FAO Fisheries and Aquaculture Report No. 971 RAP/R971 (En)
ISSN 2070-6987

Report of the

FAO WORKSHOP ON THE STATUS OF SHARED FISHERIES RESOURCES IN THE NORTHERN ARABIAN SEA – IRAN (ISLAMIC REPUBLIC OF), OMAN AND PAKISTAN

Muscat, Oman, 13–15 December 2010

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Karachi, 2011

ISBN 978-92-5-106799-4

PREPARATION OF THIS DOCUMENT

This document contains the report of the FAO Workshop on the Status of Shared Fisheries Resources in the Northern Arabian Sea – Iran (Islamic Republic of), Oman and Pakistan which was held in Muscat, Oman, from 13 to 15 December 2010.

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Report of the FAO Workshop on the Status of Shared Fisheries Resources in the Northern Arabian Sea – Iran (Islamic Republic of), Oman and Pakistan. Muscat. Oman, 13–15 December 2010.
FAO Fisheries and Aquaculture Report. No. 971. Karachi, FAO. 2011. 58p.

ABSTRACT

The FAO Workshop on the Status of Shared Fisheries Resources in the Northern Arabian Sea – Iran (Islamic Republic of), Oman and Pakistan was held in Muscat, Oman, from 13 to 15 December 2010. In the last three years, the Government of Pakistan, and especially the Marine Fisheries Department in Karachi, has invested to reinvigorate the stock assessment capacity of the department. A multiyear project involving stock assessments, including marine surveys, is in place through technical assistance from the FAO. Even at this early stage, the new data have largely confirmed the parlous state of many of Pakistan's marine fishery resources and leave little doubt that overexploitation is the principal reason for this. More work is needed, and much is already under way, to provide clear and specific management recommendations, but the direction and scope of the action needed is already clear.

Some of the most valuable resources in question are not limited to Pakistan's waters but are shared with regional neighbours or more widely on the high seas. Effective action to ensure sustainable fisheries in Pakistan can only come about if those sharing the resources act in concert. To this end, the Government of Pakistan proposed that the FAO convene a meeting with the two neighbours most immediately affecting Pakistan's shared marine resources – Iran (Islamic Republic of) and Oman. The meeting was to identify the stocks of most concern in this regard, look into immediate ways to coordinate and improve the stock assessment efforts among the three countries, and to look forward to ways to set and achieve management goals jointly for these shared resources. To support the convening of this meeting, the FAO Unilateral Trust Fund (UTF) project "Support to Fishery Resources Appraisal in Pakistan" sponsored the travel and expenses of the meeting, and the Sultanate of Oman graciously agreed to host the meeting in Muscat.

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ACKNOWLEDGEMENTS

The meeting organizers and participants would like to recognize the financial support provided by the Government of Pakistan, through the FAO UTF project, and the support, hospitality and organization provided by the Ministry of Fisheries Wealth, the Sultanate of Oman, as meeting hosts. The financial support from the Institute of Marine Research, Bergen, Norway, for the contribution and participation of Drs. Espen Johnsen and Gavin Macauley is gratefully acknowledged. The organizers also appreciate the lively and constructive participation from all participants in the workshop. The contributions of Dr Ross Shotton in preparing meeting materials and the draft of the meeting report are especially appreciated as are his insightful comments and presentations to the workshop.

LIST OF ABBREVIATIONS AND ACRONYMS

FL	fork length
GCC	Cooperation Council for the Arab States of the Gulf
GEF	Global Environment Facility
GIS	geographic information system
GPS	Global Positioning System
GRP	glass-reinforced plastic
IFRO	Iranian Fisheries Research Organization
IMR	Institute of Marine Research
IOFC	Indian Ocean Fisheries Commission
IOP	Indian Ocean Programme
MFD	Marine Fisheries Department, Pakistan
MFW	Ministry of Fisheries Wealth, Oman
MSY	maximum sustainable yield
OMZ	oxygen minimum zone
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
RECOFI	Regional Commission for Fisheries
RFMO	regional fisheries management organization
SWIOFC	Southwest Indian Ocean Fisheries Commission
TCP	Technical Cooperative Project
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
VMS	vessel monitoring system

OPENING OF THE WORKSHOP

The Food and Agriculture Organization of the United Nations (FAO) Workshop on the Status of Shared Fisheries Resources in the Northern Arabian Sea – Iran (Islamic Republic of), Oman and Pakistan was opened on behalf of His Excellency Dr Hamad Bin Said Al-Oufi, Undersecretary of the Ministry of Fisheries Wealth, which had sponsored meeting arrangements in the Sultanate of Oman and acted as hosts for the Workshop.

Dr Hamad Bin Said Al-Oufi, through Dr Saoud Al-Habsi, Director General of Fisheries Research, expressed his pleasure in opening the Workshop and appreciation and gratitude to those involved in the organization of the gathering. In welcoming their guests from Iran (Islamic Republic of) and Pakistan and the representatives of FAO, he noted that the Workshop represented the cooperative spirit among the regional countries of the Arabian Sea and Sea of Oman in seeking the right path to active cooperation. He noted that FAO had been active in coordinating arrangements between the members, internationally and regionally, and in identifying common concerns and mutual issues, including the establishment and functioning of regional organizations under the FAO umbrella such as the Regional Commission for Fisheries (RECOFI) and the Indian Ocean Tuna Commission (IOTC).

These organizations enhance cooperation in marine surveys, in adopting scientific research and in responding to discussions related to fisheries resources management, its laws and regulations. This improved governance of marine organisms and shared stocks in the regional waters through facing the challenges and difficulties and was a mandate that fell upon the administrations of fisheries resources in the respective countries.

He noted that, through this event, participants were looking to realize further cooperation to explore the shared fisheries stocks and resources in regional waters so that mutual programmes and projects could be conducted to develop their fisheries potential. Oman looked forward to the results from the Workshop to assist in developing the scientific and technical information available for the fisheries researcher and administrations to achieve a more comprehensive understanding of shared fisheries stocks and achieve successful and active management of relevant stocks both nationally and regionally. He also anticipated that the Workshop would identify and develop research programmes to deal with the shared situations in need of further studies. Oman looked forward to the Workshop providing a forum for conducting future regular tripartite consultations on technical and scientific cooperation on the shared stocks in the northern Arabian Sea so as to achieve sustainable development of the shared stocks managed sustainably for future generations.

In closing, Dr Al-Oufi thanked all those who participated in holding this meeting and especially the Organizing Committee from the Ministry of Fisheries Wealth for their efforts.

Following the opening ceremony, Mr Paul Fanning introduced the specific objectives of the meeting. He noted that these were:

- to identify fish stocks of regional concern that were not the mandate of IOTC and to document the relevant information about the fisheries that was available;
- to prepare a synthesis on recent data that were available regionally, in particular for the pelagic and mesopelagic species;
- to identify opportunities to address common problems through collaborative actions;
- to find ways and means of institutionalizing a permanent mechanism for cooperative work;
- to identify what data were available, e.g. the Nansen Programme as an endeavour to make existing data available;
- to prepare overviews with respect to shared resources, their fisheries and fishery trends.

In closing, Mr Fanning sincerely thanked the Omani hosts for their efforts in organizing events locally in an efficient and effective manner. He further noted that the genesis for the meeting lay with Mr. Moazzam Khan, Director General of the Marine Fisheries Department in Karachi, Pakistan. Immediately following, Dr Saoud Al-Habsi, Director-General of Fisheries Research, was elected Chair of the meeting by acclamation and the Agenda as stated in Appendix I was adopted.

ORGANIZATION OF THE WORKSHOP

The Workshop was held in Muscat, Oman, at the Safeer International Hotel from 13 to 15 December 2010. The Workshop programme (Appendix I) included overview presentations on the fisheries and research programmes active in each country that are related to transboundary and straddling fishery resources that are, or are potentially, exploited by these countries. Technical sessions addressed specific issues associated with each of these shared resource groups. These consisted of mesopelagics, small pelagics, tuna and other large pelagics, in particular king mackerel, sharks, and some other species. The participants (listed in Appendix II) included scientists and fishery advisers from Iran (Islamic Republic of), Oman and Pakistan with assistance from FAO, which also acted as the Secretariat for the meeting.

1. REGIONAL AND NATIONAL OVERVIEWS

1.1 Regional perspective on shared resources and relevant programmes (R. Shotton)

The recent origins of fisheries research and development in the Arabian Sea had their antecedents in the International Indian Ocean Expedition exploration programme (1959–1965). This was a pioneering endeavour that reflected the realization that, of the major marine areas, least was known about the Indian Ocean. As a consequence, the United Nations Development Programme (UNDP), which at that time used FAO to implement and execute its field programmes, raised tens of millions of dollars for fisheries research and development in the Indian Ocean region. Among the institutional consequences of this funding was the creation of the Indian Ocean Fisheries Commission (IOFC), which funded a subcommittee to address fisheries issues in the Persian Gulf and Gulf of Oman[1] regions, as well as the Southwest Indian Ocean Fisheries Commission (SWIOFC). The IOFC was disbanded in 1999.

This programme produced much oceanographic and biological data and showed the seas off the coasts of Oman to be of high biological productivity. Prompted by the findings of the International Indian Ocean Expedition programme, the Indian Ocean Programme (IOP) of FAO undertook five or six (depending on definitions) surveys of coastal waters of the Arabian Sea using the original research vessel *Dr Fridtjof Nansen* to investigate its fish resources in the period from January 1975 to November 1976. These surveys covered the region from Pakistan to Somalia and included Yemen and Oman. The IOP subcontracted the execution of the fisheries survey and assessment work to the Institute of Marine Research in Bergen, Norway, and staff at the institute carried out the surveys.

Based on the acoustic data collected during these surveys, the fish resources of Oman were originally estimated to be between 1.4 and 2.2 million tonnes, later figures refer to 600 000 tonnes for the small pelagic fishes and 120 000 tonnes for demersal fishes, making it one of the most productive areas in the Indian Ocean. This was also a period of rapid development of fisheries acoustics equipment and techniques that saw the change from analogue to digital data processing methods during the period of this series of first resource surveys. A major consequence of these surveys was the realization that the northern Arabian Sea provided habitat for enormous stocks of mesopelagic fish – primarily the lantern fish (*Benthosema pterotum*). Questions about possible acoustic resonance effects in the acoustic estimates have resulted in conclusions that this stock's abundance is in the millions of tonnes rather than tens of millions of tonnes – initial estimates had referred to mesopelagic stocks of "some 100 million tonnes of mesopelagic fish in the North Arabian Sea". Naturally, such estimates created much excitement and interest not only in the region but far beyond.

[1] Generally referred to as the Sea of Oman in the Islamic Republic of Iran.

Following the completion of the North Arabian Sea Survey, the *Dr Fridtjof Nansen* remained in the area in 1977, undertaking survey work in Pakistani waters under a bilateral agreement. A Japanese vessel, the *Shoyo Maru*, was subsequently made available by the Government of Japan and carried out surveys in October–December 1975 and in 1976.

At this time (1977), the Government of France was also active in providing assistance. It reported that in a bilateral programme of assistance with Pakistan, a French vessel undertook exploratory fishing in the northern part of the Arabian Sea. Catch rates varied from 200 kg/hour at 130 m to 2 300 kg/hour at 50 m: "Off Iran good yields were obtained in certain waters although in the Gulf of Oman resources were less abundant and resources were being exploited by foreign trawlers of the long distance fleet. In general resources were less abundant than off Pakistan."

The UNDP involvement led to a major surge in fisheries programmes in the Indian Ocean. The UNDP requested the IOP to develop a regional fishery survey and development project for the Red Sea, which, under the auspices of the UNDP, was given funds from the Organization of the Petroleum Exporting Countries (OPEC) to an amount of US$4 000 000. Much of the work of this project, which was undertaken in the 1980s, remains the defining scientific work on species as wide in range as cuttlefish, lobster, shrimp and small pelagics in the Red Sea and Gulf of Aden region.

A further programme – the Regional Fisheries Survey and Development Project – was funded that would embrace the Persian Gulf and coastal waters of the Gulf of Oman. This programme, executed over three years, used four research trawlers to undertake a randomized trawl survey in the waters of Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (see also Sivasubramaniam, 1981). Although the project was originally formulated in 1972, field surveys were fully under way around the end of that decade. This survey has created a major database of immense value, as the trawl stations were carried out using an agreed standard protocol and scientific staff were employed to identify catches, record length and weight frequencies and gonad conditions. Physical observations were also undertaken. FAO has not shown appropriate stewardship of this information, and neither have the regional countries, to the extent that few people, either at FAO headquarters or in the region are aware of this mine of information.[2] Details of the data structure are given by Shotton (1994a).

The *Dr Fridtjof Nansen* programme undertook a second series of cruises as follows:

- March 1983 (pre-monsoon conditions);
- November–December 1983 (northeast monsoon conditions);
- April–May 1984 (immediate pre-monsoon conditions).

The fourth survey planned for September 1984 (immediate post-monsoon conditions) had to be cancelled, which left a gap in the study of the annual cycle.

The survey in Omani waters emphasized the shelf area from Ras al Hadd southward to Salalah because of the high productivity of this region. The shelf north of Ras al Hadd is narrow and has a much lower productivity, and this area was not covered in the first survey. The first survey partially overlapped with a special survey on the mesopelagic resources in the Gulf of Oman, while the second survey included an acoustic coverage of the mesopelagic fish in the same area. The results from the investigations on mesopelagic fish are reported by various researchers.

The shallow waters of the Masirah Bank were found to be the most important nursery ground for the juvenile stages of the main small pelagic species. This area is probably vital for the regeneration of the small pelagic fish stocks and should be closed to industrial fisheries.

[2] An additional positive outcome of the 2010 Muscat Workshop was the provision of the data by the Secretariat to the Institute of Marine Research in Bergen to include in its NANSIS database.

The total biomass of demersal fish during the three surveys was estimated at 335 000, 360 000 and 335 000 tonnes, respectively (average of 345 000 tonnes). The dominant demersal fish were longfin breams (*Nemipterus* spp.) 11 percent, sea breams (Sparidae) 12 percent, catfish (Ariidae) 9 percent, croakers (Sciaenidae) 10 percent, grunts (Pomadasyidae) 9 percent and emperors (Lethrinidae) 6 percent.

It was believed that a level of exploitation of 23 percent of the initial biomass was justifiable. In absolute terms, the researchers concluded that a yield of 270 000 tonnes of pelagic fish a year seemed reasonable if the total ecosystem maintained its productivity level of 1983–84. However, it was stressed that it was vital that the levels of the fish stocks and the level of the production of the ecosystem were monitored if intensive exploitation were carried out.

The next extensive series of surveys in the Omani area were carried out in the early 1990s by the research vessel *Rastrelliger*. The survey of 1989–1990 resulted in a small pelagics biomass estimate of 252 000 tonnes. Greatest abundance was again found to be in the Masirah – Ras al Madrakah region (189 000 tonnes) with lesser abundance in the Muscat – Ras Al-Had region (9 000 tonnes). The four major species encountered were Indian oil sardine (*Sardinella longiceps*), Indian scad (*Decapterus russelli*), horse mackerel (*Trachurus indicus*) and bigeye scad (*Selar crumenophtalmus*).

The *Rastrelliger* survey estimated the demersal biomass over the entire Omani continental shelf area to be 565 000 tonnes, a figure 36 percent higher than the estimates from the *Dr Fridtjof Nansen* survey in 1983–84. Total potential yield of all species (commercial and non-commercial) was estimated to be 126 000 tonnes, of which the potential yield of commercial species was 67 000 tonnes. Seventeen percent of the total biomass was in the Gulf of Oman and 83 percent was in the Arabian Sea. The biomass of lanternfish was estimated to be 4 490 000 tonnes.

These surveys might be considered the last of the "historical era". In the following years, the Iranian Fisheries Research Organization started a comprehensive series of demersal trawl surveys in their waters and, in addition, undertook specialized surveys of mesopelagic stocks using the research vessel *Ferdows 1* along the northern coast of the Gulf of Oman. This series of cruises found abundant resources of *Benthosema* and valuable bycatch of squid and hairtail (*Trichiurus lepterus*), especially at certain times of the year in the western part of the Gulf. At around the same time (≈ 1992), the Committee for Development and Management of Fisheries Resources of the Gulfs, a subsidiary body of the IOFC, recommenced activities. Several papers relating to myctopohids were produced in 1994 for technical meetings of this committee, e.g. Shotton (1994b, 1994c and 2001) and Shotton and Agnew (1994).

The truly contemporary era of surveys in the area is represented by the "NIWA" cruises by the *Al Mustaqila 1* (2007–08) and the cruises by the *Ferdows 1* and *Dr Fridtjof Nansen* cruises in Pakistani waters in 2010. Reporting on the general results of these cruises is left to those present at the meeting who participated on the surveys.

1.2 Fisheries and shared resources of Pakistan (*M. Moazzam Khan*)

Pakistan is located in the northern Arabian Sea and has two maritime provinces: Sindh (300 km shelf) (maximum 75 km) and Balochistan (800 km shelf) (maximum 45 km).

There are about one million fishermen in Pakistan and the major fishing grounds are located in coastal areas, especially among Sindh creeks. The Sindh coastal area has a wide continental shelf (75 km) and the Indus River discharges into this area. There exist many interwoven creeks and there are widespread mangroves and mudflats. The major settlements in the area are Karachi, Thatta and Badin. In the Balochistan coastal area, there is a narrow continental shelf (74 km), no major river discharge, many sheltered bays and mangrove patches at Miani Hor, Jiwani and Kalmat Khor. Major settlements occur at Gwader, Pasni, Ormara, Jiwani and Sonmiani.

Oceanographic conditions are characterized by a monsoon reversal from the southwest monsoon and northeast monsoon with two intermediate calm periods. There is an oxygen minimum layer and upslopping of deep water during the northeast monsoon. Fish resources include demersals, small pelagics, large pelagics, shellfish and mesopelagic fishes. These fishes are forced closer to the coast during the period of the upwelling when the oxygen minimum comes closer to the shore. Overall productivity benefits from the nutrient-rich waters coming from the Somali upwelling.

Demersal stocks are estimated to be 500 000 tonnes and their maximum sustainable yield (MSY) is estimated to be 300 000 tonnes. The level of exploitation is 164 340 tonnes. Major demersal species include catfishes, croakers, eels, ribbonfish and sharks. Resources of small pelagic species are estimated to be 700 000 tonnes and their MSY is estimated to be 235 000 tonnes. The current level of exploitation is 88 547 tonnes. Major species include sardinellas, thryssas, anchovies, scads and Indian mackerel. Stocks of large pelagic species are estimated to be 88 000 tonnes and their MSY is estimated to be 60 000 tonnes. The level of exploitation is 52 231 tonnes. Major species include tunas, billfishes, dolphinfish and pelagic sharks. Stocks of shellfish are estimated to be 171 000 tonnes and their MSY is estimated to be 47 500 tonnes. The level of exploitation is 33 655 tonnes and major species include shrimp, lobster, crab, cephalopods and clams/ivory shell. Fishing, especially the removal of the top predators, has changed the whole ecosystem trophic structure. Sharks, in particular, have been substantially reduced. This heavy fishing pressure has caused a refocusing of fishing effort on small pelagics, especially Indian mackerel, which is being overfished.

Mesopelagic stocks are estimated to have a biomass of 10 000 000 tonnes and their MSY was estimated to be 5 000 000 tonnes. There is currently no exploitation of these stocks. The major species are the lanternfishes.

Stocks that are shared with other Arabian Sea countries are the large pelagics – yellowfin tuna, billfishes, skipjack and longtail tuna, pelagic sharks, dolphinfish and croakers. Yellowfin tuna caught in Pakistan's waters are believed to belong to a single region-wide stock, and possibly other larger pelagic species consist of a single stock as well. Croakers appear to migrate into Iranian waters but there is no conclusive evidence for this. It was noted that an estimate of 88 000 tonnes for pelagic resources has, by repetition, become the standard unfished biomass estimate. However, the original reference for this cannot be found and it is considered that estimates of large pelagic biomass values were mainly wild guesses.

1.3 Fisheries and shared resources of Oman (*L. Al Kharusi*)

This presentation provided a useful explanation of the organizational structure of the Ministry of Fisheries Wealth (MFW) in Oman and reporting relationships. The sector consists of an industrial sector consisting of trawlers and longliners. Foreign-owned and foreign-operated vessels are reported to take 10 percent of the catch and few Omani vessels are entering the fishery. The sector employs 34 000 fishermen, who use 14 000 small boats.

Traditional fishing areas extend along the entire Omani coastline of just over 3 000 km. The distribution of fishermen and vessels in Oman is shown in Table 1.

Table 1
Numbers of fishermen and vessels in Oman

Region	Fishermen	Boats
	(no.)	
Musandam	3 625	1 274
Al Batinah	11 205	4 347
Muscat	4 436	1 624
Al Shaiqiyah	7 743	3 013
Al Wusta	3 634	1 635
Dhofar	4 114	1 939

Table 2
Reported landings in Oman, 2001–09

Year	Total landings (tonnes)
2001	129 904
2002	142 668
2003	138 485
2004	165 018
2005	157 322
2006	147 665
2007	151 745
2008	151 910
2009	158 653

The predominant type of fishing vessel is made from fibre-reinforced plastic and these range in length from 4.2 m to 8.6 m (outboard engine powers range from 25 hp to 115 hp). The dhow class fishing boats are made from wood or glass-reinforced plastic (GRP). Their engine power ranges up to 480 hp and their length up to 23.5 m. The largest vessels can carry up to 65 tonnes of fish.

Table 2 gives the total recorded landings in the last decade. These data show somewhat stable landings with a slight increasing trend during this period. Peak landings were recorded in 2001 for small pelagics; 2002 for demersal species; 2004 for large pelagic species and 2003–2005 for crustaceans. Total landings of sharks and rays have been stable. The ex-vessel value of landings has increased from OMR79. 39 million in 2004 to OMR104 million in 2009 (OMR1 = US$2.6).

A number of management challenges are perceived for the region:

- managing the existing fishery to prevent fish stocks from being overexploited;
- while many of the large pelagic stocks are highly migratory, little is known about their migratory routes and spawning grounds;
- there is still a lack of comprehensive knowledge of myctophid fishes in Omani waters; and
- little is known about the stock structure of small pelagic fishes in Omani waters.

Oman has witnessed several serious marine mortality incidents in coastal waters involving harmful algal blooms in its waters in recent years, and these have been increasing in frequency over the last two decades. Fish mortalities have been associated with these plankton blooms that have been caused by the fish-killing red- tide organism *Cochlodinium*, caused by harmful algal blooms. It is believed that these environmental perturbations have been caused by the discharge of ballast water introducing exotic algae and the impact of sewage and industrial effluents on the local seas.

It is understood that more information is needed about how marine ecosystems function on varying scales in Omani waters, how human activities affect marine ecosystems and how, in turn, these ecosystems affect society. An Omani national strategy should promote the scientific and technological advances required to observe, monitor, assess and predict environmental and socio-economic events and long-term trends.

Fish traders are considered to be central drivers in the overexploitation of fish stocks and in evading regulation. There is a need to develop effective programmes to monitor fish trade and resource trends and disseminate problem-solving information. This should be supplemented with appropriate harvesting permits, certification and control over delivery of fish products to control commercial demand. Another requirement is the development of property rights and co-management regimes in fisheries management that encourages local protection. This will require multilevel governance institutions operating at a local and international level to ensure that such initiatives succeed.

Decision-makers need information on the impact of fishing practices on fish species and ecosystems; cost/benefit analyses of protecting spawning grounds and other critical habitats and of alternative management strategies/policies. They must understand the interrelationship between different sectors in fisheries and social/economic impacts of changes in regulations, including the possible reactions of fishermen to changes in management regulations.

1.4 Fisheries and shared resources of Iran (Islamic Republic of) (*M. Sistani and T. Valinassab*)

Reported catches in southern waters of Iran (Islamic Republic of) have shown a generally increasing trend over the period 1993–2008. Table 3 shows these trends disaggregated for four groups over the period 1997–2008.

Table 3
Reported landings of fish in Iran (Islamic Republic of) 1997–2008

Year	Shrimp	Demersals	Small pelagics	Large pelagics
		(tonnes)		
1997	7 620	158 380	10 000	83 000
1998	5 774	128 726	12 000	90 000
1999	4 570	119 430	17 200	93 000
2000	9 850	115 150	23 000	112 500
2001	6 940	110 560	30 805	115 000
2002	5 726	105 839	24 150	133 285
2003	7 100	106 596	25 000	160 432
2004	5 940	106 230	24 800	177 195
2005	9 128	119 725	19 094	–
2006	5 951	116 811	26 311	225 374
2007	7 450	115 031	30 164	176 926
2008	9 642	127 566	35 843	163 790

Per capita fish consumption in Iran (Islamic Republic of) is 7.35 kg. Total catch in southern waters is 342 000 tonnes, and a major part of the catch increase is attributed to greater landings of tuna, sardines and hairtail. The value of the southern catch in 2008 was estimated at US$423 million with an export value of US$60 million.

The Iranian fishing fleet in the Persian Gulf and the Sea of Oman consists of 7 970 fishing boats and 3 033 dhows, and 44 tuna purse seiners and trawlers; and there are 152 fisheries cooperatives and more than 142 000 fishermen. The types of gear used are: gillnets on fishing boats and dhows for large pelagics; bottom trawls on artisanal boats, dhows and industrial vessels; traps for shrimp, cuttlefish and demersal species such as groupers on boats and dhows; trolling for tuna and mackerel and purse seines for sardine and tunas on industrial vessels. Paired-vessel trawling for small pelagic fish is developing.

Management measures consist of: fishing licence restrictions; closed fishing zones, e.g. of nursery grounds; closed seasons, e.g. for cuttlefish, shrimp and silver pomfret; use of standard gear and fishing devices, minimum mesh sizes and restrictions on increasing engine power. There is a mandatory requirement to use bycatch reduction devices in shrimp fisheries. Dhows must use square mesh panels in Bushier and Hormozgan Provinces during the shrimp fishing season. There are 80 mm bycatch reduction devices in Hormozgan and Bushier Provinces for industrial trawlers.

The main management issues are considered to be management of multispecies fisheries, control of pollutants and monitoring of red tides. Conservation and rehabilitation is achieved through marine security guards. Preventive measures include detection of illegal catches, use of vessel monitoring systems (VMSs), use of observers on industrial vessels, conservation measures on nursery grounds, the creation of artificial reefs, and mangrove conservation.

Data are collected from 10 percent of vessels (based on their dimensions) in four southern provinces. Data collectors are based at 35 landing sites. Industrial vessels use a self-reporting protocol and use logbooks and observers. These methods are reviewed by a scientific catch committee. Landing sites are selected for sampling based on the selection of sample landing sites based on the types of fishing gear, large landings, diversity of vessel types and landed species. Based on these criteria, 35 sites out of 60 are sampled. Final controls are performed in scientific committees involving catch statistics supervisors from the provinces, experts from headquarters and fishermen's representatives. Fishing effort is derived from the licensing data.

Research in Iran (Islamic Republic of) involves swept area trawl methods and biological studies of demersal species, biological studies of large and small pelagic species, stock assessment of shrimp, myctophidae and hairtails and nutrition studies for, e.g. narrow-barred Spanish mackerel. Maximum sustainable yields and L_{50} are provided for some species such as *Pampus argenteus*, *Lutjanus johni*, *Pomadasys kaakan*, *Otolithes ruber*, *Acanthopagrus latus* and *Psettodes erumei*.

Large pelagic species of interest include *Thunnus tonggol*, *Thunnus albacares*, *Euthynnus affinis*, *Katsuwonus pelamis*, *Auxis thazard* and *Scomberomorus commerson.* The L_{50} is also calculated for these species. Small pelagic species of interest include *Sardinella sindensis*, *Encrasicholina punctifer*, *Sardinella gibbosa*, *Sardinella longiceps*, *Sardinella albella*, *Dussumeria acuta*, *Herklotsichthys lossei*, *Encrasicholina* sp. and *Stolephorus indic*.

1.5 Discussion

It was noted that while the extensive data series from the UNDP/FAO regional survey of 1977–1980 had been circulated to all regional countries, the major changes in computer software would have rendered the original databases unusable and no known copies of the data existed in the regional countries. However, the data record had been saved: it consisted of detailed records from a four-vessel random trawl survey of the waters of the Gulf States and the Gulf of Oman. These data were available from Dr. Shotton and a copy was made available at the meeting to the Nansen Programme so that these data could be uploaded to the NANSIS database. Regional analysts were encouraged to make use of this invaluable data record, which enables comparisons of biomass estimates and faunal composition to be made over a 30 year period of fisheries development and expansion.

In responding to a question as to how shellfish stocks had been estimated in Pakistan's waters, it was noted that these estimates were derived from the survey results of the *Dr Fridtjof Nansen*.

In discussions relating to fishing practices in Oman, it was noted that trawlers had been banned from most Omani fishing grounds and that traps and longlines were the predominant method of fishing. Maximum vessel lengths were in the range 27–30 m. The number of longliners fishing varied annually and seasonally, according to the target stock. The number of licences issues to longliners could vary from 7 to 30 over a year and it was considered that Oman now had a good record of information in its database.

Discussions noted that in Iran (Islamic Republic of), larger-scale boats must fish further than 12 nm or the 50 m isobath from shore. It is planned that demersal trawling will be banned from April 2011. The number of trawlers had decreased from 72 to 35, and their fishing season from 11 months to 4.5 months. The authors noted that efforts were being undertaken to standardize fishing gear and prevent increases in fishing power (notably engine size) in the fishing fleet. Shrimp trawlers must all use bycatch reduction devices to reduce bycatch and discards. Pollution in Iranian waters was more a concern in the Persian Gulf, and occurrences of red tide were becoming more frequent.

Observers are required on all industrial vessels, and research programmes are monitoring nursery areas and plankton abundance. There was a development programme for artificial reefs and aquaculture of sea bream. A standardized form was used to collect data from 35 landing sites, although insufficient resources exist to analyse the results adequately. Iran (Islamic Republic of) is just completing its fourth five-year plan and is about to start its fifth.

In was noted in the discussion that MSY estimates in Iran (Islamic Republic of) were being derived using a number of methods – the Fox model, Gulland's MSY estimator and by the traditional surplus production model. In relation to spawning of king mackerel, it was noted that it remained unknown where (and if) they were spawning in Iranian waters. In Iran (Islamic Republic of), there were no longliners, only purse seiners (which were not performing profitably) and gillnetters. The purse seiners were achieving catch rates of about 500 tonnes/year whereas catches of 7 000–8 000 tonnes were required to ensure profitability. It was planned that longlining would start in the future. These vessels operate mainly in the Gulf of Oman, but for year-round operations they must also operate in the Indian Ocean. However, Iranian skippers are not very familiar with the fishing grounds in the Indian Ocean and make only one or two trips a year to this area. Instead, French and Spanish fishing vessels dominate tuna fishing in this area. Marine security guards, who are a part of the armed forces, were responsible for enforcing conservation regulations, and this programme worked well. They also run the marine patrol craft.

In discussions concerning fishing practices in Oman, it was noted that trawlers must now fish at least 10 nm from the coast to avoid interactions with the gear of small-scale fishermen. Dhows, a common vessel class, are now built from fibreglass rather than wood as in the past.

1.6 Recommendations

It was agreed that a mechanism was needed to facilitate data exchange and ideally a formal mechanism should exist to achieve this.

2. OVERVIEWS ON NATIONAL STOCK ASSESSMENT ACTIVITIES INCLUDING CURRENT RESEARCH, SURVEYS, STOCKS UNDER CONSIDERATION AND RELATED ISSUES

2.1 The *Dr Fridtjof Nansen* surveys in the Arabian Sea (*E. Johnsen and G. Macaulay*)

The first "Nansen" surveys were during the period 1975–1993, although cruises after 1994 were done by the new *Dr Fridtjof Nansen*. These are described by Sætersdal *et al.* (1999). The survey undertaken in 2010 was the first in the region since 1984. The Nansen Programme has the general objectives of: (a) providing support to ensure sustainable fisheries; (b) providing combined fish and environmental monitoring surveys; (c) gaining knowledge on fish stocks; and (d) supporting management decisions. The presentation explained how the NANSIS database system worked. This system records all of the results of the Nansen Programme in a readily accessible form, starting with the first Nansen survey in the region that began in February 1974. All summary reports of the system are also in the database and are readiy accessible through the Internet. The NANSIS contact person at the Institute of Marine Research (IMR) in Bergen, Norway, is Jens Otto Krakstad (e-mail: jens.otto.krakstad@imr.no).

In subsequent discussions, it was emphasized that NANSIS is a survey information system for logging, editing and analysing scientific trawl survey data (trawl/catch data and fish length/frequency data). The members of the Workshop suggested that NANSIS may be implemented as the standard data platform in a future data exchange programme as it is being considered for adoption as a regional standard to allow sharing and joint analysis of survey data.

The main reasons to use NANSIS are:

- All fish data sampled during the surveys by the *Dr Fridtjof Nansen* are stored in NANSIS.
- All fish data sampled by the *Rastrelliger* in Oman 1989–1990 are stored in NANSIS.
- The IMR has indicated that it will be responsible for entering data from the *Al Mustaqila* surveys in recent years into NANSIS.
- The Marine Fisheries Department (MFD), Pakistan, has already implemented NANSIS for all its survey data.

NANSIS software is available free from the FAO Web page (www.fao.org/fishery/topic/16074/en). It builds on the free database software, PostgreSQL (www.postgresql.org/).

To assist in evaluation of NANSIS, it was agreed to plan a NANSIS training course during the first half of 2011. The MFW in Oman has indicated that it is willing to host this training. Espen Johnsen is responsible for making contact with the training personnel at the IMR, Bergen, to find a suitable date for the training course. As the scientists from the MFD, Pakistan, are already well trained in NANSIS, the planned course will mainly be for Iranian and Omani scientists and technicians. Other countries that are members of the Cooperation Council for the Arab States of the Gulf (GCC) can be invited to participate in this training subject to course size limitations.

In e-mails dated 15 December 2010, Dr L. Al-Kharusi and Dr T. Valinassab requested the IMR to provide the NANSIS data from Omani and Iranian waters, respectively. The NANSIS data from Oman were given to Mr F. Al-Kiyumi and the Iranian data were given to Dr T. Valinassab by Dr E. Johnsen.

2.2 Ongoing demersal fishery resources survey in Sea of Oman at a glance (*M.J. Al-Mamry*)

The survey of demersal fish stocks of the Persian Gulf and the Sea of Oman in the western region of the Persian Gulf and the Sea of Oman is under the supervision of the GCC Fisheries Committee and targets demersal fishes. Data are collected using small-scale trawls, acoustic surveys and traps on grounds that are too rough to be trawled on. Transects cover the coastal waters of all GCC countries. The objective has been to formulate recommendations and management plans for exploitation of demersal fish species, and this has involved the estimation of biomass of the fish stocks, determination of their geographical and temporal abundance, and conducting biological investigations on selected species. Training has also been done of GCC national scientists on demersal survey techniques and data analysis.

There have been five surveys using trawl and trap sampling as follows:

- January 2009, Trawl Cruise 1;
- October 2009, Trawl Cruise 2 and Acoustic 1;
- May 2010, Trawl Cruise 3 and Acoustic 2;
- February–March 2010, Trap Cruise 1;
- October 2010, Trap Cruise 2.

Data have been collected of fish length frequency data, biological samples taken, acoustic transect data measured and ecological data recorded. Mean catches by family and species of demersal fishery resources in the area from Musandam to Ra-Al Had have been calculated, and estimates made of biomass of demersal fish from the Arabian Sea coast of Oman.

Future work will consist of: the fourth and fifth trawl cruises; establishing and maintaining a biological database for the data that have been collected; estimating the total biomass of demersal fish resources for important species; proposing management plans for their exploitation based on the results; and doing further ecological and biological studies on some selected species.

In regard to trilateral cooperation, there is a need for research studies on reproductive biology, ageing, growth and stock assessment for most of the shared stocks of critical demersal species in the Strait of Hormuz among the member counties. Regular surveys should be initiated, especially beyond the range of the existing fishery, to detect fish stocks being exploited in this region. Appropriate mechanisms between member countries for joint exploitation of fisheries need to be proposed in order to gain maximum benefits from the living marine resources in the area. An annual scientific symposium among the member States should be established to review the results of research and related studies and to monitor biological changes and environmental and biodiversity. In addition, databases need to be established for the benefit of the participating countries.

2.3 Fisheries research in Iran (Islamic Republic of) (*F. Kaymaran*)

The Iranian Fisheries Research Organization has a research programme for the:

- determination of species composition of demersal fishes;
- estimation of catch per unit area (CPUA) for 103 species, genuses or fish groups;
- estimation of biomass for 103 species, genuses or fish groups; and
- distribution pattern of commercial demersal fishes.

Field surveys are stratified longitudinally into 17 strata encompassing the entire marine coastline for collection of this information. This enables changes in these indices to be monitored over time. Results show considerable variation by region, which may or may not be due to fishing. Both commercial and non-commercial species are monitored so that distributional patterns for demersal fish can be established.

Length frequency data are also collected and the ratio of bycatch to commercial catch is monitored. Illegal fishing and “smuggling” of fish to neighbouring countries poses a problem for the collection of accurate catch data.

Gut contents studies of yellowfin tuna are being undertaken. Purpleback flying squid are the most prevalent prey and account for 37–61 percent of food items, followed by teleost fishes and crabs. Cuttlefish, shrimps, octopus and stomatopods were the other components that occur. Gonadosomatic indices of tuna are tracked and their spawning seasons occur from December to April, from January to April and from January to June. The $L_{M50\%}$ is estimated at nearly 80 cm, with a maximum length of about 260 cm.

2.4 Stock assessment in Pakistan (*M.W. Khan and M. Moazzam Khan*)

Resource assessment surveys have been undertaken over an extended period in Pakistan’s waters, as is shown in Table 4.

These surveys mapped the distribution and abundance of: (a) groupers and snappers, (b) cuttlefish, (c) invertebrates, (d) small pelagic species, (e) lizardfish and flatheads, (f) ribbonfish, catfish and sharks, (g) jacks, (h) shrimps, (i) croakers and grunts, (j) Nemipteridae, and (k) pomfrets and Scombridae. Table 5 shows the estimates of biomass. Catches remain below estimates of long-term MSYs.

Table 4
Resource surveys in Pakistani waters

Name of vessel	Type of survey	Year
F.V. Ala (Pakistan)	Exploratory fishing	1948
F.V. Machhera & *F.V. New Hope* (Pakistan)	Exploratory work	1952
F.V. Nauka & *F.V. Minslital* (Russian Federation)	Hydrography & marine fisheries resources NIRO expedition)	1969
F.R.V. Dr. Fridtjof Nansen (Norway)	Exploratory survey programme (FAO-assisted)	1975/76
F.R.V. Dr. Fridtjof Nansen (Norway)	Survey for stock assessment(FAO/NORAD-assisted)	1977
F.V. Shoyo Maru (Japan)	Exploratory fisheries survey	1975
F.V. Thalassa (France)	Fisheries, oceanography data	1977
F.V. Machhera & *F.V. Tehkik* (Pakistan)	Stock assessment survey	1983/85
R.F.V. Ferdows 1	Stock assessment survey (swept area method)	2009
Dr. Fridtjof Nassen	Stock assessment survey, acoustic survey, swept area method, oceanographic survey	2010
F.V. Thalassa (France)	Fisheries, oceanography data	1977
F.V. Machhera & *F.V. Tehkik* (Pakistan)	Stock assessment survey	1983/85

Table 5
Biomass estimates

	Biomass	MSY	Landings (2009)
		(tonnes)	
Small pelagics	700 000	235 000	88 547
Large pelagics	88 000	60 000	52 231
Demersals	500 000	235 000	164 340
Shellfish	171 000	47 500	33 655
Total	1 407 300	717 600	338 773

2.5 Discussion

Participants noted that possible three-country surveys by the *Dr Fridtjof Nansen* had been discussed but there had been no firm commitments at this time. Historic data were being re-analysed to re-estimate biomass estimates as the results and data have been disputed. Some data collected in Pakistan have been re-analysed by Chinese students, who were converting the information in to a new format, and it should be possible to re-calculate the 1983–84 data, though this would be a big project. It was the Iranian view that there were some overestimates in the old survey results and there is a need to re-survey myctophids and re-estimate abundance again.

In discussions concerning tuna, and yellowfin in particular, questions were asked about the distribution of these stocks, distribution of catch per unit effort and how many stocks existed. The IOTC had believed that there were two stocks of yellowfin tuna but, after tagging studies, they concluded that there is only one stock that inhabits both eastern and western parts of the Indian Ocean.

Brief note was made of the GCC countries' ongoing work. Biomass was being estimated from acoustic surveys and trawl catches. A trap survey was being undertaken to obtain specimens to calculate biological characteristics and sample in shallow and coral-reef areas. The acoustic system is run between trawl stations. In Oman, there had been 20–21 trawl stations to a maximum depth of 100 m. The boat size – length of 26 m – influenced both inshore and offshore sampling. Overall, the programme was considered to be working well and to have collected useful data.

In Pakistan, trawl stations had consisted of 30 minute tow at three knots. Planning was under way for a fifth survey. It was believed that better results had been achieved with the *Dr Fridtjof Nansen* than with the *Ferdows 1*. Results showed that lizardfish were the dominant species along with ribbonfish (*Lepturacanthus savala* and *Chaenogaleus macrostoma*). Many problems had been encountered in obtaining official clearance for the *Ferdows 1* to start survey work and this had reduced the possible time the vessel could spend at sea. However, this experience was used to facilitate obtaining the required approvals for the *Dr Fridtjof Nansen* when it arrived in Karachi, Pakistan.

Maximum catch was about 750 kg/tow, and this value dominated the results of the survey. Nemipteridae were the most dominant species in the Pakistani zone. There were few pomfrets. In commercial fisheries, it was noted that Indian mackerel has made a shift in landings. The large Pakistan trawl shrimp fishery was now fishing at night and, whereas in the past it had used only manually retrieved trawls, vessels are now equipped with hydraulic winches. The recent survey was to the 200 nm limit. However, the area between 100 and 200 m is limited as the shelf is narrow and there were few opportunities for trawl stations.

Further discussions on the NANSIS software noted that it can show a picture of a fish in the species field. The next enhancement of this system will be the addition of a geographic information system (GIS) in 2011. It was noted that it is easy to write query scripts to interrogate the Nansen system and that it was necessary to acquire only a little computing ability – this takes about one month. However, it was helpful to have access to an expert. The Omanis were informed that they could receive a "briefcase" of ready-to-load Nansen data from the Nansen Programme. With a laptop computer, the entire data record could be accessed through the NANSIS screens. Another feature was "Tracklog" that connected the Global Positioning System (GPS) to a laptop – this system continuously records location data into a file. Pictures of up to 10 Mbytes could also be stored. A new, major release of the system was coming although some bugs remained. It was noted that it may be possible for a course to be given in the region by the IMR in 2011. Oman has past survey data in the NIWA format but this can be loaded into the NANSIS system. The International Marine Research Centre in Bergen had the data in the NANSIS database both from the 1974 and 1983 surveys and from the ten surveys done by the *Rastrelliger*.

3. SHARED MESOPELAGIC RESOURCES, PRIMARILY *BENTHOSEMA* SP.

3.1 Myctophid resources in Oman (*N. Jayabalan*)

The abundance and density of mesopelagic fishes in the Arabian Sea is considered to be the highest in the world (Gjøsæter and Kawaguchi, 1980; Lam and Pauly, 2005). This is because of high productivity triggered by monsoon-driven upwelling (Gjøsæter, 1981, 1984; Wishner, Gowing and Gelfman, 1998). The low productivity of other fish species is because of the extensive oxygen minimum zone (OMZ) found in the region. Development of fisheries for these resources has been constrained by the lack of adequate research on mesopelagic fishes and their ecological role and by the technical and economical problems of harvesting. Table 6 shows details of mesopelagic surveys in Oman.

Table 6
Vessels that have undertaken surveys in Omani waters

Survey vessel	Area	Period
Dr Fridtjof Nansen	Northeast Arabian Sea	1975–1976
Dr. Fridtjof Nansen	Sea of Oman[1] and Gulf of Aden	1979–1981 & 1983–1984
Jeng Bang San	Sea of Oman	1989–1990
Rastrelliger	Sea of Oman and Arabian Sea	1990
Al Mustaqila 1	Arabian Sea	2008

[1] The Sea of Oman was earlier known as the Gulf of Oman.

Surveys were conducted in depths up to 500 m and, in the case of the *Al Mustaqila 1*, up to 1 000 m. The *Dr Fridtjof Nansen* surveyed the Arabian Sea up to 150 nm offshore. Mesopelagic fishes were found in dense layers along the shelf-breaks, extending 1–2 nm offshore (Aglen *et al*., 1982; Gjøsæter and Tilseth, 1983). Occasionally, an extremely high density of mesopelagics was also found offshore in the Arabian Sea (Venema, 1975; Gjøsæter, 1981). Myctophid density increased with distance offshore near the Jazair, Khuriya and Muriya Islands. All surveys on mesopelagics in the Arabian Sea and Sea of Oman found patchy distribution of the mesopelagics both spatially and temporally.

Previous surveys had occasionally found high densities ($\leq$ 100 g/m^3) extending up to several kilometres offshore. However, no such high densities were seen in later surveys (Gjøsæter, 1984). These surveys also noted seasonal changes in fish density in the Sea of Oman (Gjøsæter and Myrseth, 1980). Later surveys reported much lower fish densities than the surveys in 1970s (FAO, 1995, 1998).

The most abundant fish species present in the mesopelagic layers were the myctophids (Gjøsæter 1981, 1984):

- *Benthosema pterotum* – dominant;
- *B. fibulatum* – minor importance;
- *Myctophum spinosum*;
- *Symbolophorus evermanni*;
- *Lampanyctus teuniformis*;
- *Bolinichthys longipes*;
- *Diaphus* spp.

Other fish families commonly found were Trichiuridae, Alepocephalidae, Gonostomidae, Champsodontidae, Nettastomatidae, Maurolicidae, Stomiatidae, Sternoptychidae, Synodontidae, Gempylidae and Nemichthyidae (Venema, 1975). Non-fish groups included squid, krill, shrimp, salps and the swimming crab *Charybdis smithii* (Venema, 1975; Gjøsæter and Myrseth, 1980; Gjøsæter, 1984; Ashjian *et al*., 2002).

Species diversity in the scattering layer increased from the northeast to the southwest and from nearshore to offshore (Venema, 1975; Gjøsæter, 1977, 1981; Aglen *et al*., 1982). Dense layers of fish were found during day-time at depths of 200–450 m (Venema, 1975; Anon., 1976a, 1976b, 1976c). Concentrations of *B. pterotum* occurred in two day-time layers (D1 and D2) and one-night layer (N1) (Gjøsæter, 1984). The D1 layer was about 20–40 m thick and consisted mainly of *B. pterotum* at

150 m depth. The D2 layer was located at 250 m and is about 90–150 m thick. During sunset, the D1 and D2 layers migrate to the surface to form the N1 layer.

Size distribution by layer

The size distribution within different scattering layers is unclear. The *Dr Fridtjof Nansen* found shallow day-time layers to contain two size classes of *B. pterotum*, with the deep layer consisting of larger fish (Aglen *et al*., 1982; Gjøsæter and Tilseth 1983). However, the *Jeng Bang San* survey found adult and large-sized fish in shallow day-time layers and small fish at night (FAO, 1998).

Seasonal changes

The offshore current (the Findlater Jet) running northeast parallel to the Oman coastline triggers open-ocean upwelling during the southwest monsoon and autumn intermonsoon periods. The *Dr Fridtjof Nansen* found increased mesopelagic acoustic backscattering during the August–November period (Venema, 1975; Anon., 1976a, 1976b, 1976c). This was related to increased primary production and zooplankton biomass. In addition to open-ocean upwelling, the summer southwest monsoon leads to intense upwelling along the southeast coast of Oman, especially in the Ras al Hadd region and resulting in high primary and zooplankton productivity. Dense mesopelagic layers are found near the upwelling areas. During other seasons, the density of mesopelagics decreases by 50 percent (Strømme and Tilseth, 1984; Ashjian *et al*., 2002). An extensive vertical OMZ with concentration of less than 0.3 ml/litre is common in the Arabian Sea at 100–1 000 m depth (Olson *et al*.; 1993; Koppelmann and Weikert, 1997) and mesopelagic fishes were found to be well suited to the OMZ (Gjøsæter, 1977, 1981; Kinzer, Bottger-Schnak and Schulz, 1993).

Biology of Benthosema pterotum[3]

The maximum size of *B. pterotum* is about 6 cm in total length with a weight up to 0.68 g. Most individuals measure less than 3.5 cm long. Males mature at 25 mm long and females at 28 mm. Age at sexual maturity is 4–5 months. Fecundity is around 200–2 000 eggs per female, and females are larger than males. A sex-ratio of 1:1 generally occurs.

Most fish die after spawning, and two year-classes can be produced within a year. Actively spawning individuals occur during all the seasons in the Arabian Sea. Eggs are spawned in depths of 100–300 m and hatch before they reach the surface layer. The fish feed on zooplankton and, in turn, form the major source of food for deep-water and pelagic fish, thus acting as the important link between secondary producers and other higher trophic levels.

Estimates of myctophid biomass in Omani waters

Myctophids form an unfished biomass in Omani waters (Gartner, 1993). However, there are vast differences in the estimates of biomass of myctophids among the surveys, as shown in Table 7.

[3] General sources: Hussain and Ali-Khan, 1987; Gjøsæter and Tilseth, 1988; Dalpadado. 1988; Gartner, 1993; FAO, 1997; Valinassab, Pierce and Johannesson, 2007; NIWA, 2009.

Table 7
Biomass estimates of myctophids in Omani waters

Survey vessel	Period	Area	Biomass *(million tonnes)*
Dr. Fridtjof Nansen[1]	Spring 1975	South Oman	15.0
Dr. Fridtjof Nansen	Autumn 1975	South Oman	17.0
Dr. Fridtjof Nansen	Spring 1976	South Oman	15.0
Dr. Fridtjof Nansen	Summer 1976	South Oman	6.0
Dr. Fridtjof Nansen	Autumn 1976	South Oman	11.0
Dr. Fridtjof Nansen	Spring 1975	Sea of Oman	20.0
Dr. Fridtjof Nansen	Autumn 1976	Sea of Oman	8.0
Dr. Fridtjof Nansen	Spring 1976	Sea of Oman	13.0
Dr. Fridtjof Nansen	Summer 1976	Sea of Oman	11.0
Dr. Fridtjof Nansen	Autumn 1976	Sea of Oman	15.0
Dr. Fridtjof Nansen	Summer 1979	Sea of Oman	8.0
Dr. Fridtjof Nansen	Winter 1981	Sea of Oman	11.0
Dr. Fridtjof Nansen	Winter 1983	Sea of Oman	7.0
Jeng Bang San	1989–1990	Sea of Oman	2.2
Rastrelliger	1990	Sea of Oman	4.0
Rastrelliger	1990	Arabian Sea	0.5
Al Mustaqila 1	2008	Arabian Sea	1.3

[1] Sætersdal *et al*. (1999) questioned the high biomass estimates of this *Dr. Fridtjof Nansen* survey.

Management implications for myctophid exploitation

Although all the reports indicate large biomasses of *B. pterotum* and overfishing may not be a danger, there needs to be caution in harvesting the resource for several reasons. It is presumed that, for now, production of fishmeal and fish oil will be the only product option.

Benthosema pterotum spawns during afternoon–evening hours while migrating to the surface (FAO, 1997) and, hence, fishing at the surface would constantly remove reproductive individuals. Moreover, the potential effect of a *Benthosema* fishery on its ecosystem is poorly understood. By conducting trial fishing, suitable fishing times, seasons, grounds and yields can be determined. As the commercial fishery for myctophids by Iran (Islamic Republic of) – started in 1996 in the Sea of Oman – showed low catch rates, less than 30 tonnes/d that were uneconomic, the fishery appears to not be profitable for the size of the vessel employed. Hence, further trials are needed to identify the best gear and vessel size.

Conclusion

The entire western part of the Sea of Oman appears to have high densities of myctophids. However, before initiating harvesting, especially of *B. pterotum*, several issues must be considered. From the Iranian experience, trial fishing can be undertaken to identify a sustainable harvesting method. Still, there is lack of knowledge on the biology and population dynamics of lanternfishes and what impact the extensive removal of these fishes might have on the biology and population dynamics of species that prey on myctophids.

3.2 Lanternfishes of the Sea of Oman (*T. Valinassab and A. Salarpour*)

The main targeted species is *B. pterotum*. Its biomass has been estimates at 2.3 million tonnes and it is distributed all along the Gulf of Oman. A target of 200–300 000 tonnes was set for the first step of exploitation. The mean length and weight of *Benthosema* in Iranian waters are about 4 cm and 0.34 g.

It occurs in two depth layers: D1 of 100–150 m and D2 of 250–450 m. The fishing grounds are in the northwest region of the Gulf of Oman.

This fish undergoes an upward migration at night and downward migration at dawn. During the day, it separates into two layers – D1 and D2. Large quantities of hairtail (ribbonfish) and purple-back flying squid are taken as bycatch during this fishery. These weigh 4–5 kg. Other bycatch has included *Bathophilus indicus* (Melanostomiinae), *Chauliodus sloani*, *Vinciguerria* sp. (Phosichthyidae), *Harpadon nehereus* (Synodontidae), *Lestrolepis japonica* (Paralepididae), *Bolinichthys photothorax*, *Diaphus garmani*, *Diaphus effulgen*, *Acropoma japonica* (Acropomatidae), *Synagrops adeni*, *Cookeolus boops* (Priacanthidae), *Histiopterus typus* (Pentacerotidae), *Champsodon sagittus*, *Neoepinnula orientalis* (Gempylidae) and *Cubiceps baxteri* (Nomeidae). Otolith studies are also being undertaken.

3.3 Mesopelagic biomass and distribution in Pakistani waters (*M.T. Hanif*)

The mesopelagic depth zone can be defined as the range over which light is extinguished and it usually starts between 200 and 1 000 m. Many mesopelagic species undertake diel vertical migrations to near-surface depths at night; other species remain constantly in the mesopelagic zone. Most mesopelagic species are Stomiiformes, of which the Myctophidae are the globally dominant group. Recently, fish of the families Gempylidae, Nomiedae, Acropomatidae, Bregmacerotidae, Gonostomatidae and Champsodontidae have been found to be frequently associated with the myctophids.

A pelagic survey was conducted in Pakistani waters from 12–31 October 2010 using scientific echo sounders and pelagic trawling to estimate the amount and types of pelagic and mesopelagic fish. Echo-sounder data were scrutinized and classified according to standard acoustic survey practices. Acoustic data were recorded using a Simrad ER60 echo sounder transmitting from drop-keel-mounted transducers at nominal operating frequencies of 18, 38, 120 and 200 kHz. The acoustic data were analysed using only the 38 kHz data.

The data were divided into day/night classes and the intervals when the mesopelagic fish migrated down/up. Based on four different sections the different following parts were defined:

Time of day	From	To	Duration	Transect distance (nm)
DAY	07:30	17:00	09:30	1 054
Migrates down	05:45	07:30	01:45	160
Migrates up	17:00	19:00	02:00	253
NIGHT	19:00	05:45	10:45	1 110
Total				2 577

Mean backscattering values from the EK60 at 38 kHz during daytime, night-time and during the migration are shown in Table 8.

Table 8
Backscattering values during daytime, night-time and migration

Depth (m)	Area	Mean backscatter – Daytime			Migration	Mean backscatter – Night-time		
		Meso	*Plankton*	*Total*	*Meso/ plankton*	*Meso*	*Plankton*	*Total*
< 180	Shallow	2	560	562	2 293	87	2 642	2 729
> 180	Deep	1 465	265	1 730		0	117	117
Total		1 467	825	2 292	2 293	87	2 759	2 846

Table 9 shows the mean S_a for the different strata used during the cruise.

Table 9
Mean S_a by stratum

Stratum	Mean Pel1	Mean Pel2	Mean Mesfi	Mean Plankton
Balochistan Shelf	137	6	156	1 053
Offshore Central	0	0	1 820	2 674
Offshore East	0	0	1 616	1 991
Offshore West	0	0	1 263	2 742
Sindh Shelf	81	9	38	1 565
Means	44	3	979	2 005

The offshore strata contained extensive scattering layers that migrated from mesopelagic depths to within 100 m of the surface at dusk and descended to 300–700 m at dawn. This characteristic of myctophids and other mesopelagic fish was confirmed by trawl sampling of the respective layers.

Summary

The plankton-fish echo marks were evenly distributed over the entire survey area except for shallow inshore regions of approximately 25 m or less. Echoes of mesopelagic scatters were only separate from the plankton-fish mixture at night and were included with the plankton-fish category during the day. As a result, the distribution of S_a classified as mesopelagic is discontinuous, depending on where the ship surveyed by day or night. In spite of this drawback, it is apparent that the mesopelagic biomass is present essentially uniformly over the offshore area. At times, dense clumps of myctophids were observed but there was virtually no mesopelagic biomass on the shelf proper (< 200 m), day or night.

3.4 Discussion

The Iranian experts noted that pair trawling for mesopelagic fishes was being undertaken in their waters but were of the view that single-vessel, stern-trawling was "best". It was noted that Iranian authorities were going to try using a cod-end pump in the future. It was considered that myctophids were suitable for human nutritional requirements but that they did not taste good. Ageing in Iran (Islamic Republic of) was being done with the help of a Polish expert using a daily ring method. Otoliths were polished but without sectioning. In Iran (Islamic Republic of), knowledge existed as to catch rates, bycatch composition and prices and manufacture of fishmeal for these species. Results show that the fishery is commercially viable but there is still no commercial fishery. Their research showed that myctophids lived for from 345 days to one year and matured at age three to five months. However, there was a need to determine their complete life cycle. There was no knowledge as to their stock structure or the existence of subpopulations. In Iran (Islamic Republic of), the distribution of this species appears to be continuous. The fishery has only targeted the D1 layer and has never affected resource abundance. There had been problems with their Simrad EK500 and they had been advised to obtain an EK60. Genetic studies were now being undertaken.

In discussions of the Pakistan paper, it was observed that the acoustic survey used both zigzag and parallel transects. The estimated biomass of mesopelagic resources across the continental shelf was 2 000 000 tonnes. More biological information was needed, e.g. What was driving the vertical movements? Were there seasonal changes in availability? What was the oxygen concentration in the waters they inhabited and where was the thermocline? All good questions. It was the Iranian view that the answers were available to these questions. The issue of the ecological dependence on myctophids by prey species was raised. For example, might the distribution and abundance of myctophids affect tunas? And, what is the role of *Benthosema* in the local ecosystem? Were there other species that were dependent on this fish? It was the Iranian view that many fish species feed on the myctophids at night. As the myctophids are zoophagous, they follow the plankton towards the surface at night. Their view was that squid feed on the myctophids and tunas feed on the squids.

3.5 Recommendations

Background

There was a realization that the three respective countries held considerable information on the behaviour and biology of myctophids in the northwest Arabian Sea and that much survey information had also been collected along with considerable trial commercial-fishing results. For this reason, it was agreed that there would be benefits from a dedicated effort to document this existing information.

Proposal

It was proposed that a consultant, ideally a person who was directly involved in some aspect of this fishery, should be recruited to visit the three countries to document all available information. This information should be compiled into a single report for discussion and evaluation by a regional working group consisting of approximately two people from each participating country.

Data to be collected

- species composition and relative abundance of mesopelagic fishes in the northwest Arabian Sea;
- records of observations of the behaviour of myctophids – specifically, their diel and season movements;
- records of times and places of spawning; relative strength of spawning;
- information on their fisheries biology – size, size at maturity, sex ratios, mortality rates, growth rates, estimates of management and fishery population parameters;
- information on their ecological role as a prey species – their importance to regional predators; ecosystem implications of a fishery targeted on these fishes;
- factors affecting/determining their abundance, especially oceanographic factors (strength of upwelling, position of the intertropical convergence zone, etc.);
- information on stock/population structure;
- size and sex frequency information;
- results from commercial fishing feasibility trials; and
- bycatch rates and related information.

The data workshop would be held at a regionally convenient location.

4. SHARED LARGE PELAGIC AND RELATED RESOURCES INCLUDING SHARKS AND LARGE MACKERELS

4.1 Status of shared stock fishery of kingfish (*Scomberomorus commerson*) (*F. Al-Kiyumi*)

The kingfish (*Scomberomorus commerson;* Scombridae) is distributed throughout Indo-Pacific waters and the Mediterranean Sea. It performs long-shore migrations of up to 1 000 nm and grows to a maximum fork length (FL) size of 240 cm and a maximum weight of 70 kg. The commercial importance of kingfish is well known throughout its range of distribution, including the GCC countries. However, the kingfish fishery is not currently managed properly in these waters where there is growth-overfishing and recruitment failure as a consequence of the intense harvest of immature fish. In Oman, the catch peaked at 27 834 tonnes in 1988 and then dramatically decreased to 2 559 tonnes in 2001. Information on biology and stock characteristics of the species is available for this species in Omani waters from a number of authors.

There were many grounds to justify this study: (a) there is no stock assessment on a regional basis; (b) a large database of length frequency (33 232 measurements) is available for Saudi Arabia, Kuwait, Qatar, Bahrain, United Arab Emirates and Oman that has been collected through the regional project; (c) a recent genetic study in the sea area of the Regional Organization for the Protection of the Marine Environment suggests that the fishery is supported by a single stock in the region; and (d) there is a need for stock assessment on a regional basis to enable effective management of the stock.

It has been assumed that the length data of fish caught by all gear in the Persian Gulf, Sea of Oman and Arabian Sea are representative of the population of the fishery in the study area. Parameters of the length–weight relationship were taken from a previous study in the region, and fork length at first maturity (L_m) was approximately 80 cm. Fifteen sampling sites were located along the coastline of the GCC countries (Kuwait, Saudi Arabia, Bahrain, Qatar, United Arab Emirates and Oman).

The length frequency data used for analyses were collected between January 2004 and December 2006 on a monthly basis through the GCC Kingfish Monitoring Programme by the respective member states. The fork length was measured to the nearest 1 mm, and 33 232 fish caught by drift gillnets, set gillnets, hand lines and trolling lines were measured. Fish length ranged from 21 cm to 170 cm FL and lengths were pooled in 10 cm size groups for stock assessment. All data were pooled to study the stock status of the fish in the Persian Gulf, Sea of Oman and Arabian Sea.

Table 10
Kingfish catches in GCC countries and estimated percentage of immature fish in the landings

Country	Total catch (tonnes)	Immature (%)
Saudi Arabia	5 432	46.91
Bahrain	107	81.31
Qatar	1 810	85.25
United Arab Emirates	4 768	79.01
Oman	3 167	42.19
Kuwait	105	–
	15 389	60.31

To determine the contribution of immature fish to the total fish catch in the respective countries, the mid-length of each size group was converted to a corresponding weight using the length–weight relation:

$$Wt = 0.0076\ L^{2.9826}$$

Total weights of immature fish measuring less than 80 cm were pooled. Ninety percent of samples were taken from the Arabian Sea and the majority of fish were less than the L_m. Table 10 lists catch and contribution of immature fish to landings.

Growth parameters were estimated as L_∞ = 183 cm; K = 0.4 per year; t_o = -0.76 per year and the growth performance index (ø) as 4.13. Estimates of other population parameters were as follows:

Parameter	Value
Length at first capture	63 cm
Total mortality (Z)	1.59 (SE=0.025)
Natural mortality (M)	0.5
Fishing mortality	1.09
Exploitation rate (E)	0.69
Exploitation ratio (U)	0.546
Yield	15 389 tonnes (av. 2004–06)
Maximum sustainable yield	11 224 tonnes

Estimation of optimum fishing mortality rate showed the following:

Biological reference points	Estimate
F_{opt}	0.5
Y_w/R at the current fishing mortality	2.95 kg
Y_w/R at F = 0.5	3.24
SSB at the current F	11.4 percent
SSB at F = 0.5	27.8 percent
Optimum length at capture (L_{opt})	111.7 cm (95 percent CI of 100.6–124.1 cm)

It was found that the average length at capture (L_c) of 63 cm is well below the length at first maturity reported from earlier studies in the region, although age and growth parameter assessments of kingfish in the western Indian Ocean using length frequency and otoliths have resulted in varied estimates of growth rates, mortality rates and longevity. The present length data analyses clearly indicated growth and recruitment overfishing, suggesting the need for effective regional regulatory measures as soon as possible. Experiments on gillnet selectivity with 110 mm stretched mesh captured about 58 percent of fish below length at first maturity. Increasing the mesh size to 120 mm, 130 mm and 140 mm resulted in the capture of 41 percent, 27.5 percent and 15 percent of immature fish, respectively.

Our preliminary results for various fishery biological parameters have led to the following conclusions:

- The kingfish stock in the Persian Gulf is showing severe stress.
- The drift/set gillnet fishery requires regulation by the management authorities and appropriate management measures to stop growth-overfishing.
- Large quantities of immature fish are landed by the member countries.
- The average length of fish caught (63 cm FL) is lower than the length at first maturity (≈ 80 cm FL) of the species.
- Fishing mortality (F = 1.09 per year) is higher than natural mortality (M = 0.5 per year); the high exploitation rate (E) of 0.69 indicates overexploitation of the resource.
- The average annual yield (15 455 tonnes) is higher than the MSY of 14 771 tonnes for GCC countries.
- Biological reference points indicate the need for reducing fishing mortality through conservation regulations.

As the kingfish fishery is from a single stock in member countries, the following may be considered for regional benefit:

- Kingfish are highly migratory but little is known about their migration and spawning in GCC waters. Hence, a tagging programme should be undertaken.
- A cooperative monitoring programme should be started in all regional countries.
- Existing studies can inform on changes to permitted gillnet mesh sizes. If needed, additional studies should be initiated on an urgent basis.
- The GCC meeting held in Oman in February 2010 proposed setting the minimum landing size at 65 cm (FL).

4.2 Sharks fisheries and their trade in the Persian Gulf and Sea of Oman (*T. Valinassab*)

The Gulf of Oman has depths up to 3 200 m, a salinity = 35‰ and a water temperature of 32 ºC. It extends from 56º30'E to 61º25'E. At least 40 species of shark are known to occur in this body of water. The main species of commercial interest are the white cheek shark (*Carcharhinus dussumieri*), the spottail shark (*Carcharhinus sorrah*) and the milk shark (*Rhizoprionodon acutus*).

Sharks are processed as fillets for domestic consumption; dried and salted mostly in the east of the Gulf of Oman in Sistan-o-Baluchistan and exported to Pakistan without any control; used by some factories as raw material for fishmeal; finned and the fins dressed and dried by fishermen for export first to the United Arab Emirates.

Landings of sharks peaked in 2005 and have since declined as indicated in Table 11.

Table 11
Reported Iranian landings of sharks

Year	Landings *(tonnes)*
1998	8 221
1999	7 920
2000	9 005
2001	8 976
2002	8 071
2003	11 689
2004	13 298
2005	14 086
2006	13 516
2007	11 821

Fishing methods to catch sharks are bottom and drift gillnets, bottom trawl (taken as bycatch) and trolling – a few dhows use this gear. The bycatch in the trawl fishery in the Gulf of Oman was less than 1.1 percent during the period 2002–05.

Resource management

A six-month closed season for sharks exists from March to August. In the Persian Gulf, the ban on bottom trawlers, introduced in 1993, continues. Monthly catch statistics are collected in all areas to determine trends in catch and changes of fishing effort. The fishing season for bottom trawlers in the Gulf of Oman is to be decreased from 11 to 8 months and then to 135 days – this process started in 1998 and continues to date. Efforts are made to determine the standard mesh size of gillnets by the Iranian Fisheries Research Organization (IFRO) to decrease the catch per unit effort (CPUE) and to encourage catching of fishes bigger than the L_{M50}. The trawl vessel fleet size will be decreased from 69 to 38 to reduce exploitation of demersal stocks.

4.3 Assessing shark stock delineations and movements in the Arabian Sea (*A.C. Henderson*)

The importance of sharks and rays in Omani fisheries was noted and thus the need for research on their dynamics. This importance arose from: (a) their monetary value; (b) their ecological importance; and (c) there being a potential source of bioactive compounds. For this study, shark fishermen were interviewed, data were collected from landing sites, including the purchase of specimens for dissection, and the project's own longlines were used to sample areas beyond the range of the local fishery.

The first shark project was from 2001 to 2004. It determined what species occurred in Omani waters, ascertained the distributions of the various species, and assessed the biology of the most common species. In addition, the study facilitated establishing a management plan for the shark fishery. The project confirmed the presence of 46 species of elasmobranchs in Omani waters and included two new species of guitarfish. It also extended the known range of some species, e.g. the Galapagos shark.

Important species in Omani waters are: milk shark *(Rhizoprionodon acutus*) – 47 percent; bigeye houndshark (*Lago omanensis*) – 11 percent; spottail shark (*Carcharhinus sorrah)* – 11 percent; slit-eye shark (*Loxodon macrorhinus*) – 6 percent; scalloped hammerhead (*Sphyrna lewini*) – 5 percent; blacktip shark (*Carcharhinus limbatus*) – 4 percent; and silky shark (*Carcharhinus falciformis*) – 4 percent. Analysis of catches showed important variations in abundance for different regions of the Omani coast and in different seasons.

Shark Project II (Henderson, Al-Oufi and McIlwain, 2008) has been running since 2009 and involves an assessment of shark population movements, stock delineations and breeding grounds in the Sultanate of Oman. It is funded by the MFW. Tagging studies have been undertaken using pop-up tags and traditional dart tags. Genetic analysis has involved microsatellite markers using short tandem repeats in nuclear DNA. Some DNA extracted from tissue microsatellite markers amplified with polymerase chain reaction (PCR) amplicons either scored on a gel (electrophoresis) or sequenced has been analysed. The main drawback is the development of primers. The study's focus is on species for which molecular markers have already been identified. Study species include the blacktip shark (*Carcharhinus limbatus*), bull shark *(Carcharhinus leucas*), spottail shark (*Carcharhinus sorrah*), scalloped hammerhead shark (*Sphyrna lewini)*, silky shark (*Carcharhinus falciformis*) and milk shark (*Rhizoprionodon acutus*).

4.4 Estimating fishing and natural mortality from female to embryo ratios: a model for the *Rhizopriodon acutus* fishery of Oman (*A. Govender and A. Henderson*)

Shark fisheries are important in Oman. In 1999, 780 tonnes were taken and, in 2007, 477 tonnes – a considerable decline. Forty-four species occur in the commercial catch, of which the milk shark is in the top eight species harvested. The traditional fishery takes 96 percent of the shark catch.

An age-structured model has been developed to assist in the management of the milk shark resource. It predicts the number of embryos a single milk shark would produce throughout her life time. Outputs include *M* (natural mortality) and *F* (fishing mortality) and an overall embryo–female ratio (of surviving females), which is then used to determine the status of the stock.

The main assumptions of the model are that when fecundity increases with age, (a) the selective removal of older individuals would result in a higher overall embryo–female ratio in the catch (targeting of larger individuals), but (b) a lower ratio in the surviving population because smaller individuals dominate, and that (c) milk sharks pup every year. In the case of milk sharks in Oman, these assumptions are reasonable and applicable to the model.

From observed data, it was shown that milk sharks produce one embryo a year at age one increasing to 4.5 embryos at age seven. The input parameters of the model include:

- female ages;
- selectivity-at-age;
- maturity-at-age; and
- embryo–female ratios at age (from the catch).

The model:

- predicts the survival of females and, hence, the number of embryos surviving;
- predicts the number of embryos "lost" because of females being caught; and
- optimizes the *M* and *F* that best predict the overall female–embryo ratio in the catch.

Age-specific mortalities (linked by an average *F* using a selectivity function) for females are used in the population-at-age equation. Estimates of 0.28 per year for *M* and 0.08 per year for *F* have been obtained. A preliminary stock assessment has shown that milk sharks in Oman are optimally exploited. The milk shark population is assumed to be resilient because it has an early maturity, short life span and fast growth, which is atypical of most shark species.

4.5 Recommendations

4.5.1 Kingfish

Background

Kingfish are highly valued for their fisheries by all three countries participating in the Muscat Workshop. There were valid concerns that the resource is suffering from growth-overfishing. In addition, as much of the regional kingfish catch consists of immature, or barely mature, individuals, there was concern that recruitment-overfishing may also be occurring. Little firm information was available to inform on the migratory patterns of this species or whether there were specific spawning and nursery areas.

The GGC countries had recognized the need for a regional programme to address the issues of management of this shared stock, and a substantial programme had already collected much information. However, it was realized that knowledge was needed of the resource characteristics in Iranian waters, as Iranian harvesting was almost certainly of the same stock/stocks.

The meeting recognized the competence of the IOTC over “tuna-like” fishes in the Arabian Sea but noted that inevitably the focus of the IOTC was on management of tunas and that this was the primary concern, especially of the major distant-water fishing countries. The resource-adjacent nations, on the other hand, had additional priorities and these rarely received the necessary attention by the IOTC. For this reason, the meeting was of the view that a kingfish working group, perhaps functioning in conjunction with the Regional Commission for Fisheries (RECOFI) was needed. It was noted that an appropriate membership of such a working group would involve countries that were not members of the IOTC (e.g. most GCC countries), not members of RECOFI (e.g. Pakistan) and in some cases, not a member of either regional fisheries management organization (RFMO, e.g. Yemen).

Proposal

It was proposed that a working group be established, if possible in collaboration with the RECOFI, to address regional issues arising from the kingfish fishery. A research programme would need to be established to identify/re-confirm the management requirements and define a technical programme of work. This programme would supplement and complement the existing kingfish research programme of the GCC countries. It is anticipated that this programme of work, to be identified by the working group, would include the following:

- a review of the benefits from a collaborative programme of genetic studies of kingfish;
- an extended programme of length frequency analyses of catches and particular attention to the timing of landings of catches of this species by the regional countries – to investigate the regional migration patterns;
- a review and research of factors determining the abundance; and
- other relevant aspects of its population biology.

The working group should convene in a regionally convenient location.

Organization

In the first instance, the FAO regional fisheries officer in Cairo should be requested to undertake the arrangements for the first meeting of the working group. The collaboration and involvement of the IOTC should also be sought.

4.5.2 Sharks

Background

Presentations at the Workshop emphasized the current importance of shark fisheries in the region and also, with rare exceptions, the vulnerability of these fishes (and also of the batoids) to fishing both as targeted and as bycatch species. There was concern that elasmobranch species may be becoming depleted, unnoticed by fisheries managers. Moreover, the taxonomy of these fishes could be difficult, which exacerbates their management problems. None of the countries in the regional appeared to have satisfactory shark management plans. Nor was there any working group explicitly addressing the problems of the elasmobranchs in general, although it was noted that the IOTC was addressing shark issues, but in relation to bycatch in tuna fisheries.

Proposal

It was proposed that a working group be established, if possible in collaboration with the RECOFI, to address regional issues relating to elasmobranchs and their fisheries. A research programme would need to be established to identify/re-confirm the management requirements and define a technical programme of work. It is anticipated that this programme of work, to be identified by the working group, would include the following:

- a review of the most important taxonomic issues of this group;
- a review of particular elasmobranch conservation problems;
- an assessment of the possible benefits of a tagging programme and the elements of its execution;
- an assessment of the need to revise the FAO species identification guides for this area; and
- other relevant aspects of their population biology and fisheries management.

The working group should convene in a regionally convenient location.

Organization

In the first instance, the FAO regional fisheries officer in Cairo should be requested to undertake the arrangements for the first meeting of the working group. The collaboration and involvement of the IOTC should also be sought.

5. SMALL PELAGIC RESOURCES, DEMERSAL RESOURCES AND OTHERS

5.1 Small pelagic fisheries resources of the Sultanate of Oman *(S. Zakialdeen Abdul Haleem)*

Small pelagic species are important in the marine food chain and many large pelagic fishes, such as kingfish and tunas, depend on them for food. This implies a high natural mortality (*M*), which has to be considered. Thus, a balance is required between the amount of fish taken out of the ocean and how many fish are to be left to maintain trophic links in the ecosystem.

The prominent species/groups that contribute substantially to the small pelagic catches of Oman are mainly various sardines, anchovies, scad, mackerel and mullets. Of these, the Indian oil-sardine (*Sardinella longiceps*) and Indian mackerel (*Rastrelliger kanagurta*) are the dominant species. These are taken by cast net, gillnet and encircling net. Sardine and mackerel have short life spans, and fluctuations in their abundance depend on their spawning success, which is primarily fishery independent depending on physical, chemical and biological oceanographic variables as well as fishery-dependent parameters. A pilot study on sardine fishery was initiated in 1985, and in 1987–1990 further research on sardine was conducted by scientists from Oregon State University. Then, in 2007–09 further biological and stock assessment data were collected. The aim of the project was the development and management of the small pelagic fishery to MSY level in Oman. The project focused on the three important small pelagic fishes – Indian oil-sardine, Indian mackerel and scad (*Decapterus russelli*) – and examined their biology and population characteristics and undertook stock assessments.

Past survey results of small pelagic fishes in Oman are presented in Table 12.

Table 12
Estimates of biomass of small pelagic species in Omani waters

Survey	Biomass		
	Gulf of Oman	Arabian Sea (tonnes)	Total
Dr. Fridtjof Nansen (1975–1976)	17 400 000	2 456 000	19 856 000
Lemaru (1977–1978)	8 000 000	6 200 000	14 200 000
Rastrelliger (1989–1990)	45 533	206 749	252 282
Al Mustaqila 1 (2007–2008)	–	1 926 198	1 926 198

Table 13 shows the abundance by species collected by the *Al Mustaqila 1.*

Table 13
Biomass of small pelagic resources from the Arabian Sea (NIWA survey of 2007–08)

Species group	Biomass (tonnes)
Scads	1 368 780
Sardine	330 848
Clupeids	160 389
Anchovies	66 182

Indian oil-sardine occurs in abundance in Omani waters and those of Iran (Islamic Republic of), Pakistan, India and Yemen. It forms the largest single fishery in Oman in terms of volume (Dorr, 1991). *Sardinella gibbosa* and *Sardinella sindensis* are also seen in the catch but in small quantities. Indian oil-sardine contributes on average 80 percent of the total small pelagic landings in the traditional fisheries. Landings of Indian oil-sardine have shown some fluctuation but there has been a clear declining trend in their catch. The sardine fishery has two different markets:

- dried on beaches (sun dried);
- wet (fresh for human consumption).

Shaklee and Shaklee (1990) indicated the existence of only one stock of *Sardinella longiceps* in the Gulf of Oman and Arabian Sea. This stock is not confined to the waters of any particular country but is shared by the neighbouring countries.

In 2009, 23 percent of Omani landings (36 602 tonnes) with a value of OMR9.8 million were landed. This was an increase of 9 percent over the previous year. Of this, 20 990 tonnes were exported and 15 312 tonnes were consumed locally. Catches since 2000 have been much lower than those prior to this date but have been generally stable at this lower level. Catches have been stable in the Gulf of Oman but have increased in the Arabian Sea. Industrial trawlers do not target these fish and their catches of these species are negligible.

The fishery for *R. kanagurta* in Oman is, compared with that for *S. longiceps*, moderate. In 2009, total landings were 10 986 tonnes, worth OMR6.4 million. The increase in catch over 2008 was 22 percent. This species inhabits shallow waters and has a life span of three to four years. Updated information on the biological parameters, stock structure, population dynamics and stock assessment of this species is soon to be available from ongoing research in Oman. Fish length at 50 percent maturity ($L_{50\%M}$) is about 26 cm for both males and females. During the collection of samples of Indian mackerel, specimens of possibly *Rastrelliger brachysoma* have been collected from Mahout. They resemble Indian mackerel but have a deeper body. Morphological, morphometric and anatomical characters have been recorded.

Stock identification and stock structure with mitochondrial DNA analysis is a prerequisite for understanding the stock structure of this fish. Updated information on the biological parameters, population dynamics and stock assessment is soon to be presented from the ongoing research project in Oman. A marketing strategy for small pelagics is needed as excess catch is now used as cattle feed – a low-value use.

5.2 Coastal small pelagics in Pakistan (*M. Moazzam Khan and M. Wasim Khan*)

The fishery for small pelagics species in Pakistan targets sardinellas (*S. albella*), *Thryssa setirostris*, *Stolephorus commersonii* and Indian mackerel. Catches have been rather stable since 1999. Harvesting is done from open-decked wooden boats (katras) with long-shaft outboard motors and slightly larger horas/rachins. These boats have a crew of around seven. Most fishing is in shallow waters using surround nets.

The exploitation is below estimated MSYs. Mean catch per tow is shown in Table 14.

Table 14
Mean catch per standard tow (i.e. 1.75 nm)

Species	kg
Dussumieria acuta	4.504
Thryssa vitrirostris	54.039
Thryssa dussumieri	26.453
Sardinella sp.	12.024
Sardinella albella	0.358
Sardinella gibbosa	1.393
Sardinella longiceps	0.287
Sardinella sindensis	0.050
Thryssa sp.	
Thryssa hamiltonii	0.009
Thryssa setirostris	0.241
Clupeidae	
Ilisha sp.	2.555
Ilisha melastoma	0.149
Stolephorus sp.	0.185
Stolephorus indicus	0.003
Total	102.249

5.3 Discussion

The reason for the 75 percent decline in landings of Indian mackerel after 1999 was raised. The only explanation was that some form of regime shift had occurred but no hard information was available. Several participants noted that the dominant *Sardinella* species in the area was *S. sindensis* and not *S. fimbriata*. This would probably be the consequence of an ecological change rather than a fishery effect.

Differences were noted in the size at maturity of *S. fimbriata* around the region. In India, size at maturity was 22 cm while it was 29 cm in Oman. Some participants were of the view that genetic analysis would be needed to separate breeding populations of this species. However, it was expected that *S. fimbriata* in the Arabian Sea consisted of a meta-population that would show a trend in characteristics along much of its range. An analysis of population variability and/or structure might be accomplished with a regional meristics programme that measured trends in these characteristics around the northwest Arabian Sea. Any such differences may be caused by physical factors as much as real genetic differences. It was noted that such comprehensive studies had been done in Pakistan. There, it was found that some species were common to specific areas. In Pakistan, the top predators had been removed from the ecosystem and now *R. kanagurta* could be found up to 700 g, in which case they looked like small tunas. Their main breeding area had been found to be in eastern Pakistan.

Fishing for this species was mainly by beach seine, but beaches were being taken over by hotels, etc., and there was a need to find a compensating mechanism for fishermen who became excluded from their usual fishing grounds. In addition, there were historical changes in landing sites. *S. fimbriata* was considered a good eating fish and was used for bait and for human consumption in Pakistan when large sizes dominated the catch. Traditional management methods had proved best for their management. Fishing around major urban centres in Pakistan is prohibited – to conserve the resource.

In Pakistan, an encircling “Kutaran” net was used but it has been banned in Sind Province. The fishery is seasonal and no other species were caught at this time. A gillnet fishery for Indian mackerel was also undertaken. Monofilament nets were banned as were encircling nets because people mistakenly thought that they caught other fishes. However, this type of fishing was not harmful as the fishery was undertaken in shallow waters and was monospecific. The catch was mainly used for fish meal. Indian mackerel were exported frozen.

It was noted that the Iran Fishing Company was using vessels for paired purse seining and that they operated up to 400 m from shore. It was thought that this expertise could be transferred to other countries in the region. Catch composition was also changing in Iran (Islamic Republic of), with *S. sindensis* now the dominant species and not *S. fimbriata*. The next programme was intended to find schools of small pelagics in the offshore waters and would involve a two-year survey. The IFRO was also undertaking icthyo-plankton studies. Most sardines (95 percent) were converted into fishmeal and prices had been low for 10–15 years, so there had been little interest in fishing this species. However, good prices were now being obtained.

In India, a project had started to research three species, one of which was Indian scad, but regular biological observations had not been obtained. It was thought that a biomass of 5–6 million tonnes existed. There was little interest in Indian oil-sardines, which implied that there was a marketing problem. Biomass estimates were based on the fished biomass rather than a survey biomass. Research was market-driven. The fishery used ≈ 300 small pelagic purse seiners and ≈ 700 trawlers.

In discussions on the assessment of demersal stocks, the point was made that CPUE is a better indicator of stock status that stock biomass, as indicated by trawl surveys. A complication with this estimator is deciding on the correct survey availability of the fish. Iranian practice is to use a value of 0.5 but it is known that the behaviour of different species varies and that it also depends on the season and many other variables. A preferable alternative is the CPUA. The CPUE was found to be more variable in shallow waters but the behaviour of different species is different. A further requirement was that during surveys the trawl wing spread must be kept constant.

One experience recounted for Oman was that variability of abundance also varied among species. For example, different species of *Lutjanus* changed their apparent abundance differently – pomfrets were decreasing in abundance, lizardfish were increasing in abundance. Together with this, there has been a deterioration in the quality of the marine ecosystem with an increase in opportunistic species. This is creating a marketing challenge to use species otherwise discarded. In Pakistan, previously low-valued catfish now fetches good price and is exported to Bangladesh.

In discussions relating to sharks, it was noted that growth rings on skeletal parts of sharks were clear and facilitated ageing.

5.4 Recommendations

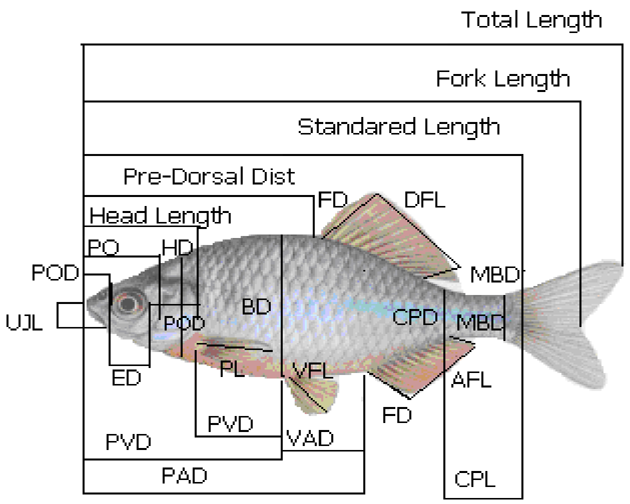
Background

It was agreed that a small pelagic species be chosen for cooperative research, with joint genetic studies to determine the number of stocks in the region. Such a programme could be first implemented using simple landing-site sampling methods and meristic analyses of the sample – this should be cheap and easy to do. Each country could design a field sampling programme to identify species and time of spawning and to measure morphometric data on at least an annual cycle using a common protocol – this should result in a good data set. Data to be collected would include fin ray counts, body dimensions and macroscopic examination of gonads. Table 15 indicates the information that could be collected.

It was agreed that such a study would be well qualified for funding through FAO's Technical Cooperation Programme, or by an interested donor, given the programme's direct implications for regional food security. The Secretariat was asked to prepare a proposal for presentation to FAO through the fisheries officer at the regional headquarters in Cairo.

Table 15
Relevant information to be collected through a regional stock-analysis sampling programme of fish morphometric and meristic data

Sheet No:	**Sample ID:**
Country:	**Location of catch:**
Date of Collection:	**Date of analysis:**
Genus:	**Species:** **Sex:**



HD Head depth
BD Body depth
FD Fin depth
ED Eye diameter
PO Pre-opercle
PL Pectoral length
UJL Upper jaw length
MBD Minimum body depth
CPD Caudal peduncle depth
DFL Dorsal fin length
AFL Anal fin length
VFL Ventral fin length
CPL Caudal peduncle length
VAD Ventral anal distance
PVD Pectoral ventral distance / pre-ventral distance
POD Pre-orbital distance
PAD Pre-anal distance

S.N.	Details	mm	S.N.	Details	mm
1	Total length		19	Dorsal fin depth	
2	Standard length		20	Anal fin length	
3	Fork length		21	Anal fin depth	
4	Head length		22	Ventral fin length	
5	Pre-opercle length		23	Pectoral fin length	
6	Head depth		24	Caudal fin length	
7	Pre-orbital distance		25	Tail spread	
8	Post-orbital distance		I.	No. of dorsal fin spines	
9	Eye diameter		II.	No. of dorsal fin soft rays	
10	Upper jaw length		III.	No. of anal fin spines	
11	Body depth		IV.	No. of ventral fin spines	
12	Caudal peduncle depth		V.	No. of ventral fin rays	
13	Pre-dorsal distance		VI.	No of pectoral rays	
14	Pre-ventral distance		VII.	No of dorsal finlets	
15	Pectoral-ventral distance		VIII.	No. of anal finlets	
16	Pre-anal distance		IX.	No. of lateral line scales	
17	Ventral-anal distance		X.	Gill raker count 1st arch lower limb / upper limb	
18	Dorsal fin length		XI.	Pelvic scutes Pre-pelvic / post-pelvic	

Proposal

Support should be solicited to fund a programme of collection of samples of *Sardinella fimbriata* in the coastal countries of the Arabian Sea. The core countries in the programme would be Iran (Islamic Republic of), Oman and Pakistan. As a proposal for discussion, samples of 100 fish could be collected at beach landing sites on a weekly basis throughout the period of the fishery. A number of sites (≤ 10) could be selected for each country. Meristic counts and morphological measurements would then be collected following the guide provided in Table 15. The funding that is being sought should facilitate the entry of data into an appropriately designed database. Each country would analyse its data according to a pre-agreed manner for national publication. Then, a workshop would be held to synthesize the data for a regional analysis and publication. The programme should be designed, negotiated and in place to start at the beginning of the fishing season for this species.

Organization

In the first instance, the FAO regional fisheries officer in Cairo should be requested to investigate how a first meeting of the Small Pelagics Working Group might be arranged. This officer should also be asked to prepare a regional Technical Cooperative Project (TCP) for funding. The primary objective of the TCP would be to facilitate the collection of data relating to the small pelagic fishes, as proposed, on a regional basis, enable the data to be analysed and undertake the preparation of an appropriate report.

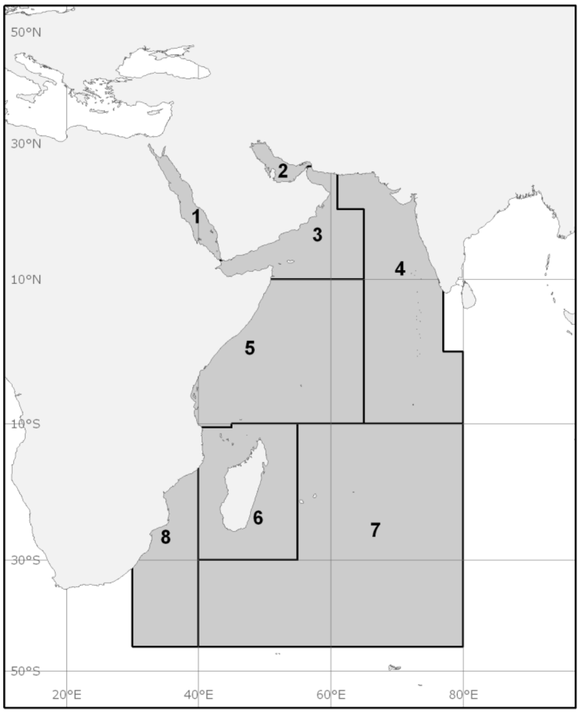
6. CONSIDERATIONS RELATING TO CREATION OF A REGIONAL FISHERIES MANAGEMENT ORGANIZATION FOR THE ARABIAN SEA (*R. SHOTTON*)[4]

6.1 Background

The Arabian Sea (Figure 1) forms a somewhat discrete marine area bordered to the north by the coasts of Iran (Islamic Republic of) and Pakistan, to the west by the coast of Oman and the Al Mahra and Hadramout Governorates of Yemen. To the southwest, the northern coast of Somalia may also be considered as delimiting this sea. To the east, the western coast of India provides the final coastal boundary. The Arabian Sea is continuous with the Gulf of Oman[5] and receives a deepwater warm saline water intrusion that moves southeastward across the sea. It is also continuous with the Gulf of Aden and thus the Red Sea, from which it also receives a deepwater warm saline water mass intrusion. To the south, the Arabian Sea is continuous with the Indian Ocean.

The Arabian Sea is oceanographically active. It is subject to upwelling from both the northeast and southwest monsoons, with the result that areas of productivity as high as any found in the world exist during periods of strong upwelling.

Figure 1
FAO-reported catches statistical subareas for the western Indian Ocean



[4] The views expressed in this section are solely those of the author and have not been approved or endorsed by any person or agency.
[5] Generally referred to as the Sea of Oman by Iran.

6.2 Fisheries of the Arabian Sea

A simple description of the reported fish catches of the Arabian Sea is complicated by the aggregation of fish catches by FAO into a western Indian Ocean area – FAO Reporting Area 51 (Figure 1) – in their reports although reporting subareas exist. It is not known how to access disaggregated data on the basis of these subareas.

The area is characterized by rather narrow continental shelves, perhaps with the exception of the waters around Socotra Island. Thus, the major fisheries of interest are for pelagic species, both small pelagic fishes, primarily Indian oil-sardine, medium-sized pelagic species (e.g. *Scomberomorus* spp.) and a variety of large tunas, especially skipjack (*Katsuwonus pelamis*), longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis*) and yellowfin (*Thunnus albacares*). The deep waters of the Arabian Sea are also home to major concentrations of myctophid species, primarily *Benthosema pterotum*. Bycatch associated with fisheries that have targeted this species includes squids and cutlassfish (*Trichiurus lepterus* spp.)

Countries reporting landings in recent years from FAO Area 51 that probably fish in the Arabian Sea include: China, France, India, Iran (Islamic Republic of), Italy, Japan, Oman, Pakistan, Republic of Korea, Seychelles, Somalia, Spain, Taiwan Province of China, Thailand and Yemen.

Total reported fish landings in the FAO database by coastal countries of the Arabian Sea in 2008 are shown in Table 16.

Table 16
FAO reported landings by Arabian Sea States, 2008

	Landings, 2008
	(tonnes)
India	2 065 809
Iran (Islamic Republic of)	341 980
Oman	145 631
Pakistan	343 414
Somalia	29 800
Yemen	127 132

Note: These figures include landings in the Persian Gulf (Iran [Islamic Republic of]) and Red Sea (Yemen). Yemeni data are at times estimated by FAO.

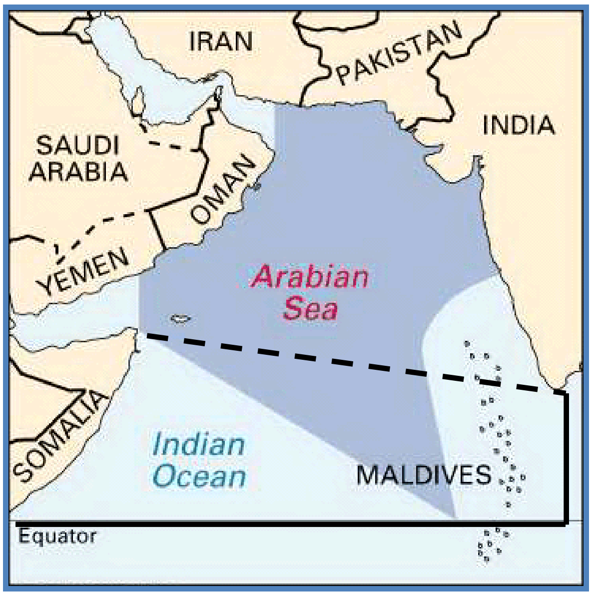
6.3 Regional governance of fisheries[6]

6.3.1 Existing arrangements

There are two regional organizations for international cooperation in the management of fisheries in the Arabian Sea area (Figure 2) area. One of these, the RECOFI is an FAO Article 14 organization, i.e. an organization with the capacity to establish fisheries management regulations. Its area of mandate includes the Gulf of Oman and coastal regions of Omani waters in the Arabian Sea. However, the focus of its membership is in the Persian Gulf: Iran (Islamic Republic of) and Oman (and the United Arab Emirates to a minor extent) are the only members that have marine areas outside of this region. The second of these is the IOTC, another FAO Article 14 organization. Its mandate is strictly for tuna and tuna-like species. No RFMO exists for management of other fisheries in the Arabian Sea, and in this context the Arabian Sea remains one of the few and diminishing number of high seas areas in the world for which no regional arrangement exists with the mandate for management of high seas fisheries and related marine environmental affairs

[6] Much of this material has been taken from Rogers, Warner and Lugten (2010).

Figure 2
Arabian Sea area
Note: The two superimposed lines show possible closing limits.



The following sections provide some detail on existing high seas arrangements for the Indian Ocean in order to provide some background for considerations in regard to the needs for and possible mandate of an RFMO for the Arabian Sea.

6.3.2 The Indian Ocean Tuna Commission (IOTC)[7]

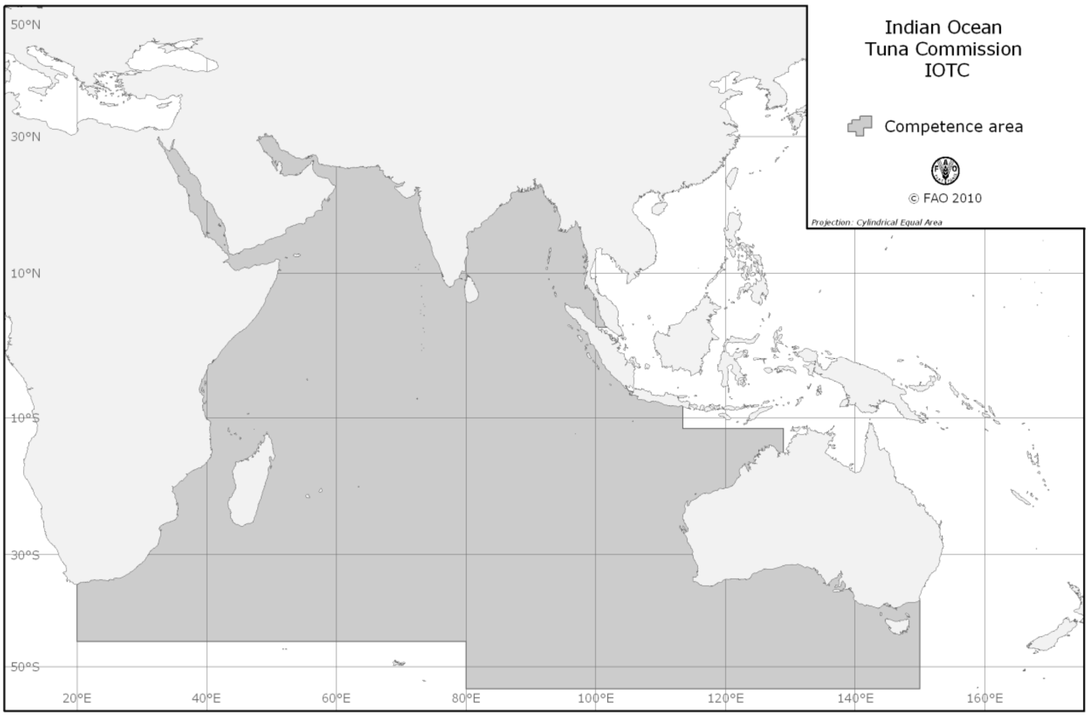
The IOTC is an intergovernmental organization mandated to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. Its objective is to promote cooperation among its members with a view to ensuring, through appropriate management, the conservation and optimum utilization of stocks and encouraging sustainable development of fisheries based on such stocks.

The IOTC was established in 1993 under Article 14 of the FAO Constitution and entered into force in March 1996. Its area of competence (Figure 3) is the Indian Ocean and adjacent seas, north of the Antarctic Convergence as far as necessary to cover such areas for the conservation and management tuna and tuna-like species that migrate into or out of the Indian Ocean. This area coincides with the FAO Statistical Areas 51 and 57 and includes high seas and zones of national jurisdiction.

The members of the IOTC are: Australia, Belize, China, Comoros, Eritrea, European Community, France, Guinea, India, Indonesia, Iran (Islamic Republic of), Japan, Kenya, Madagascar, Malaysia, Mauritius, Oman, Pakistan, Philippines, Republic of Korea, Seychelles, Sierra Leone, Sri Lanka, Sudan, Thailand, United Kingdom, United Republic of Tanzania and Vanuatu. Senegal, South Africa and Uruguay are cooperating parties.

[7] IOTC Web site: www.iotc.org/English/index.php.

Figure 3
Area of competence of the IOTC



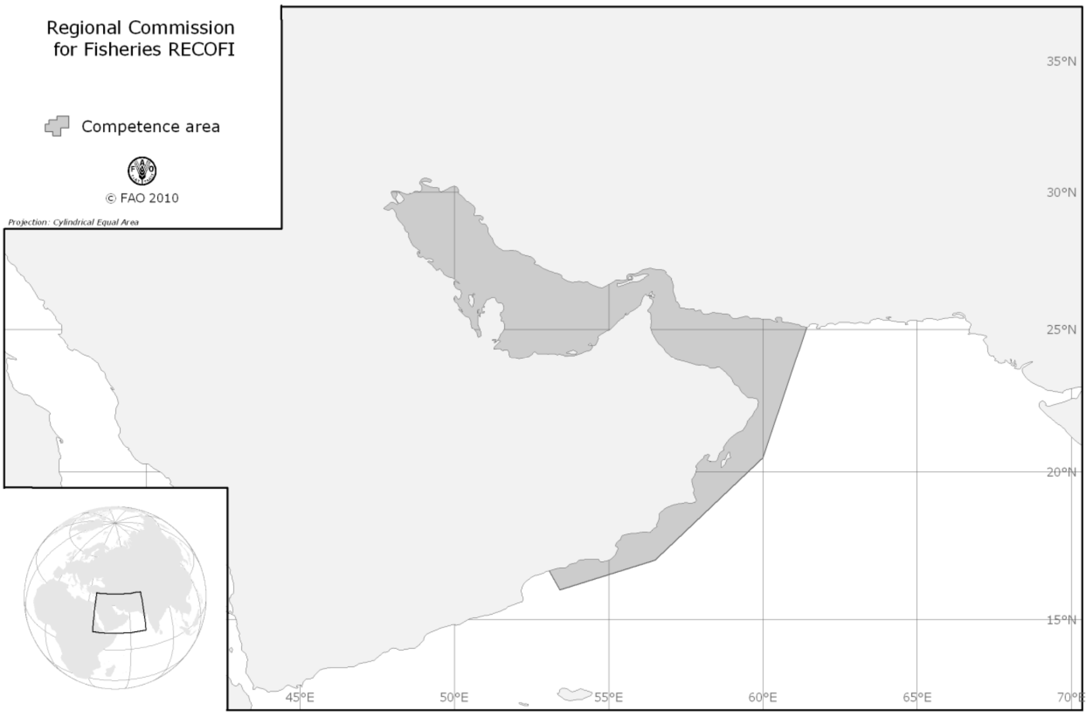
Some believe that the IOTC Agreement is limited by certain gaps in its constitution – minimal attention is given to the environment and there are no specific provisions regarding implementation of the precautionary approach or an ecosystem approach to fisheries management. An IOTC Working Party on Ecosystem and Bycatch meets regularly to examine implementation of an ecosystem approach to fisheries, but their focus has been on bycatch of other fish, sharks, sea turtles and seabirds. The IOTC does not use area-based management tools.

In 2008, the IOTC underwent a performance review that recommended that its Agreement either be amended or replaced by a new instrument. The lack of an ecosystem approach to fisheries management, no mention of the precautionary approach, and no application of area-based management tools were deficiencies identified by the review panel.

6.3.3 The Regional Committee on Fisheries (RECOFI)

The RECOFI was established by the FAO Council in 1999 as a FAO Article 14 body. Its area of competence is the Persian Gulf and Gulf of Oman (Figure 4), and the RECOFI covers all living marine resources in the area. The function of the RECOFI is to promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in the area.

Figure 4
Area of competence of the RECOFI



Current members of the RECOFI are Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates. Yemen is a non-member state that exploits a shared fishery resource with RECOFI members and, as such, it is invited to attend plenary sessions as an observer. The RECOFI has no ongoing or planned activities to implement the precautionary approach, an ecosystem approach to fisheries, or area-based management tools.

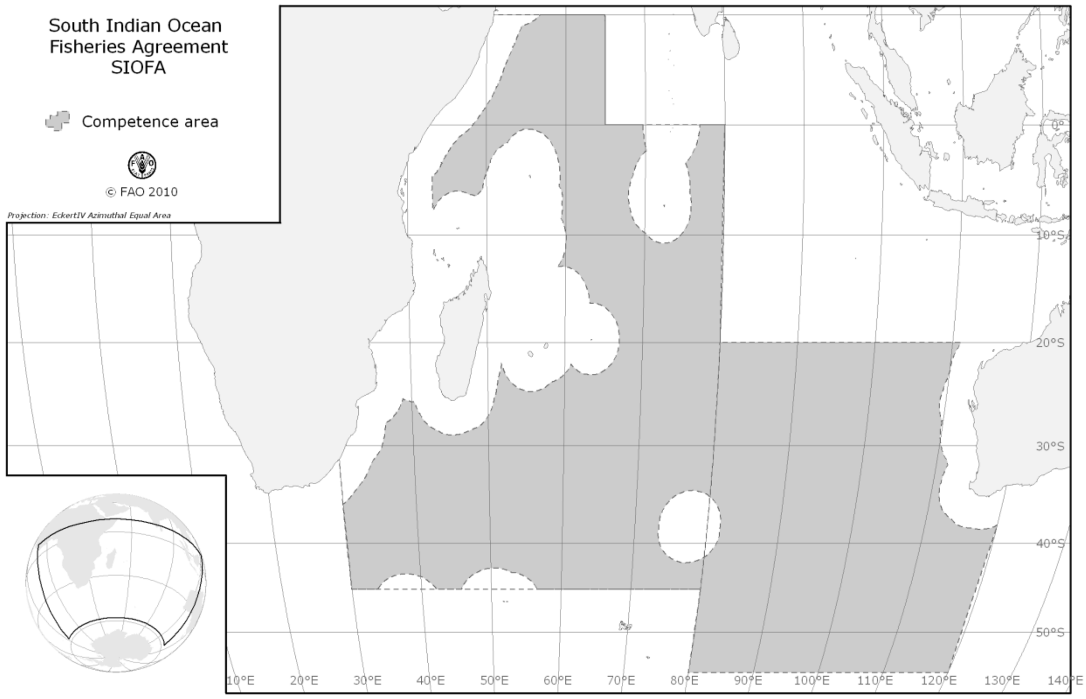
Article XII of the RECOFI Agreement allows for amendment to the Agreement by a two-thirds majority, but it would appear unfeasible that the RECOFI could exercise jurisdiction over a much greater area of ocean space beyond national jurisdiction.

6.3.4 The Southern Indian Ocean Fisheries Agreement (SIOFA)

The SIOFA was signed in 2006 by 13 States: Australia, Comoros, European Community, France, Japan, Kenya, Madagascar, Mozambique, Namibia, New Zealand, Russian Federation, Seychelles and Yemen. Its objective is to ensure the long-term conservation and sustainable use of the fishery resources in its area of competence (Figure 5) through cooperation among the contracting parties, taking into account the needs of developing States bordering the area. The geographic area of application of the SIOFA is extensively detailed in Article 3 of the Agreement. It contains a large portion of the high seas Indian Ocean, and excludes all waters under national jurisdiction.

Although there is overlap between the waters of the SIOFA and the IOTC, the mandates of the two agreements are for different species. The SIOFA is concerned with non-scombroid species, which will include deepwater species such as orange roughy. As a more recent Agreement than the IOTC, the SIOFA incorporates more modern principles of environmental and fisheries management. For example, its Article 4 acknowledges the duty of States to cooperate, the implementation of an ecosystem approach to fisheries management, the application of the precautionary approach, the protection of biodiversity in the marine environment and a requirement that fishing practices shall take due account of the need to minimize the harmful impact that fishing activities may have on the marine environment. Article 6 of the Agreement elaborates how these principles are to be achieved.

Figure 5
Area of competence of the SIOFA



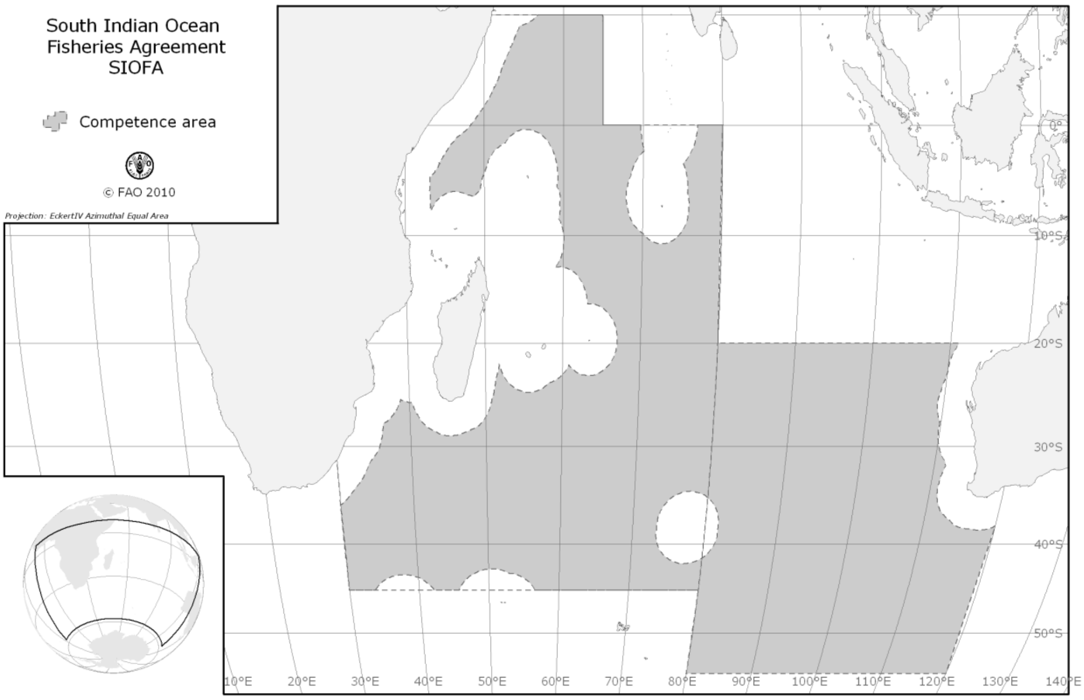
Mauritius has just ratified this Agreement (at the end of November 2010), and as the second coastal State and fourth State to ratify the agreement (along with the Cook Islands, European Union and Seychelles) will bring the Agreement into force in three months.[8] The effectiveness of the forthcoming SIOFA management regime remains to be seen, but the concerns of States such as Australia (which failed to be an original signatory) and those States that were original signatories but have for some years failed to ratify the Agreement should be noted.

6.3.5 South West Indian Ocean Fisheries Commission (SWIOFC)

The SWIOFC was established as an Article 6 FAO RFB in 2004 by the FAO Council. Its rules of procedures were adopted by the SWIOFC at its first session in 2005. Its area of competence is the waters of the southwest Indian Ocean within the national jurisdiction of coastal states (Figure 6). The current members of the SWIOFC are: Comoros, France, Kenya, Madagascar, Maldives, Mauritius, Mozambique, Seychelles, Somalia, South Africa, United Republic of Tanzania and Yemen.

[8] Since drafting this report, Mauritius has signed the Agreement and it should come into force on 10 March 2011.

Figure 6
Area of competence of the SWIOFC



The SWIOFC's area of mandate does not include areas beyond national jurisdiction, and its management mandate is to promote the sustainable utilization of the living marine resources by complying with, and promotion of, the FAO Code of Conduct for Responsible Fisheries, including the precautionary approach and the ecosystem approach to fisheries management. It should be noted that the SWIOFC has only advisory status as an Article 6 FAO body.

6.3.6 Discussion

Even before the 2006 United Nations General Assembly (UNGA) Resolution 61/105 (Box 1), there had been an international impetus to create RFMOs for high seas areas where none had existed before. The process of establishing an RFMO usually involves: (a) protracted negotiations on the proposed organization's text; (b) a signatory meeting to accept the text; (c) a period whereby States ratify the text; and (d) entry into force of the organization when the agreement has been ratified by the specified number of States. In the case of the SIOFA, negotiations over the text began in 2000. Subsequent negotiating sessions followed in Madagascar and Kenya with detailed interim discussions. A signing ceremony of the text was held in Rome in July 2006. However, entry into force of the agreement took another 5 years.

Box 1
United Nations General Assembly Resolution 61/105 of 2006 – selected sections

Resolution adopted by the General Assembly. 61/105. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments.

Noting the obligation of all States, pursuant to the provisions of the Convention, to cooperate in the conservation and management of living marine resources, and recognizing the importance of coordination and cooperation at the global, regional, subregional as well as national levels in the areas, inter alia, of data collection, information-sharing, capacity-building and training for the conservation, management and sustainable development of marine living resources, …

II

Implementation of the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks

14. *Calls upon* States parties to the Agreement to harmonize, as a matter of priority, their national legislation with the provisions of the Agreement, and to ensure that the provisions of the Agreement are effectively implemented into regional fisheries management organizations and arrangements of which they are a member; …

IX

Subregional and regional cooperation

63. *Urges* coastal States and States fishing on the high seas, in accordance with the Convention and the Agreement, to pursue cooperation in relation to straddling fish stocks and highly migratory fish stocks, either directly or through appropriate subregional or regional fisheries management organizations or arrangements, to ensure the effective conservation and management of such stocks; …

65. *Invites*, in this regard, subregional and regional fisheries management organizations and arrangements to ensure that all States having a real interest in the fisheries concerned may become members of such organizations or participants in such arrangements, in accordance with the Convention and the Agreement;

66. *Encourages* relevant coastal States and States fishing on the high seas for a straddling fish stock or a highly migratory fish stock, **where there is no subregional or regional fisheries management organization or arrangement to establish conservation and management measures for such stocks, to cooperate to establish such an organization** or enter into another appropriate arrangement to ensure the conservation and management of such stocks, and to participate in the work of the organization or arrangement;

There are two other organizations of possible relevance to coastal states of the Arabian Sea. These are the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (the Nairobi Convention) and the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project. The Nairobi Convention (a United Nations Environment Programme [UNEP] organization) provides a mechanism for regional cooperation, coordination and collaborative actions, and enables the contracting parties to harness resources and expertise from a wide range of stakeholders and interest groups towards solving interlinked problems of the coastal and marine environment. The Nairobi Convention was signed in 1985 and came into force in 1996, making it one of 17 regional seas conventions and action plans. The Nairobi Convention area extends from Somalia in the north to South Africa, covering ten States.

The objectives of the UNDP/Global Environment Facility (GEF) ASCLME[9] Project are:

- to gather new and important information about ocean currents and how they interact with and influence the climate, biodiversity and economies of the western Indian Ocean region;
- to document the environmental threats that are faced by the countries of the region through a "transboundary diagnostic analysis";
- to develop a strategic action programme that sets out a strategy for the countries to deal collectively with transboundary threats; and
- to strengthen scientific and management expertise, with a view to introducing an ecosystem approach to managing the living marine resources of the western Indian Ocean region.

It is unclear to what extent this project is achieving its objectives. A further organization of potential interest is the Indian Ocean Commission, an intergovernmental organization that links Comoros, Madagascar, Mauritius, France (for Réunion) and Seychelles together to encourage cooperation. It started in January 1984 and has as objectives:

- diplomatic cooperation;
- economic and commercial cooperation;
- cooperation in the field of agriculture, maritime fishing, and the conservation of resources and ecosystems; and
- cooperation in cultural, scientific, technical, educational and judicial fields.

The original objective was to encourage trade and tourism. Recently, cooperation has focused on marine conservation and fisheries management. This organization has funded a number of regional and national conservation and alternative livelihoods projects.

While all of these organizations are of interest, only the RECOFI appears to come close to having the mandate that would be well included in any regional fisheries organization while also being one with a mandate for addressing high seas issues.

6.4. CONSIDERATIONS REGARDING A REGIONAL FISHERIES MANAGEMENT ORGANIZATION FOR THE ARABIA SEA

6.4.1 Geographical considerations

The geographical area of an RFMO should have political, physical and biological coherence, i.e. the range of the area to come under the RFMO should make sense. As far as possible, it should cover the geographical ranges of the species that are of regulatory concern. In the case of straddling stocks, special arrangements such as the United Nations Fish Stock Agreement[10] should be invoked. Self-evidently, if a conservation regulation can only apply to a fish stock when it is in part of its range, there will be a danger of overfishing or some other non-compliance with conservation measures when the fish are beyond the region of competence of the RFMO.

Likewise, if the RFMO decides to address issues of environmental concern, if it has no control over events that affect the environment in the regulatory area, then it risks reduction in its potential effectiveness. On the other hand, an area that is huge and embraces too many members risks being ineffective through an inability to reach agreement on the need to undertake regulatory action. It would seem that the Arabian Sea is a reasonably-sized area for consideration for an RFMO.

[9] ASCLME Web site: www.asclme.org/

[10] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

6.4.2 Functional responsibilities

While RFMOs vary considerably in their objectives, they all have consistent themes. FAO notes that the objectives of RFMOs are to better conserve and manage fish stocks, particularly for fishery resources that are exploited solely or partially in the high seas and, in particular, for straddling stocks and highly migratory species. In this, RFMOs work to strengthen international cooperation, promote transparency, address non-members, and enhance monitoring, control and surveillance measures, including the implementation of mandatory VMSs, the adoption of regional schemes for port State measures and the development of approved or IUU vessel lists.

Although RFBs are composed of independent States, they are not supranational organizations. States join an RFMO because of common interests and concerns for conserving and managing the target fish stocks. In this, RFMOs can only be as effective as their members permit.

The perceived lack of action by RFMOs and their inability in some cases to stem stock declines should be viewed in the context of the obstacles that many face. A lack of political commitment by the members of some RFMOs and unyielding positions incompatible with sound regional fisheries management have thwarted, if not stalled, efforts undertaken within some RFMOs to meet and address conservation and management challenges. This situation hinders RFMO performance, while criticism is directed at the organizations rather than at their members. Members must collaborate effectively and take difficult decisions if they are to be successful, even though not all members have identical interests. The strong political will of the member states of each RFB must be the primary prerequisite for the effective role of RFBs.

What issues should be addressed?

It is for the prospective members to decide what the focus of a newly formed RFMO should be. However, there are two general directions that RFMOs have been developing:

- a body strictly concerned with issues of fisheries management; or
- a body with wider environmental concerns that go beyond management of species of commercial interest, bycatch and associated species.

An example of the first case would be the soon-to-be implemented SIOFA. Its general principles, noted in its Article 4 are:

(a) measures shall be adopted on the basis of the best scientific evidence available to ensure the long-term conservation of fishery resources, taking into account the sustainable use of such resources and implementing an ecosystem approach to their management;

(b) measures shall be taken to ensure that the level of fishing activity is commensurate with the sustainable use of the fishery resources;

(c) the precautionary approach shall be applied in accordance with the Code of Conduct (for Responsible Fisheries) and the 1995 Agreement, whereby the absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures;

(d) the fishery resources shall be managed so that they are maintained at levels that are capable of producing the maximum sustainable yield, and depleted stocks of fishery resources are rebuilt to the said levels;

(e) fishing practices and management measures shall take due account of the need to minimize the harmful impact that fishing activities may have on the marine environment;

(f) biodiversity in the marine environment shall be protected; and

(g) the special requirements of developing States bordering the Area that are Contracting Parties to this Agreement, and in particular the least-developed among them and small island developing States, shall be given full recognition.

In somewhat of a contrast, the Commission for the Conservation of Antarctic Living Marine Resources (CCAMLR) better typifies the second type of RFMO. For example, in the preamble to its convention it notes:

"RECOGNISING the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica; notes as follows"

and

"CONSIDERING that it is essential to increase knowledge of the Antarctic marine ecosystem and its components so as to be able to base decisions on harvesting on sound scientific information"

Its first Convention article notes:

"2. Antarctic marine living resources means the populations of fin fish, molluscs, crustaceans and all other species of living organisms, including birds, found south of the Antarctic Convergence."

In its second convention article, the following is noted.

"1. The objective of this Convention is the conservation of Antarctic marine living resources.

2. For the purposes of this Convention, the term 'conservation' includes rational use.

3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;

(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and

(c) prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources."

In the case of the CCAMLR, there is wide acceptance that the members **should** support measures that ensure that ecosystems are kept in balance by not excessively harvesting one component of an ecosystem. In the case of the CCAMLR, the concern was for krill. At the time, it was thought that a major fishery for this crustacean was imminent – in reality this might become the case only now, 40 years later. Krill is the major food item for baleen whales, penguins, some seals and many species of seabirds as well as, of course, for fish. It is of interest to consider parallels with myctophid fish in the Arabian Sea.

There are advantages and disadvantages in having strictly fisheries management issues and environmental issues within the mandate of a single organization. The advantage of separating these two issues between separate organizations is that each respective organization can concentrate on its single mandate. In this way, they are likely to be more effective, at least in a narrowly defined context. However, on balance, there are many advantages to including fisheries and environmental concerns within a single organization.

First, it reduces the chances of polarization with separate organizations pursuing their respective agendas usually only with cursory acknowledgement of the need to collaborate (and, even more importantly, compromise) over issues of common interest. For example, the Convention on Biological Diversity is proposing a number of marine reserves for the Indian Ocean, but as yet there has been no collaboration with those actually involved in the fishing industry.

Second, when two organizations exist with contiguous mandates, there is always bureaucratic pressure for one or both to extend their operations into the field of the other. When one or other of the organizations is less well funded or of less institutional competence/strength, inevitably, the stronger one starts undertaking the activities that belong within the mandate of the other. An interesting case in point is that in the Red Sea. This area does not have an RFMO to represent the interests of the fisheries, not least in ensuring (or attempting to achieve) the sustainability of the fish resources. However, the Red Sea does host a UNEP regional seas programme – the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) – and, in the absence of any RFMO, the PERSGA has embraced a wide range of fisheries management activities. At some point, balancing will be required between its different activities.

At a national level, responsibilities for fisheries and marine environmental activities often are assigned to different ministries – conservation and environment to one ministry, and the mandate for fisheries to another. Naturally, fisheries has a more commercial orientation (and answers to a completely different set of stakeholders and clients) than does the ministry of conservation and/or environment. Which ministry has the upper hand in leading delegations to RFMOs often changes with the government and/or the strength/personality of the minister. It can happen that the lead ministry at an RFMO meeting (if it is not that for foreign affairs) is lead by the ministry of the environment, and policies that favour conservation over exploitation are promoted. Usually, it is evident at RFMOs, which delegations fall into which camps.

How well an RFMO performs its tasks and achieves its objectives is another issue separate from what is, or should be, its mandate. Lodge *et al*. (2007) provide a detailed review of best practices for RFMOs.

6.4.3 Membership

Conventionally, RFMOs are open to any country that agrees to support the objectives of the organization. Immediate coastal States are the most logical candidate to be members of an RFMO along with states that flag and license vessels to fish in the area of competence of the RFMO. Many other countries may belong to an RFMO because of historical participation in fisheries in the area or some other reason. A further category of participants is for those deemed "non-contracting parties". These are States that have not joined the RFMO (and thus have no financial obligations to the RFMO) but which fish in the area and agree to observe rules and regulations of the RFMO. Such "participants" do not have voting rights.

How decisions are made is up to the signatories of the convention. Many RFMOs require consensus agreement – this is the "lowest common denominator" as if even only one member does not agree then a potential management decision cannot be accepted. The alternative is some form of majority voting, e.g. simple or two-thirds majority. In addition to this, the texts of many conventions allow countries to "reserve their positions", in which case they are not bound by the management decision. Note that under the Vienna Convention of 1912, any country that has not agreed to an international agreement is not obliged to conform to the agreement. In addition, the relevant provisions of the Law of the Sea Convention should be kept in mind (Box 2).

Box 2
Relevant provisions of the Law of the Sea Convention

***Law of the Sea Convention:* HIGH SEAS: SECTION 1 - GENERAL PROVISIONS**

Article 87 - Freedom of the high seas

1. The high seas are open to all States, whether coastal or land-locked. Freedom of the high seas is exercised under the conditions laid down by this Convention and by other rules of international law. It comprises, *inter alia*, both for coastal and land-locked States: …

(e) freedom of fishing, subject to the conditions laid down in section 2;

2. These freedoms shall be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas, and also with due regard for the rights under this Convention with respect to activities in the Area.

Article 118- Cooperation of States in the conservation and management of living resources

States shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States, whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, cooperate to establish subregional or regional fisheries organizations to this end.

6.5 What is an appropriate area for an RFMO for the Arabian Sea?[11]

What the area of mandate should be of an RFMO for the Arabian Sea may be a contentious issue. Clearly, it should include the northwest central part of the Indian Ocean, bounded in the north by Iran (Islamic Republic of) and Pakistan, in the east by India and in the west by Oman. But, what about the Gulf of Oman? Physically and biologically this area is an extension of the Arabian Sea – it has far greater affinity with the Arabian Sea than with the Persian Gulf, and yet it is included in the RECOFI area. In this case, there would appear to be sound grounds to transfer competence for this area to a newly formed RFMO for the Arabian Sea. This would leave a more compact and coherent management area in the Persian Gulf. The two most affected and major coastal states – Iran (Islamic Republic of) and Oman are already members of the RECOFI. Oman might reconsider the benefits of remaining a member of the RECOFI. One concern would be the United Arab Emirates – two of its Emirates have coastlines on the Gulf of Oman. If the United Arab Emirates wished to be represented in a new RFMO to which the Gulf of Oman had been transferred, this might be expensive for a very short section of coastline.

It is unknown to the author what legal steps that would be involved in changing the boundaries of an existing RFMO, but one concern is that any change to the text of an existing RFMO would invite re-opening discussion on other sections of the convention. This may be something that is to be avoided!

Another area of concern is the Gulf of Aden. As with the Gulf of Oman, this area would be more logically handled by an RFMO with the mandate for the adjacent Arabian Sea, although it has commonly been included in a marine arrangement for the Red Sea[12] despite having only the narrowest of connections with this area. A country of concern here is Djibouti, which has no coastline on the

[11] The author notes the particular sensitivity of this issue and stresses that the text here is intended only to simulate discussion.
[12] See the PERSGA Web site: www.persga.org.

Red Sea but may consider its interests more aligned with Red Sea countries that with those of the coastal states of the Arabian Sea. This is a further issue for reflection.

Where to delimit the competence of an Arabian Sea RFMO to the south is also not immediately self-evident. The northern area of the SIOFA does not seem to have been well determined. Its area of competence includes the offshore areas of Somalia, Kenya and part of the Yemen – i.e. the southwest part of the Arabian Sea. As such, the SIOFA area (Box 3) is bounded by the 10°N parallel east to its intersection with the 65°E meridian. A more logical re-arrangement here might be to move the northern boundary of the area of competence of the SIOFA to the equator and include in the offshore area of Kenya and any remaining of Somalia into a new Arabian Sea RFMO. Again, this would require renegotiation of the SIOFA, which may be an undesirable action. Difficulties!

Box 3
Area of application of the SIOFA

ARTICLE 3 – AREA OF APPLICATION

1. This Agreement applies to the Area bounded by a line joining the following points along parallels of latitude and meridians of longitude, excluding waters under national jurisdiction: Commencing at the landfall on the continent of Africa of the parallel of 10° North; from there east along that parallel to its intersection with the meridian of 65° East; from there south along that meridian to its intersection with the equator; from there east along the equator to its intersection with the meridian of 80° East; from there south along that meridian to its intersection with the parallel of 20° South; from there east along that parallel to its landfall on the continent of Australia; from there south and then east along the coast of Australia to its intersection with the meridian of 120° East; from there south along that meridian to its intersection with the parallel of 55° South; from there west along that parallel to its intersection with the meridian of 80° East; from there north along that meridian to its intersection with the parallel of 45° South; from there west along that parallel to its intersection with the meridian of 30° East; from there north along that meridian to its landfall on the continent of Africa.

6.6 Administrative issues

6.6.1 An RFMO secretariat

A major issue for an RFMO is that of the secretariat. This always involves costs and the often highly politicized process of deciding where the secretariat is to be located. This process is simplified if one country makes an offer that no other country can match, e.g. by offering to pay accommodation costs or by making a building available. However, sometimes the attractions of possible alternative sites are very evenly matched.

An alternative to having a fixed location of the secretariat is to have a "movable" secretariat in which member countries assume responsibility for this task for, say, one or two years. This may reduce expenses but at the cost of loss of "corporate" memory as the executive secretary for the RFMO would rotate in this case along with the supporting secretarial functions. If the secretariat becomes responsible for monitoring vessel movements, catch quotas, inspections, etc., if is difficult to see how a rotating secretariat could be successful.

6.7 Moving ahead

Should coastal States decide to investigate further the merits and implications of establishing an RFMO, one method would be to establish an ad hoc committee to explore this possibility further. If this process is formalized, funding assistance could be requested from a development agency, e.g. the European Union, FAO, or a similar organization. Coastal States could be invited to nominate one or two representatives and a chairperson be appointed to ensure continuity of the process. At least three to five years should be allowed for negotiations over an appropriate convention text, and at least this period again, for the convention to come into force.

Much experience now exists as to possible models for an Arabian Sea RFMO, and this experience is available to assist States structure an RFMO that best reflects their needs and desires. Thus, these steps might be:

- agree as to the need for a regional RFMO;
- establish a steering committee with one or two members from interested States;
- prepare terms of reference for the committee and agree on a reporting schedule;
- identify the desired geographical area of the RFMO;
- identify the functional mandate of the proposed RFMO.
- agree on a meeting schedule (two or three times a year – taking advantage of other meetings e.g. FAO’s Committee o Fisheries;
- seek funding for the process if/as required;
- undertake a series of regional meetings to review mandate and draft convention text;
- hold sign ceremony to open the convention to ratification, agreement and/or acceptance; and
- enable the RFMO to come into force once the threshold number of ratifications has been received.

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APPENDIX I

Workshop schedule

DAY ONE

13 December 2010

08:00–08:45 **OPENING CEREMONY**

First Technical Session – Regional and national overviews

1. Election of the Chair and Administrative matters
2. Overviews with respect to shared resources, fisheries and fishery trends,

09:00–10:00

i. Regional perspective on shared resources and relevant programmes
Dr Ross Shotton, Workshop Secretariat

ii. Fisheries and shared resources of Pakistan
Mr M. Moazzam Khan

iii. Fisheries and shared resources of Oman
Ms Lubna Al Kharusi

BREAK

10:15–12:15

iv. Fisheries and shared resources of Iran
Mr Mohebali Sistani and Dr. T. Valinassab

3. Overviews on national stock assessment activities including current research, surveys, stocks under consideration and issues

i. The Nansen surveys and key results
Dr Espen Johnsen

ii. Ongoing demersal fishery resources survey in Sea of Oman at a glance
Dr Juma Al-Mamry MFW

iii. Fisheries research in Iran
Dr F. Kaymaram IFRO

iv. Stock assessment in Pakistan
Mr M. Wasim Khan MFD

Discussion of potential regional coordination of programmes

LUNCH

Second Technical Session – Mesopelagic resources

13:30–15:00

4. Technical papers on shared mesopelagic resources, primarily *Benthosema Sp.*

i. Myctophids in Omani waters
Dr N. Jayabalan MFW

ii. Myctophids in Iran
Dr Tooraj Valinassab IFRO

iii. Mesopelagic biomass and distribution in Pakistan waters
Mr Tariq Hanif MFD

BREAK

15:30–17:00	Discussion of technical papers on shared mesopelagic resources, recommendations for future research, regional coordination and potential management and development of these resources

MONDAY EVENING WORKSHOP DINNER

HOSTED BY

OMAN MINISTRY OF FISHERIES WEALTH

Time and venue will be announced in the workshop

DAY TWO

14 December 2010

Third Technical Session – Large pelagics and related resources

08:30–10:30	Technical papers on shared large pelagic and related resources including sharks and large mackerels i. Status of shared stock fishery of kingfish *Scomberomorus commerson* *Ms Fatma Al-Kiyumi MFW* ii. Large pelagic fisheries in Pakistan *Mr M. Moazzam Khan MFD*

BREAK

11:00–12:30	Technical papers on shared large pelagic and related resources including sharks and large mackerels – continued i. Large pelagic fishes (tuna and tuna-like) in Iran *Dr F. Kaymaram* *ii.* Assessing shark stock delineations and movements in the Arabian Sea *Dr Aaron Henderson SQU* Discussion of technical papers on shared large pelagic resources, recommendations for future research, regional coordination and potential management and development of these resources

LUNCH

Fourth Technical Session – Small pelagics and unrelated resources

13:30–15:00	1. Technical papers on small pelagic resources, demersal resources, others i. Indian oil-sardine and Indian mackerel fisheries of Oman *Dr Shama Zaki MFW* ii. Coastal small pelagics in Pakistan *Dr Asif Riaz and Mr. Tariq Hanif*

BREAK

15:30–17:00	Discussion of technical papers on shared small pelagic resources, recommendations for future research, regional coordination and potential

management and development of these resources

WEDNESDAY MORNING FIELD TRIP

MUTTRA FISH MARKET

BUS DEPARTS AT 06:00 AND WILL RETURN BEFORE 09:00

DAY THREE

15 December 2010

	Carry-over Technical Session – Outstanding items from earlier discussions
08:30–10:30	1. Time to revisit or update discussions from earlier sessions with particular emphasis on technical recommendations (if needed) i. Estimates of fishing, natural and total mortality from female to embryo ratios: a model illustrated for the milk shark *Rhizoprionodon acutus* from Oman *Dr Anesh Govender SQU* ii. Considerations relating to creation of a regional fisheries management organization (RFMO) for the Arabian Sea. *Dr Ross Shotton, Workshop Secretariat*
	BREAK
	Wrap-up Session – Recommendations and report contents
11:00–12:30	Discussion of workshop recommendations including RFMO considerations
	LUNCH
13:30–17:00 *Includes a working break*	Review materials for agreed inclusion in the workshop report with particular emphasis on recommendations advanced in technical sessions

APPENDIX II

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This document contains the report of the FAO Workshop on the Status of Shared Fisheries Resources in the Northern Arabian Sea – Iran (Islamic Republic of), Oman and Pakistan which was held in Muscat, Oman, from 13 to 15 December 2010.
In the last three years, the Government of Pakistan, and especially the Marine Fisheries Department in Karachi, has invested to reinvigorate the stock assessment capacity of the department. A multiyear project involving stock assessments, including marine surveys, is in place through technical assistance from the FAO. Even at this early stage, the new data have largely confirmed the parlous state of many of Pakistan's marine fishery resources and leave little doubt that overexploitation is the principal reason for this. More work is needed, and much is already under way, to provide clear and specific management recommendations, but the direction and scope of the action needed is already clear.
Some of the most valuable resources in question are not limited to Pakistan's waters but are shared with regional neighbours or more widely on the high seas. Effective action to ensure sustainable fisheries in Pakistan can only come about if those sharing the resources act in concert. To this end, the Government of Pakistan proposed that the FAO convene a meeting with the two neighbours most immediately affecting Pakistan's shared marine resources – Iran (Islamic Republic of) and Oman. The meeting was to identify the stocks of most concern in this regard, look into immediate ways to coordinate and improve the stock assessment efforts among the three countries, and to look forward to ways to set and achieve management goals jointly for these shared resources. To support the convening of this meeting, the FAO Unilateral Trust Fund (UTF) project "Support to Fishery Resources Appraisal in Pakistan" sponsored the travel and expenses of the meeting, and the Sultanate of Oman graciously agreed to host the meeting in Muscat.

ISBN 978-92-5-106799-4 ISSN 2070-6987

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