externalities in coastal fisheries** but not covered in the items. **Please circle one number for each line**

Statement	EA	A	M	FA	NA
1. You may face some difficulty in fishing if too many vessels operate in a small area	5	4	3	2	1
2. Net entanglement problems often occur if too many vessels operate in the same area	5	4	3	2	1
3. You cannot fish in the area where a colleague is fishing	5	4	3	2	1
4. You cannot fish in the area where many colleagues are fishing	5	4	3	2	1
5. Less catch is expected if you operate in the area which has just been fished by many colleagues	5	4	3	2	1
6. Less catch is expected if you operate in the area which has just been fished by a colleague	5	4	3	2	1
7. Conflicts among fishermen at sea are rising	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

____

Instruction for section G:

The following statements are measuring fishermen's **willingness to cooperate** to manage their fish resources. Please use the scale below to indicate the appropriateness of the statements listed below. Also you are asked to list issues that are pertinent to **cooperation** but not covered in the items. **Please circle one number for each line**

G. Willingness to cooperate

Item	EA	A	M	FA	NA
1. You returned under-sized fish into the sea when caught in your net	5	4	3	2	1
2. Set your nets at a distance from other fishermen gears	5	4	3	2	1
3. Inform on colleague who break the fishing rules	5	4	3	2	1
4. Attend workshops arranged by the Ministry of Agriculture and Fisheries	5	4	3	2	1
5. Renew your fishing licence and boat licence	5	4	3	2	1
6. Speak to the head of the tribe about the problem of your fishery	5	4	3	2	1
7. Discuss fishing problems frequently with more than one fisherman	5	4	3	2	1
8. Participate in a group to resolve conflicts in fishing	5	4	3	2	1
9. Persuades others to follow fishing rules	5	4	3	2	1
10. Participated in reef construction in your village	5	4	3	2	1
11. Share important information	5	4	3	2	1
12. Share information about fish concentration on the grounds	5	4	3	2	1
13. Tell your colleague about new technical developments	5	4	3	2	1
14. Share information about low cost sources of supply	5	4	3	2	1

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate**

Comments:____

____

____

Thank you for your cooperation

Hamed Said Al-Oufi (Assistant Lecturer)
Sultan Qaboos University
College of Agriculture
Department of Fisheries Science and Technology
Al-Khod, P.O.BOX 34, CN 134, Oman

Content Validity of the Scales
Specialists Responses Analysis

Table (1) Status of current fish resources (N = 11)

Statement	EA	A	M	FA	NA	Total	Mean[1]
	F	F	F	F	F	F	
1. Your fish catch per trip declines	8	2	0	1	0	50	4.55
2. Your target species per trip decline	5	5	1	0	0	48	4.36
3. The large fish are difficult to find or catch	7	2	2	0	0	49	4.45
4. We need to spend longer hours looking for fish then we used to.	8	3	0	0	0	52	4.73
5. The percentage of trash fish in your daily catch has increased.	4	5	1	0	1	44	4.0

(EA) Extremely Appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly Appropriate **(NA) Not at all Appropriate** **(F) Frequency**

Table (2) The causes of overfishing (N = 11)

Statement	EA	A	M	FA	NA	Total	Mean
	F	F	F	F	F	F	
1. Fish resources decline if too many vessels are operating in the same area	8	0	1	2	0	47	4.27
2. Fish resources are limited due to small area	2	3	1	4	1	34	3.09
3. Fish resources decline if all vessel are large in size	3	5	2	1	0	43	3.90
4. Fish resources decline if all vessels use high horse-powered engines	4	2	5	0	0	43	3.90
5. Fish resources decline if all vessels employ a large number of nets	8	2	1	0	0	51	4.64
6. Fish resources decline if fishermen increase their fishing time per trip	5	5	1	0	0	48	4.36
7. Fish resources decline if fishermen increase their fishing days per month	5	2	3	1	0	44	4.0
8. Fish resources decline due to pollution	2	1	1	6	1	30	2.72
9. Fish resources decline due to weather	1	1	1	5	3	25	2.27
10. Fish resources decline if fishermen use encircling gear	4	5	3	0	0	49	4.45

(EA) Extremely appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly appropriate **(NA) Not at all appropriate**
(F) Frequency

[1] Specialists answers for each item were measured on a scale of five, (EA (5)), (A (4)), (M (3)), (FA (2)), and (NA (1)). Number of responses in each category is multiplied by the value attached to that category. Then the scores are aggregated in the total column. The mean is calculated by dividing the total score for each item by the number of specialists (11).

Table (3) The consequence of overfishing (N = 11)

Statement	EA	A	M	FA	NA	Total	Mean
	F	F	F	F	F	F	
1. Your catch contains a high proportion of trash fish	3	6	1	0	1	43	3.91
2. Your fishing area becomes further away from your village	7	2	2	0	0	49	4.45
3. Your fishing hours become longer	9	1	1	0	0	52	4.73
4. Your fuel consumption increases	7	2	2	0	0	49	4.45
5. Many fishing areas are barren	7	2	1	0	1	47	4.27
6. You have to use more fishing gears to catch fish	4	4	3	0	0	45	4.09
7. Your income declines	8	1	0	2	0	48	4.36
8. It is in God's hand how much fish remain in the sea	1	3	2	1	4	29	2.64

(EA) Extremely appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly appropriate **(NA) Not at all appropriate** **(F) Frequency**

Table (4). Externalities in coastal fisheries (N = 11)

Statement	EA	A	M	FA	NA	Total	Mean
	F	F	F	F	F	F	
1. You may face some difficulty in fishing if too many vessels operate in a small area	3	5	3	0	0	44	4
2. Net entanglement problems often occur if too many vessels operate in the same area	6	3	2	0	0	48	4.36
3. You cannot fish in the area where a colleague is fishing	3	3	2	2	1	38	3.45
4. You cannot fish in the area where many colleagues are fishing	3	5	3	0	0	44	4
5. Less catch is expected if you operate in the area which has just been fished by many colleagues	5	4	1	1	0	46	4.18
6. Less catch is expected if you operate in the area which has just been fished by a colleague	4	1	4	1	1	39	3.55
7. Conflicts among fishermen at sea are rising	4	2	3	1	1	40	3.64

(EA) Extremely appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly appropriate **(NA) Not at all appropriate** **(F) Frequency**

Table (5) Willingness to cooperation (N = 11)

Item	EA	A	M	FA	NA	Total	Mean
	F	F	F	F	F	F	
1. You returned under-sized fish into the sea when caught in your net	6	3	2	0	0	48	4.36
2. Set your nets at a distance from other fishermen gears	6	3	2	0	0	48	4.36
3. Inform on colleague who break the fishing rules	4	5	1	0	1	44	4.0
4. Attend workshops arranged by the Ministry of Agriculture and Fisheries	4	6	0	0	1	45	4.09
5. Renew your fishing licence and boat licence	4	4	3	0	0	45	4.09
6. Speak to the head of the tribe about the problem of your fishery	4	6	0	0	1	45	4.09
7. Discuss fishing problems frequently with more than one fisherman	4	5	2	0	0	46	4.18
8. Participate in a group to resolve conflicts in fishing	6	5	0	0	0	50	4.55
9. Persuades others to follow fishing rules	3	4	2	2	0	41	3.73
10. Participated in reef construction in your village	5	2	2	2	0	43	3.91
11. Share important information	5	2	2	2	0	43	3.91
12. Share information about fish concentration on the grounds	3	3	4	1	0	41	3.73
13.Tell your colleague about new technical developments	3	6	1	1	0	44	4.0
14. Share information about low cost sources of supply	4	2	3	1	1	40	3.6

(EA) Extremely appropriate **(A) Appropriate** **(M) Moderate**
(FA) Fairly appropriate **(NA) Not at all appropriate** **(F) Frequency**

Letters related to field work

Appendix 6(A)	Letter from Hull University to Sultan Qaboos University (SQU)
Appendix 6(B)	Letter from SQU to the Ministry of Agriculture and Fisheries
Appendix 6(C)	Letter from SQU to the Wali (Governor) in Barka
Appendix 6(D)	Letter from SQU to the Wali (Governor) in Masn'a
Appendix 6(E)	Letter from SQU to the Wali (Governor) in Suwaiq
Appendix 6(F)	Letter from the Wali in Barka to Sheikhs in coastal villages
Appendix 6(G)	Letter from the Wali in Masn'a to Sheikhs in coastal villages
Appendix 6(H)	Letter from the Wali in Suwaiq to Sheikhs in coastal villages

THE UNIVERSITY OF HULL
INTERNATIONAL FISHERIES INSTITUTE
HULL HU6 7RX • UNITED KINGDOM
TELEPHONE 01482 466421/346311 • FACSIMILE 01482 470129/466205
TELEX 9312134728 HUG

The Vice Chancellor
Sultan Qaboos University
SULTANATE OF OMAN

14 January 1998

Our Ref DAP\MF\Chan

Dear Vice-Chancellor

Mr Al-oufi. H. is currently a full-time student at this University, conducting research studies leading to the degree of PhD. His progress has been very satisfactory to date and has been reviewed in the reports submitted to the Cultural Division of the Oman Embassy in London.

Having completed a review of previous research and formulated a methodology for the empirical part of his work, he is returning to Oman at the end of January to conduct a survey of fishermen.

Mr Al-oufi needs access to information on the fisheries currently held in the Ministry of Agriculture and Fisheries. I very much hope that you will be able to facilitate Mr Al-oufi's access to the Ministry for the purpose of his research.

Yours sincerely

D A Palfreman

Dr D A Palfreman
Senior Lecturer

بسم الله الرحمن الرحيم

Appendix 6 (B)

Sultan Qaboos University
Office
of the Secretary General

جامعة السلطان قابوس
مكتب أمين عام الجامعة

Ref: S.Q.U/S.G/
Date: / /141 Hijra
/ /199

الرقم : ج.س.ق/أ.ع/٣/٩٨-١٤٠
التاريخ : / / ١٤١هـ
الموافق : ٢٦ / ١ / ١٩٩٨م

المديرية العامة للثروة السمكية
الرقم: س
التاريخ: ٢٧/٩/١٤١٨هـ
الموافق: ٢٦/١/١٩٩٨م

الشيخ / عبدالله بن علي باكثير المحترم
مدير عام المديرية العامة للثروة السمكية
وزارة الزراعة والثروة السمكية

تحية طيبة وبعد ،،،،

يسرني إفادتكم بأن الفاضل / حمد بن سعيد بن سليمان العوفي مبتعث من الجامعة لنيل درجة الدكتوراه بجامعة في مجال إدارة الثروة السمكية هول بالمملكة المتحدة ، ويرغب المذكور المساعدة في حصوله على المعلومات المتعلقة بأصحاب قوارب الصيد التقليدية في منطقة الباطنة.

وعليه، نرجو التكرم بتسهيل مهمته ومساعدته حسب الإمكانيات المتوفرة لديكم.

مقدرين لكم حسن تعاونكم الدائم .

وتفضلوا بقبول فائق الاحترام والتقدير،،،،

الفاضل/ مدير دائرة الإحصاءات السمكية
نرجو مساعدة المذكور [illegible]
للحصول على المعلومات المطلوبة .

سعيد بن مبارك المحرمي
مدير مكتب أمين عام الجامعة

بسم الله الرحمن الرحيم

Sultan Qaboos University

Office
of the Secretary General

جامعة السلطان قابوس

مكتب أمين عام الجامعة

Ref : S.Q.U/S.G/
Date : / /141 Hijra
/ /199

الرقم : ج.س.ق/أ.ع/٣-٩٨/١٠٠
التاريخ : / / ١٤١هـ
الموافق : ٢٦/ ١ / ١٩٩٨م

المديرية العامة للثروة السمكية
الرقم
التاريخ ٢٧/٩/١٤١٨هـ
الموافق ٢٦/١/١٩٩٨م

الشيخ / عبدالله بن علي باكثير المحترم
مدير عام المديرية العامة للثروة السمكية
وزارة الزراعة والثروة السمكية

تحية طيبة وبعد ،،،،

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وعليه، نرجو التكرم بتسهيل مهمته ومساعدته حسب الإمكانيات المتوفرة لديكم.

مقدرين لكم حسن تعاونكم معنا.

وتفضلوا بقبول فائق الاحترام والتقدير،،،،

سعيد بن مبارك الحرمي
مدير مكتب أمين عام الجامعة

Appendix 6 (C)

بسم الله الرحمن الرحيم

Sultan Qaboos University

OFFICE OF THE DEAN

P.O. Box 34, Al-Khod 123
Sultanate of Oman
Telex 5602 SQU ON, Cable Jami'ah
Telephone 515201, Fax 513418
E-mail raeesi 99@squ.edu.om

مكتب العميد
صندوق البريد ٣٤ ، الرمز البريدي ١٢٣
سلطنة عُمان
تلكس ٥٦٠٢ إس كيو يو إن ، برقيا الجامعة
تلفون ٥١٥٢٠١ ، فاكس ٥١٣٤١٨
البريد السلكى raeesi 99@squ.edu.om

الرقم : ج. س. ق. / ك. ز / ٦٢ / ٩٨
التاريخ : غرة ذي القعدة ١٤١٨هـ
الموافق : ٢٨ / ٢ / ١٩٩٨م

سعادة / والي بركاء المحترم

السلام عليكم ورحمة الله وبركاته ... وبعد ،،،

الموضوع : جمع بيانات أحصائية لمشروع بحث لدرجة الدكتوراة - كلية الزراعة - جامعة السلطان قابوس

إشارة إلى الموضوع أعلاه ، نود أن ننوه إلى سعادتكم بأن **الفاضل / حمد بن سعيد العوفي** مدرس مساعد بكلية الزراعة بصدد إجراء بحث في القرى الساحلية التابعة للولاية في الفترة من ١ مارس لغاية ٣٠ مايو ١٩٩٨م . ويتضمن البحث مقابلات مع بعض الصيادين وشيوخ المناطق في الولاية وهذه المعلومات سوف تستعمل لإعداد بحث لنيل درجة الدكتوراة في مجال إدارة الثروة السمكية لصغار الصيادين في منطقة الباطنة . وحتى تعم الفائدة المرجوة من هذا البحث نرجوا من سعادتكم التكرم تسهيل مهمة الباحث وذلك بإيعاز شيوخ ورشداء المناطق الساحلية بهذا الخصوص .

شاكرين لسعادتكم حسن تعاونكم ، وتفضلوا بقبول فائق الإحترام والتقدير .

البروفسور / كريستوفر دي لو
عميد كلية الزراعة .

بسم الله الرحمن الرحيم

Sultan Qaboos University
COLLEGE OF AGRICULTURE
OFFICE OF THE DEAN
P.O. Box 34, Al-Khod 123
Sultanate of Oman
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جامعة السلطان قابوس
كليـــة الزراعـــة
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تلفون ٥١٥٢٠١ ، فاكس ٥١٣٤١٨
البريد السلكى raeesi 99@squ.edu.om

الرقم : ج س ق / ك ص ز / ٦٠ / ٩٨
التاريخ : غرة ذي القعدة ١٤١٨هـ
الموافق : ٢٨ / ٢ / ١٩٩٨م

سعادة / والي المصنعة المحترم

السلام عليكم ورحمة الله وبركاته ... وبعد ،،،

الموضوع : جمع بيانات أحصائية لمشروع بحث لدرجة الدكتوراة – كلية الزراعة – جامعة السلطان قابوس

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شاكرين لسعادتكم حسن تعاونكم ، وتفضلوا بقبول فائق الإحترام والتقدير .

البروفسور / كريستوفر دي لو
عميد كلية الزراعة .

بسم الله الرحمن الرحيم

Sultan Qaboos University
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جامعة السلطان قابوس
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تلفون ٥١٥٢٠١ ، فاكس ٥١٣٤١٨
البريد السلكى raeesi 99@squ.edu.om

الرقم : ٢٠٠٤ س . ت / ٥١٠ ز / ٦١ / ٩٨
التاريخ : غرة ذي القعدة ١٤١٨هـ
الموافق : ٢٨ / ٢ / ١٩٩٨م

سعادة / والي السويق المحترم

السلام عليكم ورحمة الله وبركاته ... وبعد ،،،

الموضوع : جمع بيانات أحصائية لمشروع بحث لدرجة الدكتوراة – كلية الزراعة – جامعة السلطان قابوس

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شاكرين لسعادتكم حسن تعاونكم ، وتفضلوا بقبول فائق الإحترام والتقدير .

البروفسور / كريستوفر دي لو
عميد كلية الزراعة .

وزارة الداخلية
ولاية بركاء
مكتب الوالي

الرقم : ط/ ١/ م / ع / ١٢٧
التاريخ : ١٧/١/١ ١٤١٩
الموافق : ١٦/ ٣ / ١٩٩٨

الشيخ المحترم ،

تحيه طيبه وبعد :

بناء علي الرساله الوارده الينا من جامعة السلطان قابوس كليه الزراعه تحت رقم ٩٨/٣٦م المورخه ١٩٩٨/٣/٢٨م والمتضمنه جمع بيانات احصائية لمشروع بحث لدرجة الدكتوراه - كلية الزراعه جامعة السلطان قابوس بصدد اجراء بحث في القرى الساطيه التابعه لهذه الولايه في الفترة من ١ مارس لغاية ٣٠/ مايو ١٩٩٨م ويتضمن البحث مقابلات مع بعض الصيادين و شيوخ المناطق .

نامل التكرم بابلاغ الصيادين بشان ذلك لتسهيل مهمة الباحث الفاضل / حمد بن سعيد بن سليمان العوفي مدرس مساعد بكلية الزراعه بجامعة السلطان قابوس .

شاكرين لكم تعاونكم .

وتقبلوا فائق الاحترام »

١٦ / ٣ / ١٩٩٨

سيف بن مهنا الهنائي
نائب والي بركاه

سلطنة عمان
وزارة الداخلية
مكتب والي بركاء

نسخة الى : الفاضل / عميد كلية الزراعه بجامعة السلطان قابوس .
- الملف .
ح / ن

بسم الله الرحمن الرحيم

SULTANATE OF OMAN
MINISTRY OF INTERIOR
Wilayet Of Al Musana'a
Wali's Office

سلطنة عمان
وزارة الداخلية
ولاية المصنعة
مكتب الوالي

الرقم : م/٨/١/٤٤٥

التاريخ : ١٠/ ١١ / ١٤١٨هـ　　　　الموافق : ٩ / ٣ / ١٩٩٨م

الأفاضل / شيوخ ورشداء ولاية المصنعة / المحترمين

تحية طيبة ،وبعد :-

بناء على خطاب جامعة السلطان قابوس كلية الزراعة حول جمع بيانات أحصائية لمشروع بحث لدرجة الدكتوارة الذى يقوم به المواطن / حمد بن سعيد العوفي ويتضمن بحثه مقابلات بعض الصيادين بشأن ادارة الثروة السمكية لصغار الصيادين بمنطقة الباطنة .

وحتى تعم الفائده المرجوة من هذا البحث فانه يرجى تسهيل مهمة الباحث المذكور وتذليل الصعوبات اتجاه مايقوم به .

" وتفضلوا بقبول فائق الاحترام " ،

حمد بن خالد بن ناصر المعولي
والي المصنعه

نسخة الي :-
- عميد كلية الزراعة جوابا لخطابه رقم ٦٠/٩٨م بتاريخ ١/ ١١/١٤١٨هـ الموافق ٢٨/ ٢ / ١٩٩٨م .
- ملف الانتاج اليومي
- الملف .

(م)

SULTANATE OF OMAN
MINISTRY OF INTERIOR
Wilayat Of Al Suwaiq
Wali's Office

بسم الله الرحمن الرحيم

سلطنة عمان
وزارة الداخلية
ولاية السويق
مكتب الوالي

التاريخ : ٩/١١/١٤١٨هـ
الموافق : ٨/٣/١٩٩٨م

1186

الفاضل حمد العوفي

الأفاضل/ مشايخ ورشداء المناطق الساحلية المحترمين
بولاية السويق

السلام عليكم ورحمة الله وبركاته ،،،

يرجى العلم بأن الفاضل/ حمد بن سعيد العوفي ، مدرس مساعد بكلية الزراعة بجامعة السلطان قابوس سيقوم بإجراء بحث في القرى الساحلية بالولاية لجمع بيانات إحصائية من خلال مقابلاتكم له ومقابلة بعض الصيادين وذلك اعتباراً من تاريخ ١/٣/١٩٩٨م وحتى تاريخ ٣٠/٥/١٩٩٨م .

آملين تسهيل مهمته وتقديم المساعدة له .

وتفضلوا بقبول فائق الاحترام ،،،

عوض بن عبدالله بن منذر المنذري
والي السويق

نسخة الى :
- عميد كلية الزراعة بجامعة السلطان قابوس

Reliability Analysis

A. Perception of resource status

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	PERCEP1	e19, catch per trip decline
2.	PERCEP2	e20 target species decline
3.	PERCEP3	e21, large fish diff. to catch
4.	PERCEP4	e22, spend longer hours at sea
5.	PERCEP5	e23, trash fish high in catch

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	6.4227	4.6183	2.1490	5

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
PERCEP1	5.3196	3.3999	.6486	.6917
PERCEP2	5.3144	3.3359	.6854	.6811
PERCEP3	5.1804	3.0916	.5273	.7120
PERCEP4	5.2320	3.0185	.6343	.6748
PERCEP5	4.6443	2.8314	.3658	.8204

Reliability Coefficients

N of Cases = 194.0 N of Items = 5

Alpha = 0.7568

B. The causes of overfishing

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	OVER1	f24, too many vessels
2.	OVER2	f25, large vessel
3.	OVER3	f26, high HP
4.	OVER4	f27, large no of nets
5.	OVER5	f28, destructive gear
6.	OVER6	f29, increase fishing time per trip

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	9.7216	10.0983	3.1778	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
OVER1	8.3402	7.3655	.5143	.7180
OVER2	7.7320	6.3112	.6049	.6910
OVER3	7.3918	7.1514	.5345	.7122
OVER4	8.4845	8.0231	.4680	.7320
OVER5	8.4485	8.4248	.3090	.7655
OVER6	8.2113	6.8411	.5667	.7026

Reliability Coefficients

N of Cases = 194.0 N of Items = 6

Alpha = .7575

C. The consequences of overfishing

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	CONSE1	g30, fishing area far from village
2.	CONSE2	g31, fishing hours become longer
3.	CONSE3	g32, fuel consumption increased
4.	CONSE4	g33, fishing area barren
5.	CONSE5	g34, use more fishing gears
6.	CONSE6	g35, income decline

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	6.9330	4.4877	2.1184	6

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
CONSE1	5.6340	2.6270	.6036	.7483
CONSE2	5.6753	2.9769	.4983	.7734
CONSE3	5.8557	3.5231	.5754	.7531
CONSE4	5.7577	2.9721	.6772	.7180
CONSE5	5.8660	3.6607	.5498	.7616
CONSE6	5.8763	3.7359	.5145	.7684

Reliability Coefficients

N of Cases = 194.0 N of Items = 6

Alpha = .7869

D. Externalities in coastal fisheries

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	EXRT1	h36, face some difficl. in fishing
2.	EXRT2	h37, net entanglement prob.
3.	EXRT3	h38, can't fish in area where
4.	EXRT4	h39, less catch expected
5.	EXRT5	h40, conflicts rising

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	6.1856	5.1364	2.2664	5

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
EXRT1	4.7990	2.8972	.6115	.7113
EXRT2	4.8454	2.7946	.7259	.6576
EXRT3	5.0722	3.9015	.5975	.7289
EXRT4	5.0773	3.9888	.5292	.7442
EXRT5	4.9485	3.7901	.3757	.7869

Reliability Coefficients

N of Cases = 194.0 N of Items = 5

Alpha = .7723

E. Benefits from collective conservation activities

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	BENEFIT1	j66, do not require longer fishing hr
2.	BENEFIT2	j67, less fuel to catch the same amount
3.	BENEFIT3	j68, less conflicts
4.	BENEFIT4	j69, fishing income higher

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	4.5515	1.0776	1.0381	4

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
BENEFIT1	3.3402	.5676	.2031	.1532
BENEFIT2	3.3196	.5295	.2224	.1182
BENEFIT3	3.5103	.9973	.0405	.3230
BENEFIT4	3.4845	.9039	.1369	.2570

Reliability Coefficients

N of Cases = 194.0 N of Items = 4

Alpha = .2903

F. Fishermen's willingness to cooperate

RELIABILITY ANALYSIS - SCALE (ALPHA)

1.	COP1	n88. returned undersized fish
2.	COP2	n89, set gear at distace
3.	COP3	n90, inform on rule broker
4.	COP4	n94, attend workshop
5.	COP5	n92, renew fishing licence
6.	COP6	n93, speak to the head of the trip
7.	COP7	n94, discuss fishing prob.
8.	COP8	n95, participate in a group to resolve
9.	COP9	n96, persuade others to follow fishing r
10.	COPA10	n97, visit the governer office
11.	COPA11	n98, oppose catching sardine with encirc
12.	COPA12	own artificail reefs

Statistics for	Mean	Variance	Std Dev	N of Variables
SCALE	7.6546	7.7609	2.7858	12

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
COP1	6.7423	6.8659	.5484	.7402
COP2	6.7371	6.9305	.5195	.7429
COP3	7.1907	6.1862	.5326	.7309
COP4	7.2474	6.8918	.2422	.7675
COP5	6.9536	7.2258	.1315	.7780
COP6	6.9794	6.0410	.6497	.7166
COP7	6.8093	6.6318	.5344	.7360
COP8	7.1907	6.3106	.4778	.7382
COP9	7.0103	6.4869	.4269	.7447
COPA10	7.3041	6.3578	.4868	.7372
COPA11	6.8454	6.4630	.5706	.7305
COPA12	7.1907	7.5437	-.0119	.7973

Reliability Coefficients

N of Cases = 194.0 N of Items = 12

Alpha = .7640