APPENDIX A

Workshop agenda

REGIONAL COMMISSION FOR FISHERIES (RECOFI)

REGIONAL COMMISSION FOR FISHERIES (RECOFI)
Working Group on Aquaculture (WGA)
Regional technical workshop on sustainable marine cage aquaculture development
Muscat, Sultanate of Oman, 25–26 January 2009
AGENDA

Saturday, 24 January 2009

Arrival of workshop participants. Informal hotel lobby meeting at 20:30

Sunday, 25 January 2009

08:30-10:30	**Opening of the workshop**

1. Registration
2. Introduction of workshop participants and consultants
3. Adoption of the provisional annotated agenda
4. Introduction to the scope of the workshop and expected outputs
5. Regional review: Marine cage culture in the RECOFI region

10:45-17:15	**Marine cage aquaculture – Environmental impact and monitoring**

The discussions at the technical workshop will be facilitated and coordinated by Dr Håkon Kryvi on the local situation, needs and priorities in the region with regards to cage culture development and particularly on environmental impact assessment/monitoring and farm licensing. Dr Kryvi is currently a senior adviser to the Norwegian state pollution control authority on environmental impact of aquaculture and coastal zone management. He has long management experience dealing with all environmental concerns from cage aquaculture in Norway. He was also responsible for the marine component of a comprehensive project launched to develop a tool for aquaculture planning and suitability assessments in Norway with regards to site selection, environmental impacts, monitoring and a wide range of relevant issues and concerns for aquaculture production.

1. ***Presentation on fish cage culture in Norway - A case study***

A presentation on the regulation of the Norwegian marine finfish aquaculture industry will be delivered by the FAO consultant, Ms Pia Kupka Hansen, working as senior scientist at the

Institute of Marine Research, Bergen, Norway. The developmental events of the Norwegian finfish cage aquaculture industry will be presented in a chronological order from its early stages to its current status. The presentation will highlight how various technical and legal issues have been dealt with and adjusted over the years. The main elements that should be taken into account by technocrats in supporting the sustainable development of a marine fish cage farming industry will be presented and discussed.

Agenda objective: The presentation above aims at opening the discussion among the participants attending the workshop. The aim is to identify the needs and priorities in the RECOFI countries and in the region as a whole with regards to cage culture environmental impact assessment (EIA), environmental monitoring, site selection, etc. The group will be requested to identify the need for specific and focused activities required to develop and harmonize regional standards and protocols.

Monday, 26 January 2009

09:00-17:15	Marine cage aquaculture – Licensing

1. *Presentation of a review on cage aquaculture licensing procedures*

A review on cage aquaculture licensing procedures indicating the general principles and guidelines involved in establishing a cage culture farm will be presented. The review will draw from the current regulations in place in selected countries where cage aquaculture is an important economic activity (e.g. Spain, Norway, Greece, Chile and the United States of America). The review aims at showing examples of best practices aim at helping the government with policy options for better governing of marine aquaculture and recommendations for a legal framework in terms of aquaculture permitting.

Agenda objective: The aim is to identify the needs and priorities in the RECOFI countries and in the region as a whole with regards to marine cage culture licensing procedures. The group will be requested to identify the need for specific and focused activities required to develop and harmonize regional protocol.

2. *Workshop summary and findings*

A workshop summary will present the main issues and points discussed by the participants. Based on these the workshop consultants will identify specific and focused activities required as follow-up actions needed to reach the objectives of developing the targeted cage aquaculture protocols for the region. A number of brief project concept notes describing the issue and inputs required, will be prepared following the workshop. The project briefs produced will be presented and prioritized during the fourth WGA meeting for inclusion in the next work plan proposal for discussion ant the fifth session of the Commission that will take place in May 2009.

Agenda objective: To identify and prioritize follow-up activities.

Coffee and lunch breaks

Throughout the workshop there will be the following breaks. The tentative timings are given below:

Morning break	– 15 minutes	– Starting at 10:30
Lunch break	– 1.5 hours	– Starting at 12:30
Afternoon break	– 15 minutes	– Starting at 15:30

APPENDIX B

List of participants

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APPENDIX C

Opening speech

by

Saoud Hamood Al-Habsi
Director General for Fisheries Research
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Honourable delegates and guests,

A'Salaam Alikumm.

It is my pleasure to welcome you at the opening of the "Regional technical workshop on sustainable marine cage aquaculture development" organized by Working Group on Aquaculture of the Regional Commission of Fisheries (RECOFI) in collaboration with our Ministry of Fisheries Wealth which will be held here in Muscat from 25 to 26 January 2009. I also take this opportunity to convey the warm greetings and wishes for a successful meeting from H.E. Mohammed bin Abdulla Al-Qatabi, Minister of Fisheries Wealth and H.E. Dr Hamad Al-Oufi, Undersecretary of Ministry of Fisheries Wealth.

The aquaculture sector is recognized as an important and expanding economic sector which provides food, income and an increasing number of job opportunities. RECOFI member countries also realize its importance and have started to develop and invest into this sector in a sustainable manner. As a result the RECOFI Working Group on Aquaculture was established to play a vital role in increasing communication and cooperation among the countries in and outside the region.

Since the official establishment of the WGA during the second session of Commission held in Muscat in 2003, the WGA has held numerous technical meetings and workshops. Among these, endorsed by the Commission, I wish to mention the establishment of the Regional Aquaculture Information System (RAIS) which will be officially launched before the next session of the Commission and the project on strengthening the aquaculture legal and policy framework in the RECOFI area.

The Ministry of Fisheries Wealth strongly supports the development of aquaculture in the Sultanate of Oman and as a result established the Fisheries and Aquaculture Centre to provide the technical inputs and knowledge required to properly develop and support the sector. The Centre is growing in terms of facilities and expertise, nevertheless runs an active applied research programme focused on local needs and supervises a number of priority projects. The Centre also plays an active role in dissemination current and new farming technologies and contributes significantly towards public awareness on the potential and importance of this sector. One of the main research programmes coordinated by the Centre is the identification and selection of suitable endemic species as aquaculture candidates and development of appropriate and environmental friendly farming technologies.

This important workshop will focus on the potential for cage aquaculture in the RECOFI marine waters and eventually aims at recommending on how best this farming technology should be promoted and development with regards to the safeguarding of the marine environment. The development of standard and regional protocols on environmental assessment and monitoring, licensing procedures and best management practices will certainly contribute positively to the growth of this sector.

Finally, we take this opportunity to express our sincere gratitude to all the participants from the RECOFI members, invited experts and the FAO Secretariat for organizing and holding this meeting. I wish also to thank the Organizing Committee of the Ministry of Fisheries Wealth for their support.

A'Salaam Alikumm.

الاجتماع الرابع لمجموعة عمل الاستزراع السمكي التابعة للريكوفي

الحمد لله رب العالمين ... والصلاة والسلام على أشرف المرسلين سيدنا محمد (صلى الله عليه وسلم) وعلى آله وصحبه أجمعين...

ضيوفنا الكرام ...

السلام عليكم ورحمة الله وبركاته،،،

يسعدني ويشرفني أن نرحب بكم في افتتاح الورشة الخاصة بتطوير استزراع الأقفاص العائمة والاجتماع الرابع لمجموعة عمل الاستزراع السمكي التابعة للهيئة الإقليمية لمصايد الأسماك (للريكوفي) خلال الفترة من 25-28/يناير لعام 2009م بمسقط. ونغتنم هذه الفرصة لننقل لكم تحيات معالي الشيخ/ محمد بن عبدالله القتبي – وزير الثروة السمكية وسعادة الوكيل/ حمد بن سعيد العوفي ودعمهما و تمنياتهما لهذه الورشة بالنجاح والتوفيق.

الحضور الكريم ،،،
يعتبر قطاع الاستزراع من أهم القطاعات الحديثة التي من شانها توفير الغذاء وفرص عمل جديدة. وتدرك الدول الأعضاء التابعة للهيئة الإقليمية لمصايد الأسماك (ريكوفي) هذه الأهمية وبدأت قدما في تولية هذا القطاع أهمية عظمى وبطريقة مستدامة. ولعل خير دليل على اهتمام الدول الأعضاء هو المشاركة في تأسيس مجموعة العمل الخاصة بالاستزراع السمكي لتقوم بدور حيوي وفعال لتعزيز التعاون بين الدول في مجال الاستزراع.

ومنذ التأسيس الرسمي للمجموعة والذي تم خلال الاجتماع الثاني لريكوفي في مسقط لعام 2003م، قامت المجموعة بعقد عدة اجتماعات وحلقات فنية. كما تم إعداد عدد من المشاريع من قبل المجموعة تتمثل في:

1) تأسيس نظام المعلومات الخاص بالاستزراع RAIS.
2) مشروع تقوية النظم التنظيمية وسياسات الاستزراع في منطقة ريكوفي.

وقد أدركت وزارة الثروة السمكية أهمية هذا القطاع في السلطنة. وفي ضوء ذلك تم إنشاء مركز الاستزراع السمكي في لمواكبة التطور المتوقع في قطاع الاستزراع السمكي. ويقوم المركز بالبحوث اللازمة لتطوير هذا القطاع. كما يقوم بعملية مراقبة مشاريع الاستزراع السمكي ونشر التقنيات الحديثة في وتوعية المجتمع بأهمية الاستزراع السمكي. ومن أهم الأبحاث التي يقوم بها المركز اختيار الأنواع المحلية من الكائنات البحرية القابلة للاستزراع .

ولعل تقنية الاستزراع باستخدام الأقفاص العائمة من مجالات الاستزراع الرائدة في المنطقة مما يتطلب العمل معاً من أجل التخطيط لتطويرها بطريقة مستدامة ودراسة التحديات والمخاطر التي تواجه هذه التقنية مثل المد الأحمر . ومن خلال استضافتنا لهذه الورشة، فإننا على ثقة تامة بان مخرجات هذه الحلقة من شانها المساهمة في تقديم المساعدة للدول الأعضاء لتطوير هذا المجال أملين منكم إثراء مناقشات هذا اللقاء وتقديم التوصيات والمقترحات التي من شانها إرشادنا إلى التطوير المستدام للاستزراع في الدول الأعضاء التابعة للهيئة.

والجدير بالذكر أن الهدف من هذه الورشة يتمثل في دراسة وضع الاستزراع البحري في الدول الأعضاء وذلك من خلال استعراض التقارير الخاصة بكل دولة. إننا نجتمع هاهنا لنصل إلى المقترحات والتوصيات المتعلقة بالمواضيع التالية:

- التشريعات التنظيمية والمؤسسية الخاصة بالاستزراع البحري بالأقفاص العائمة.
- الطرق العامة لإجراء دراسات تقييم التأثيرات البيئية وكيفية تقييم هذه الدراسات
- الإجراءات الموحدة لتراخيص مثل هذه المشاريع لما لها من أهمية في توحيد و تعزيز أوجه التعاون في مجال الاستزراع السمكي.
- مواصفات اختيار مواقع الاستزراع.

بالإضافة إلى ممارسات الإدارة الأفضل في مثل هذه المشاريع.

ضيوفنا الكرام ،،،
اسمحوا لي أن نتقدم بجزيل الشكر والتقدير لجميع الدول المشاركة ومجموعة العمل وخبراء وممثلي منظمة الأغذية والزراعة على تلبية الدعوة و على جهودهم المخلصة التي ساهمت في عقد هذا الاجتماع. كما أتقدم بالشكر لكل من ساهم من أجل انعقاد هذا الاجتماع وعلى وجهة الخصوص اللجنة المشرفة على التنظيم من العاملين بوزارة الثروة السمكية و وزارة القوي العاملة كما نتقدم لكم جميعاً بجزيل الشكر لتلبية الدعوة ولحضوركم الكريم.
والسلام عليكم ورحمة الله وبركاته،،،

APPENDIX D

Summary of workshop suggestions and recommendations

CAGE AQUACULTURE IN THE RECOFI AREA

The WGA *asked for* intensification of research to refine hatchery technologies to ensure mass production of species for cage aquaculture (paragraph 13).

The WGA *suggested* that proper site identification and aquaculture zoning could help reduce conflicts of interest among different and potential users of the coastal and marine environment (paragraph 15).

The WGA *agreed* that the development of common environmental protocols is needed for countries sharing the same water body (paragraph 16).

The WGA *recommended* that relevant environmental data should be collected, compiled and provided in an accessible form along with information on site selection criteria and area availability for cage fish farming (paragraph 17).

The WGA *agreed* that the encouragement of coastal zoning through the use of appropriate spatial planning tools would allow the identification and allocation of specific geographical areas to aquaculture operations. This would simplify the process of farm site selection, environmental impact assessment and licensing procedures (paragraph 18).

It was *proposed* that the WGA should review regional competence in the use of spatial planning tools and organize an inception workshop that would synthesize the knowledge acquired in the region and to recommend a road map on how to move forward (paragraph 18).

CAGE AQUACULTURE – ENVIRONMENTAL IMPACT AND MONITORING

The WGA *recognized* the need for the region and individual Commission members to develop an ad hoc EIA format based on the local marine environment conditions to determine the level of detail and elements for the completion of a full EIA study (paragraph 21).

The WGA *agreed* that the preparation of an inventory in each country of relevant habitats, natural oceanographic and topographic conditions was needed to draw up a detailed protocol and specify where to carry out specific investigations (paragraph 22).

The WGA *emphasized* the concern of the impact of aquaculture on the fishing community (paragraph 23).

The WGA *encouraged* appropriate training for the techno-bureaucrats in dealing and interpreting the results of an environmental impact assessment study (paragraph 24).

The WGA *recognized* the importance of obtaining detailed information on how to monitor cage fish farms with regards both to their benthic and pelagic impacts and suggested the monitoring programmes from other cage culture farming countries could be used but adopted to local conditions. The WGA *emphasized* the importance of monitoring results against threshold impact limits (paragraph 27).

In order to develop and establish a standard and specific fish cage culture monitoring protocol in the region, the WGA *recommended* that the RECOFI countries be responsible for the adaptation of an existing monitoring cage farming programme and EQS by establishing contact with a research institute that holds expertise in cage farming impact and monitoring. The Secretariat was *invited* to investigate expert training on monitoring procedures in Norway or other countries with an adequate and functional fish cage aquaculture monitoring programme (paragraph 29).

The WGA *agreed* that adequate information should be provided to a potential investor, in order to convey a clear understanding of the licensing application and procedure (paragraph 35).

The WGA *agreed* that the legislation involved and process in aquaculture licensing should be transparent and provide ready information on e.g. processing time, payable fees, financial guarantee for bankruptcy, etc. (paragraph 35).

The WGA *suggested* that the countries in the region should prepare an instruction guide on how to complete a licence application (paragraph 35).

The WGA *agreed* that potential aquaculture investors in the region should be informed on the necessary information to be collected prior to applying for a farm licence for a specific site (paragraph 36).

OTHER MATTERS

Algal blooms and cage aquaculture

The experts *recommended* that the WGA should organize a technical workshop on the impact of hazardous algae on aquaculture and cage culture. It was also *recommended* that the proposed workshop should be coordinated with the agenda of the Regional Organization for the Protection of the Marine Environment (ROPME) in view of the mandate of this regional organization (paragraphs 43 and 44).

Fish cage demonstration farm

The WGA *suggested* that the establishment of a commercial demonstration cage farm would greatly enhance the opportunity to gain and share the necessary experience and provide an opportunity for the authorities to evaluate the suitability of their regulations and procedures. The demonstration cage farm would allow the observation and monitoring of environmental impacts, improve husbandry practice, demonstrate the need for enforcement and make indirect tests of the regulations (paragraphs 45 and 46).

The WGA *agreed* that the farm could serve as a training centre for fish farmers, consultants and representatives of the authorities that deal with the processing of licences, environmental impact assessment and monitoring procedures and their enforcement (paragraph 47).

The WGA *encourages* the information exchange between existing research facilities (including universities) and the development of joint research cooperation programmes within the region (paragraph 47).

RECOFI-WGA legal aquaculture project proposal

The experts *recognized* the importance in implementing the legal and aquaculture project prepared by the WGA and endorsed by the Commission. The WGA was *invited* to raise the issue at the next session of the Commission in May 2009 (paragraph 48).

CLOSING REMARKS AND ADOPTION OF THE REPORT

The workshop participants acknowledged that the cage culture industry is still in an infancy stage and agreed that the governments in the region will play an important role in the future development and promotion of this faming practice as well as aquaculture as a whole (paragraph 49).

The Chairperson of the WGA *invited* all WGA focal points to circulate and discuss the workshop report and recommendations with the relevant national authorities in order to ensure a fruitful discussion during the next RECOFI (paragraph 50).

APPENDIX E

Terms of reference

COUNTRY REVIEW ON MARINE CAGE FARMING

The RECOFI-WGA Focal Points will be responsible for the preparation of a national review on marine cage culture. The reviews from all RECOFI members will be used to compile a regional status of marine cage culture. The country reviews along with the regional summary will be used as background material at the "Regional technical workshop on sustainable marine cage aquaculture development".

The reviews will pay special attention to existing, if any, national monitoring and regulatory procedures pertinent to marine cage farming. Regulations, laws or soft laws on licensing procedures, site selection and environmental impact assessment metodology adopted at the national level should be detailed and attached in appendix as an integral part of the country review.

The review will cover cage culture in marine and backishwater environments highlighting core issues related to this aquaculture practice. The review should highlight what has worked, what went wrong and what are the lessons learnt and give special attention to the existing national monitoring and regulatory framework. The review should be completed with relevant tables and figures, and contain at least one map of the country indicating the areas where cage culture is prevalent and to what extent. Photographs, if included, should illustrate key systems and techniques.

The review will be prepared along the following guiding structure (additional headings may be added, if appropriate):

- **EXECUTIVE SUMMARY**
- **BRIEF HISTORY AND ORIGINE OF MARINE CAGE AQUACULTURE IN THE COUNTRY**
- **THE CURRENT SITUATION**
  1. Description of national coastline (incl. profile, slope gradient, wind prevalence, currents)
  2. Marine fish species currently farmed (or candidates) in cages (endemic and exotic)
  3. Seed (wild or hatchery-produced) and feed supply (locally manufactured or imported)
  4. Type and size of cages used (locally built or imported)
  5. Number of existing farms and number of cages (or current applications from the private sector)
  6. Current production outputs per species
- **CURRENT PROBLEMS RELATED TO CAGE MARICULTURE DEVELOPMENT**
- **CURRENT INSTITUTIONAL REQUIREMENTS FOR ESTABLISHING AND OPERATING A CAGE FARM**
  1. Site selection
  2. Farm licensing procedures
  3. Environmental impact assesment (EIA) and monitoring
- **INSTITUTIONAL DEVELOPMENTAL POLICY**
  1. National plans and targets
  2. Production for domestic markets or exports
  3. Employment and gender issues
  4. Others
- **REFERENCES**
- **APPENDICES**
  1. National regulations/legislations/guidelines on *licensing procedure* (if any)
  2. National regulations/legislations/guidelines on *site selection criteria* (if any)
  3. National regulations/legislations/guidelines on *environmental impact assessment* (if any)

APPENDIX F

RECOFI country reports on marine cage aquaculture

edited by

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Lovatelli, A. (ed.). 2009. RECOFI country reports on marine cage aquaculture. In FAO/Regional Commission for Fisheries. Report of the Regional Technical Workshop on Sustainable Marine Cage Aquaculture Development. Muscat, Sultanate of Oman, 25–26 January 2009. *FAO Fisheries and Aquaculture Report.* No. 892. Rome, FAO. pp. 23–76.

CONTENTS

INTRODUCTORY NOTE

The RECOFI country reviews on marine cage aquaculture were prepared in occasion of the RECOFI Working Group on Aquaculture (WGA) "Regional technical workshop on sustainable marine cage aquaculture", held in Muscat, Sultanate of Oman, from 25 to 26 January 2009. The authors of the reviews were requested to follow as closely as possible the template prepared and circulated by the RECOFI Secretariat that appears in Appendix E of the present report. Some of the reviews below are rather comprehensive while others only provide scant information some what indicating the different developmental level of the cage aquaculture industry in the various RECOFI countries.

RECOFI members have been encouraging cage aquaculture over the years however the current level of development varies considerably among the countries and in general cage aquaculture can only be considered an economic activity in its early stages of development. The major constraint identified in the establishment of fish cages, particularly along the north-western shores of the Gulf, has been the limited availability of suitable farming sites characterized by shallow waters, highly fluctuating salinity and temperature levels, and inadequate sea currents. Other limitations included price competition from wild-caught fish, inadequate farming technologies for the region and the limited availability of endemic candidate species of commercial importance suitable for cage aquaculture

The first two pages of this Appendix provide official capture fisheries and aquaculture production statistics from 1998–2007 for the eight RECOFI countries extracted from the FAO FishStatPlus database.

* In order to facilitate the reading, in tables and lists these countries are abbreviated as: Iran IR, KSA and UAE, respectively.

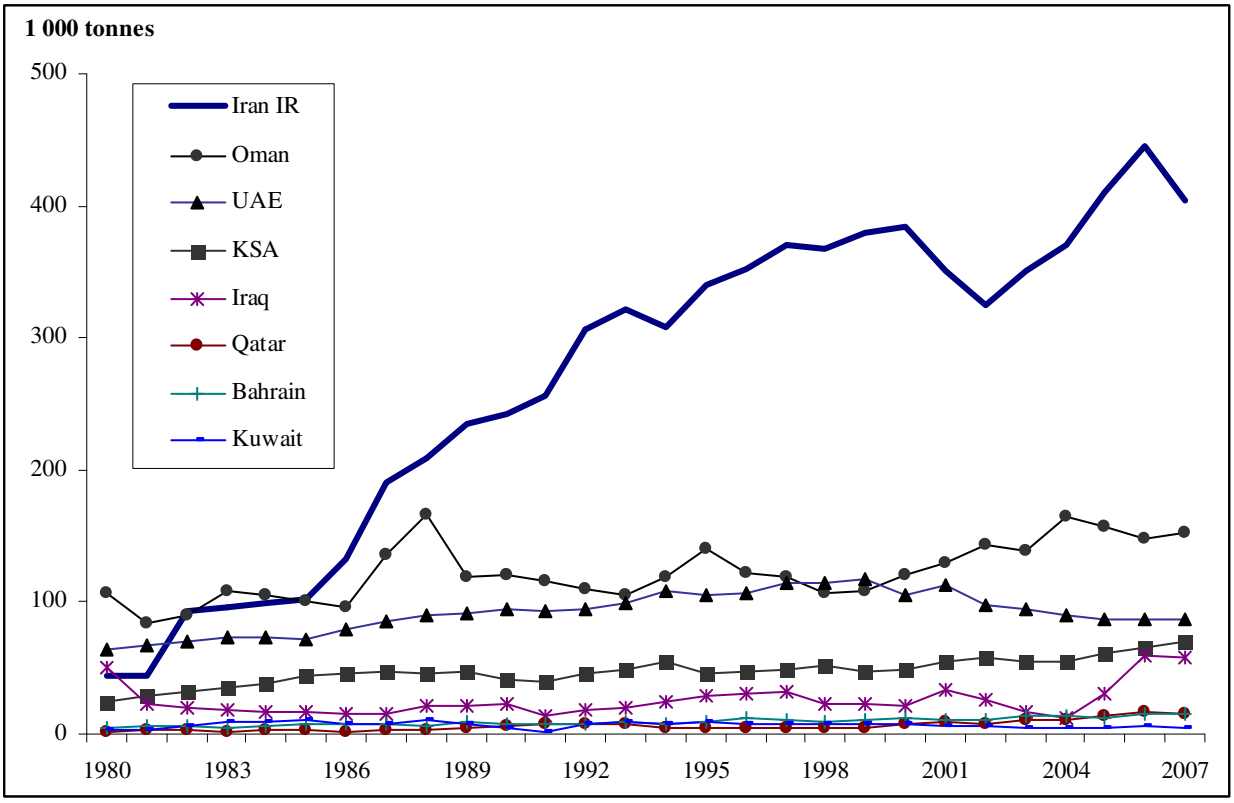
Capture fisheries production (tonnes)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Bahrain	9 849	10 620	11 718	11 230	11 204	13 638	14 334	11 854	15 594	15 012
Iran IR	367 212	380 200	383 990	351 140	324 853	350 122	369 990	410 558	445 852	403 635
Iraq	22 574	22 423	20 767	33 300	26 000	17 200	12 936	29 929	59 259	57 779
Kuwait	7 798	7 398	6 977	5 846	5 360	4 059	4 833	4 895	5 635	4 373
Oman	106 171	108 809	120 421	129 907	142 670	138 481	165 082	157 326	147 669	151 744
Qatar	5 279	4 397	7 140	8 864	7 155	11 295	11 134	13 935	16 376	15 190
KSA	51 291	46 700	49 080	55 331	57 211	55 440	55 418	60 407	65 471	70 000
UAE	114 739	117 607	105 456	112 561	97 574	95 150	90 000	86 735	87 000	87 000
TOTAL	**684 913**	**698 154**	**705 549**	**708 179**	**672 027**	**685 385**	**723 727**	**775 639**	**842 856**	**804 733**

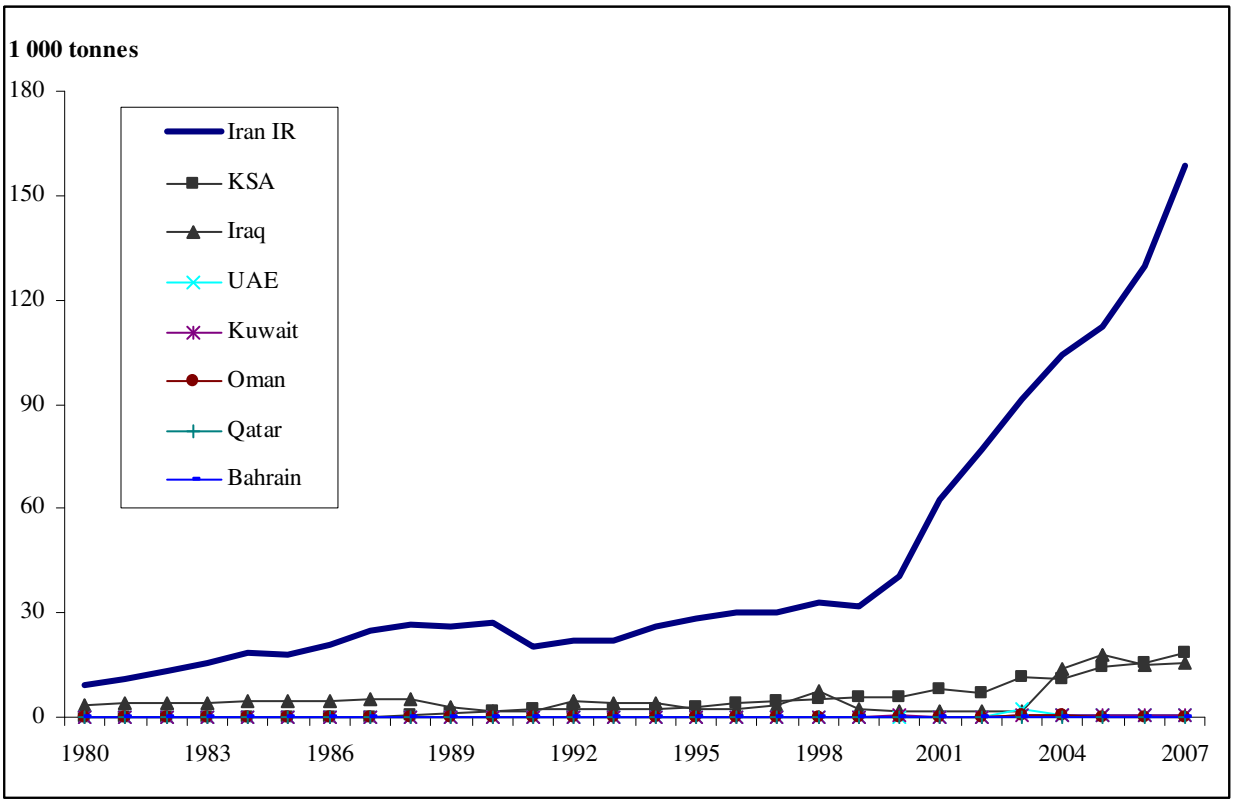
Aquaculture production (tonnes)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Bahrain	1	3	12	0	3	4	8	3	2	1
Iran IR	33 237	31 800	40 550	62 550	76 817	91 714	104 330	112 001	129 708	158 789
Iraq	7 500	2 183	1 745	2 000	2 000	2 000	13 947	17 941	14 867	15 810
Kuwait	220	264	376	195	195	366	375	327	568	348
Oman	13	0	0	0	0	352	503	173	89	90
Qatar	0	0	0	1	0	0	0	11	36	36
KSA	5 101	5 620	6 004	8 218	6 744	11 824	11 172	14 375	15 586	18 410
UAE	0	0	0	0	0	2 300	570	570	570	570
TOTAL	**46 072**	**39 870**	**48 687**	**72 964**	**85 759**	**108 560**	**130 905**	**145 401**	**161 426**	**194 054**

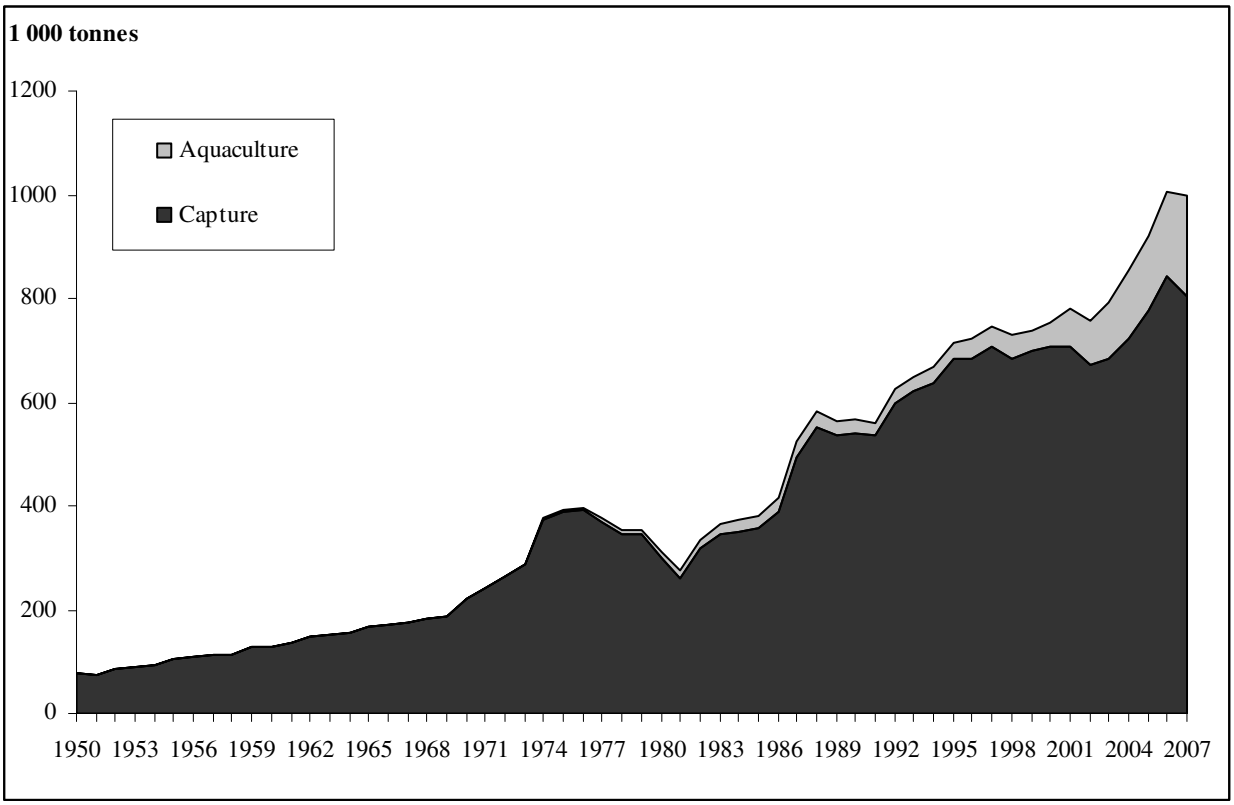
Capture fisheries production



Aquaculture production



Total production of RECOFI member countries



Islamic Republic of Iran:
A review on marine cage aquaculture

by

Mehdi Shakouri
Iran Fisheries Organization

BRIEF HISTORY OF MARINE CAGE AQUACULTURE

The Islamic Republic of Iran has some 50 years experience in aquaculture, mainly in pond culture of freshwater fishes including major Chinese carps and trout. The first cage farms were established 40 years ago in a reservoir of Karoon River in Khozestan province, southwest of the Islamic Republic of Iran. The cages were made of metal and some imported. In the 1980s use of hand made cages using traditional material expanded in inland water bodies for trout rearing. The current expansion of freshwater cage farming is limited mainly due to unsolved issues raised by the of water supply authority. Annual production in cage is limited to some 350 tonnes from 200 units.


Figure 1

Marine cage culture has a short history in the Islamic Republic of Iran. Early research activities on marine cage culture date back to the early 1990s when the Iranian Research Institute (IFRO) established some small experimental cages for the rearing of wild caught fish juveniles. In 2001 a contract was signed between the Iran Fisheries Organization (IFO) and a Norwegian company (Refa) to conduct a general survey of the coastal areas of the country. This survey gave IFO a general and reliable overview for the development of marine fish cage farming. This study also indicated possible cage farming sites along the entire coast. Following the survey, IFO selected a cage site in the Persian Gulf near by Qeshm Island and established a pilot cage farm (see Figure 1). The farm was established in 2005 with the assistance of Scottish and Nordic companies. Local marine fish species like the yellowfin seabream and the Sobaity bream were farmed experimentally to achieve local standards for marine fish farming. A second pilot farm will be established in Busher province in 2009.

In early 2002, IFO invited private companies to investment in marine cage farming. As local hatcheries are not in a position to supply reliable amounts of fish juvenile, private companies that have been interested in investing in mariculture operations have yet to establish their farms.

THE IRANIAN COASTLINE

Caspian Sea – The Caspian is a closed sea, with a surface area of 244 000 km^2, and a maximum depth of 980 m in the south. It is enclosed by Azerbaijan, the Russian Federation, Kazakhstan, Turkmenistan and the Islamic Republic of Iran. Over 120 rivers flow into the Caspian Sea, with 75 percent of its waters derived from the Volga River in the north. The salinity of the Caspian Sea is constant at approximately 13 ppt, while the temperature in the surface layers fluctuates widely with the seasons. Most temperature data received for the southern Caspian indicate temperature extremes between 9 and 28 °C at the surface. In the vicinity of rivers and cold wind spells the temperature in the top surface

layer can drop to 6–7 °C. The seasonal thermocline is found between 15–40 m depth. Below the thermocline the temperature remains below 20 °C and can reach values of 6–7 °C.


Figure 2

The Iranian coastline extends for 990 km along the SW–S–SE section of the Caspian Sea, and its territorial waters cover the deepest southern sector (Figure 2). The coastline is linear and open, without any bays or promontories to provide shelter to fish rearing cages. It is characterized by gently sloping sandy sediments, which progress to mud with increasing seawater depth and distance from the shore.

The East sector of the coast (from the border with Turkmenistan up to Kenar Darya area) is very shallow. The West coast, from the border with Azerbaijan up to Kopur Chal is also a shallow region. The central southern region has a deeper near-coast profile, with bottom slope of 0.3–1.5 percent. A number of large ports/harbours exist at the major towns, but there is a lack of other small ports/jetties along the coastline. Thus outside the principal ports it is possible to utilize only small craft (principally owned by fishermen cooperatives) which land directly onto the beach.

Tidal currents are negligible, with maximum velocity of 10–15 cm/sec. The current pattern is dominated by the influx from the Volga River and by wind forces; thus strong currents would normally be expected only during severe storms. Verbal communications have been received stating periodic occurrence of strong currents of some 2–3 knots (although one fishery officer stated even 6 knots) which damage fishermen's nets. These currents seem to be strongest at depths less than 20 m.

The shoreline is predominantly sand, with very scarce rocky outcrops. Progressing towards deeper water an increasing component of mud and clay is present, with quite uniform bottom substrates throughout the region. As an average value for the surveyed sites, the sediments can be characterized as (i) sand up to a depth of 8–12 m; (ii) sand-mud from 10–20 m; and (iii) mud–clay above 20 m.

Persian Gulf and Oman Sea – The marine basin to which the Persian Gulf belongs is bounded by the latitudes of 24º and 30º N and the longitudes of 48º and 56ºE. It is a semi-closed water body which length varies from 800 to 1 300 kilometres and a maximum width of 640 kilometres. It is separated from the Gulf of Oman by the Strait of Hormuz which stretches 56 kilometres at its narrowest point. Its depth averages 35 m and most of the basin is less than 60 m deep. The depth in the Strait of Hormoz is 91 m and in the north-western part, near the Arvand estuary is 25 m. The Sea of Oman, with an estimated area of 94 000 km^2, length of 610 kilometres, and a depth reaching 3 200 m, connects the Persian Gulf to the Indian Ocean through the Arabian Sea. A series of rivers in the north influence sedimentation, salinity and current flow (Hendijan, Heleh and Mond rivers flow in from the Islamic Republic of Iran).

The bottom topography is mostly flat and featureless, dominated by soft sediments (mud and sand) (Figure 3). The area is a subtropical zone where air temperatures reach around 0ºC in winter and 50ºC and above in summer. Water temperatures reflect these harsh conditions and fluctuate in near shore waters between 10 and 40 ºC while offshore surface water temperature fluctuations are moderated and between 18 and 33 ºC. Many aquatic organisms in the region live at the limits of their physiological tolerance and must be able to survive these wide thermal fluctuations.

The arid climate influences water salinity, which in turn influences water density, currents, water mixing and other environmental parameters. The average salinity is around 37 ppt, but due to high evaporation rates in May the salinity may reach between 40–50 ppt in shallow areas.

The dominant current is a counter clockwise movement with lower saline (less dense) water entering at the Straits of Hormuz at the surface and more saline (dense) water leaving the basin at the bottom. Thus, less saline (36,5–37 ppt) water entering the basin flows northward along the Iranian coast reaching 38 ppt in the North due to evaporation. As it flows southwards along the western side, the more saline water sinks, evaporation increases, and the denser water then flows towards the Straits of Hormuz along the bottom existing with a salinity of 40 ppt (see Figure 4).

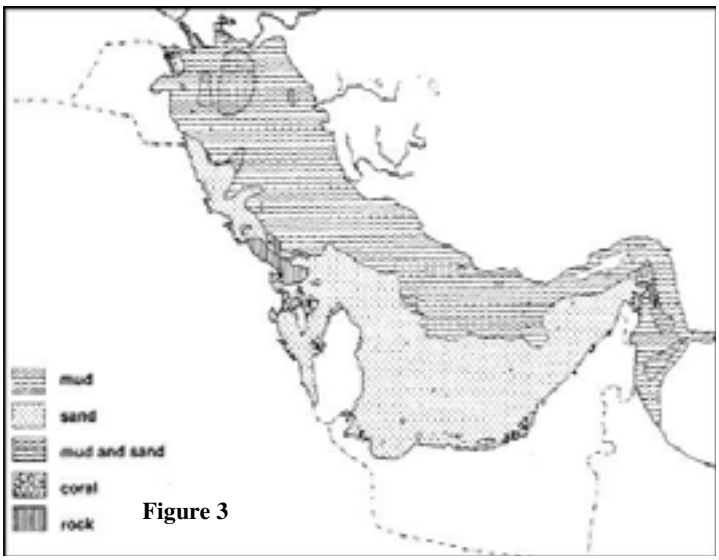


Figure 3

Moving south-east from Bandar Abbas, the Iranian coastline becomes progressively more exposed to long fetch of open sea. The Strait of Hormuz represents a transition zone between the closed waters of the Persian Gulf and the open ocean waters of the Sea of Oman.

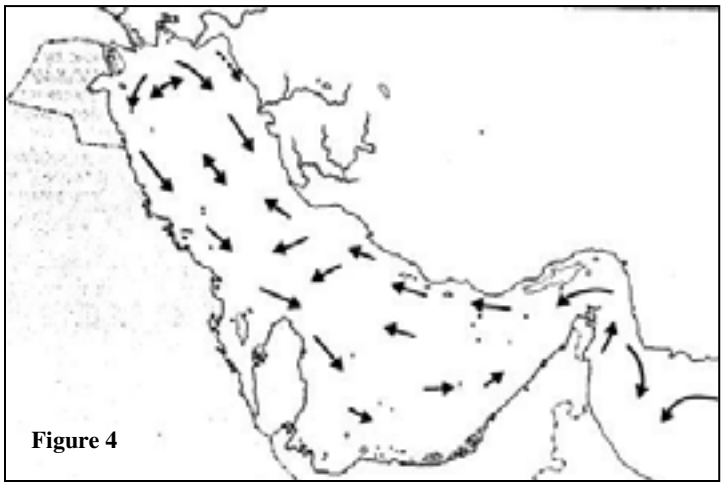


Figure 4

SITE SELECTION CRITERIA

The proposed criteria for site selection are: (i) present and future sources of pollutants and interference (from local fishing activities, shipping and transportation routes, tourism and recreation, industries and military activities); (ii) presence of natural sanctuaries, reserves and spawning grounds of important and/or endangered species; (iii) physical and chemical quality of water (e.g. temperature, salinity, currents, waves and turbulence); (iv) presence of other infrastructures.

CAGE FARMING FISH CANDIDATES

The current candidates for cage farming are listed below. Endemic species have higher priority as farming of alien fish species requires a long process before they are introduced for farming.

In southern waters - Local fish: Orange-spotted grouper or Hamoor (*Epinephelus coioides*); Yellow seabream (*Acanthopagrus latus*); Sobaity seabream (*Sparidentex hasta*); Silver pomfret (*Pampus argenteus*); dolphinfish (*Coryphaena hippurus*); milkfish (*Chanos chanos*); and Cobia (*Rachycentron canadum*). Alien fish: gilthead seabream (*Sparus aurata*); and the European seabass (*Dicentrachus labrax*).

In northern water – Caspian trout (*Salmo trutta caspius*); Kutum (*Rutilus frisii kutum*); and five species of sturgeon (*Acipencer* spp.).

In IFOs' pilot farm Sobaity seabream and the gilthead seabream are currently farmed experimentally. The local species showed a rapid growth compared to the alien one with seed material provided from a local hatchery and imported from Bahrain, respectively. A priority for the Government is to ensure the

supply of juveniles from local hatcheries, while facilities in neighbouring countries such as Bahrain and Kuwait would be an alternative source of seed. The local feed companies have the capability to produce specific aquafeeds, but need to compete with foreign companies for price and quality.

TYPE & SIZE OF CAGES USED

The cages used in the pilot farm were imported in 2004. They consisted of six circular, 50 m polyethylene floating cage. The farm layout and mooring system used are illustrated in Figures 5 and 6. The annual production capacity of the farm is 180 tonnes of fish (30 tonnes/cage). At the present the pilot farm is the only cage farm in the Iranian water of the Persian Gulf. Private companies are still searching a reliable source of fish juvenile inside the country and in neighbouring states.

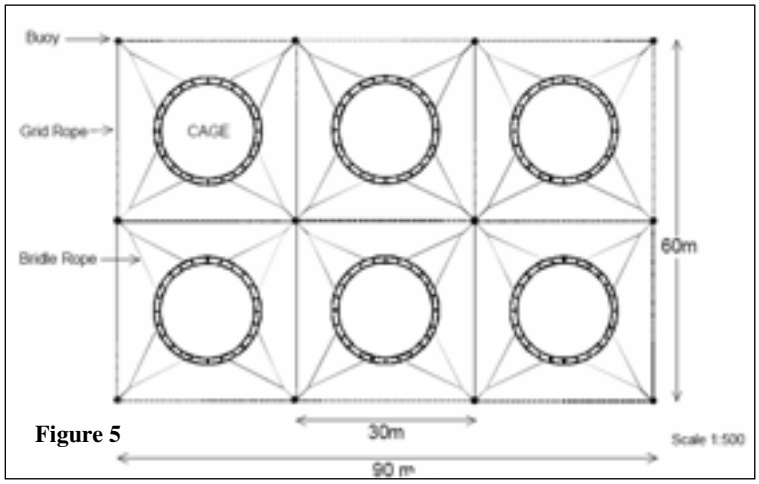


Figure 5

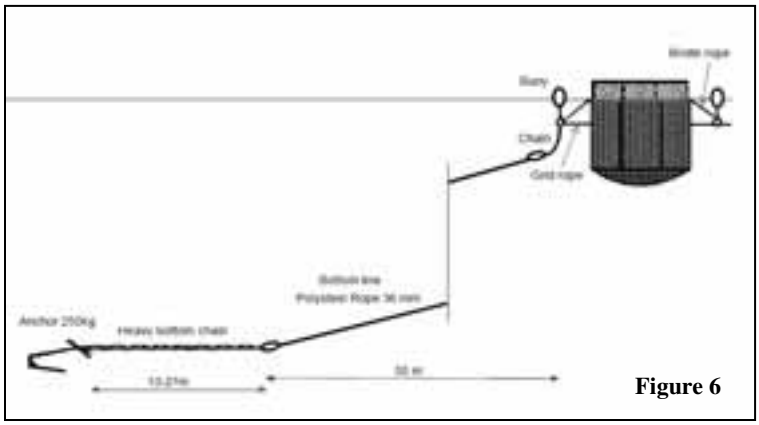


Figure 6

DEVELOPMENT PLAN

According to the IFOs' survey report, the Islamic Republic of Iran has the production capacity of 155 000 tonnes of marine farmed fish along the southern coastal waters while almost double this off the northern coastline (see Table 1).

Table 1. Estimated capacity for cage farming in the Iranian coasts of the Persian Gulf

Site	Production capacity
Bandar-e-Mahshahr	2 000
Khark and Kharko Island	10 000
Kangan, Tombak, Akhtar and Taheri	20 000
Bandar-e-Javadol Aeme	10 000
Mogam, Chiroye, Gorze and Charak	30 000
Hendorabi Island	10 000
Kish Island	15 000
Faror Island	10 000
Queshm Island	20 000
Larak Island	10 000
Hengam Island	8 000
Kuhestak	10 000
Total	**155 000**

The fourth national plan for development of marine cage culture indicates that the target production in 2009 should reach 4 500 tonnes. This objective is unlikely to be reached due to two major constraints i.e. the availability of a reliable source of seed material and the availability of better investment opportunities in other commercial fields.

The major constraints and threats for development of cage farming are:

- Lack of qualified technicians and experts in different and relevant areas;
- Shortage of seed material; and
- The difference between production cost and market price only allows for a narrow profit margin.

The major strengths and opportunities are:

- Availability of wild commercial finfish species;
- Presence of shrimp hatcheries with free production capacity;
- A large national market;
- Strong government support (low cost land; availability of favourable loans, etc.); and
- Presence of feed mill plants.

The Government welcomes and supports foreign investment in seed production and cage farming in both northern and southern waters.

FARM LICENSING

Farm licensing follows a certain process starting with the writing of an application to the IFO's provincial authorities. An environmental impact assessment (EIA) report is needed to issue a construction licence which needs to be approved by the Department of Environment Protection.

The licensing process is as below:

- Apply for cage farming by sending an application form to the provincial IFOs' office;
- Submit an overall business activity plan to the IFOs' office, if required;
- IFO issues a Principle Licence;
- Submit a feasibility study to the IFOs' office, including construction plans;
- IFO issues a Construction Licence (only after other relevant organizations such as the Department of Environment, the Maritime and Port Organization, and the Veterinary Services have approved the plan. A copy of the EIA report needs to be submitted to the Department of Environment); and
- IFO issues an Operation Licence when the farm is completed and farming activities can commence.

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Kingdom of Bahrain:
National review on marine cage aquaculture

by

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Director of Marine Resources
General Directorate for the Protection of Marine Resources

EXECUTIVE SUMMARY

The Kingdom of Bahrain has no commercial mariculture activities. Main production outputs consists of marine fish juveniles for export and local stock enhancement programmes. The coastal waters are open with no protected bays or sheltered areas and are generally shallow, with only small deep areas in the form of depressions in the sea floor. Salinities are high, tidal currents and wind velocities are medium to high. There is a potential for shallow net cage farming in selected areas, but measures for protection of cages against natural elements need to be considered. The presence of a successful and thriving fish juvenile production industry is a positive asset that will no doubt encourage future cage farming projects in the country. There are few but insufficient laws and regulations for mariculture activities including cage farming. There is a need to develop these regulations and also establish guidelines for environmental impact assessments and environmental monitoring programmes for mariculture projects.

GENERAL INFORMATION

Bahrain consists of an archipelago of islands in the shallow waters of the central Arabian Gulf (Figure 1). This archipelago comprises 36 islands covering a total area of 706 km^2. The largest island is the island of Bahrain, covering an area of about 590 km^2, where the capital Manama is located. The island is linked by causeways to neighbouring lands such as Muharraq, Sitra, Umm Na'san and Nabih Salih. The main island is also linked by a causeway to the Kingdom of Saudi Arabia. The other large islands of the Bahrain archipelago include Hawar, situated 25 kilometres to the south-east of the main island and covering an area of about 52 km^2. In order to meet the needs of the population, a further area of about 33 km^2 was reclaimed from the sea through landfill between 1976 and 1996. The reclamation is still continuing to coop with the development of tourism and industrial projects. In 2002, 13.3 percent of the existing land was used for housing purposes, 5.9 percent for agriculture, 9.3 percent for industry and commerce, 5.9 percent for the cultural heritage and tourism, and 16.5 percent by the gas and petroleum sector.

Figure 1

There is good potential for aquaculture development in Bahrain. Therefore, the Directorate of Marine Resources, General Directorate for the Protection of Marine resources, Public Commission for the Protection of Marine Resources, Environment and Wildlife has future plans to add new research and culture facilities to the National Mariculture Centre in order to cope with the expected expansion in this important sector. The rules and regulations that will control this sector are being planned. The Master plan for mariculture development in the Kingdom of Bahrain, formulated by the Directorate of Marine Resources, is continuously revised and discussed among different governmental authorities who have relation with the aquaculture affairs.

HISTORY OF MARINE CAGE AQUACULTURE

There is no marine cage farming activity in the Kingdom of Bahrain. In 1999, a trial was made using six 40 m perimeter circular floating cages. These cages were anchored at the marine terminal of the Bahrain Aluminium Factory (ALBA). This site was chosen mainly due to ease of access and anchoring of cages and security. The depth was just 9 m, so cage depth was limited to five metres. The cages were operated for two years; many problems were encountered, including profuse net fouling by amphipods and barracuda attacks. The problems were solved, but the site proved not to be suitable. Furthermore, due to expansion works by the factory, the whole operation had to be halted. This was the first and only cage farming operation in the country. Nevertheless, good experience was acquired even though the period of operation was short.

The coastal waters around the Kingdom of Bahrain are generally shallow, with natural depth not exceeding 26 m. But these depths are only limited to small size depressions on the sea bottom. Constant depth over a large area is rare in near costal waters; the majority of the coastal area is below 10 m deep, not considering dredged navigation channels. There are few larger size deep depressions of 12–16 m that may be suitable sites for shallow cage farming. Except for scattered dead or semi-dead reef areas, most of the coastal areas have sandy bottom with few small rocky outcrops. In some areas the intertidal zone stretches to several kilometres, this and the fact that near coastal areas are mainly shallow, leave very little locations near to the land that are suitable for floating cages. Such conditions may encourage consideration of fixed cage farming.

The coasts of the Kingdom of Bahrain are mainly straight with no sheltered bays. The western coast has high sea water salinity, making it less desirable for farming. Therefore, the Eastern coast is looked at when cage farming is considered. Salinity is 42–45 ppt in most areas; in the south-western coast it may reach 60 ppt. The temperatures range from 16–35 °C. Temperature fluctuations often occur in the winter, especially during days of strong cold winds, causing a drop of a few degrees in a single day.

The tidal currents are rather strong, ranging from 0.1 to 3.5 knots; stronger currents are observed in deeper areas. Wave height in open waters can reach 2 m, especially in the northern areas, mainly due to strong prevailing north and north-western winds with a maximum velocity reaching 34 miles/hour.

There is no cage farming activity in the country, but there are marine species being produced and exported as seed for cage farming in other countries, these species are likely candidates for cage farming in the country and include Sobaity bream (*Sparidentex hasta*), gilthead seabream (*Sparus aurata*), orange-spotted grouper (*Epinephelus coioides*), rabbit fish (*Siganus canaliculatus*), mangrove snapper (*Lutjanus argentimaculatus*). Other species considered are Cobia (*Rachycentron canadum*) and the red seabream (*Pagrus major*).

Fish juveniles are currently being produced at a commercial scale in the country. The National Mariculture Centre, Directorate of Marine Resources, is a leader in the region in production of juveniles of a number of fish species. There are no fish feed mills in the country, hence all fish feed used is imported.
The following table shows the species and numbers of seed produced at the National Mariculture Centre in recent years.

Year	Species	Fry produced (>1g)
2000	Sobaity bream (*Sparidentex hasta*)	525 000
2001	Sobaity bream	395 000
2002	Sobaity bream	540 000
	Rabbit fish (*Siganus canaliculatus*)	20 000
2003	Sobaity bream Rabbit fish Mangrove snapper (*Lutjanus argentimaculatus*)	240 000 30 000 4 000
2004	Sobaity bream Rabbit fish Mangrove Snapper	370 000 97 800 –
2005	Sobaity bream Rabbit fish Gilthead seabream (*Sparus aurata*)	272 250 – 1 936 506
2006	Sobaity bream Grouper (*Epinephelus coioides*) Gilthead seabream	635 000 87 950 2 914 000
2007	Sobaity bream Gilthead seabream	347 652 2 675 739

The Directorate of Marine Resources, General Directorate for the Protection of Marine Resources, is not the direct body that regulates and controls quality and safety of aquatic products. It only issues export licences for marine products and issues permits for any fish catch and processing business. There are no other specific laws or regulations for fish farming; there are also no guidelines for environment impact assessment or for any environmental monitoring programmes for mariculture. The Royal Decree on Exploitation and Utilization of the Marine Resources, issued in 2002, has a few provisions for controlling aquaculture activities of cultured organisms in different aspects such as licensing and its requirements and quality issues. According to the law, a company is not permitted to start any aquaculture project or harvest wild seed without permission from the authorized government body (General Directorate for Protection of Marine Resources).

Major constraints that could affect cage mariculture in the Kingdom of Bahrain include shortage of suitable areas with suitable depth, need for protection against tides, winds and currents, shortage of coastal land to establish supporting facilities for cage farms. On the other hand, incentives for establishing such industry include availability of long-term low interest loans, availability of seed and good technical backup.

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Kingdom of Saudi Arabia: A review on marine cage aquaculture

by

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EXECUTIVE SUMMARY

The Kingdom of Saudi Arabia occupies approximately 80 percent of the Arabian Peninsula surface area. The Kingdom has a good potential for fish farming considering the advantages offered by favourable climatic conditions, availability of land and water, and an expanding national market. By virtue of its position between the Arabian Gulf and the Red Sea, the country has a rich diversity of finfish and shellfish species. Some of the endemic species have been identified as potential and suitable aquaculture candidates. The combined coastline of the Red Sea and the Arabian Gulf extends approximately to 2 400 kilometres. The Ministry of Agriculture has identified marine as well as freshwater aquaculture as an important economic sector for the provision of fish and fish products to the national and export markets and provides support to its further development.

In the past few years special attention has been given by the Government to boost commercial aquaculture production in the Kingdom and has encouraged both national and foreign investments. To support such investments the Ministry of Agriculture provides a number of incentives including facilitations to obtain suitable land and sea areas, operational licences as well as providing advantageous financial loans. Furthermore, the Ministry has established a number of semi-commercial aquaculture projects to attract such investments.

The Department of Aquaculture is the responsible authority for issuing licences to establish and operate aquaculture projects. These are released only after an evaluation of the feasibility studies of submitted projects. To date aquaculture activities in the Kingdom have been mainly established as complimentary activities to agriculture projects or as ad hoc inland freshwater activities. Coastal aquaculture projects are presently located along the coast of the Red Sea. In 1986 aquaculture contributed less than 1 percent of fish production in the Kingdom of Saudi Arabia. This value increased to 10 percent in 2000 and to 17.6 percent in 2003 with shrimp farming considered the most successful and expanding aquaculture activity.

There are several marine finfish species that have been identified as suitable for marine cage aquaculture activities. These include the rabbit fish (*Siganus* sp.), mullet (*Mugil* sp.), yellowfin seabream (*Acanthopagrus latus*), the Sabaki tilapia (*Oreochomis spilurus*), the exotic Asian seabass (*Lates calcarifer*), and a number of grouper (*Epinephelus* spp.) and snapper species (*Lutjanus* spp.). The Asian seabass is a recommended species particularly as the country has successfully introduce the hatchery technology for this species. At present only one company (Fisheries Tabuk Company) has established a cage culture operation on the northern reaches of the Red Sea (near Tabuk) farming the Mediterranean gilthead seabream (*Sparus aurata*). Marine cage culture is expected to become an important source of fish production in the future, however a stronger support should be provided to the private sector particularly with regards to the use of modern open sea cages and access to hatchery technologies.

CONSTRAINTS TO CAGE MARICULTURE DEVELOPMENT

The major constraint to a larger-scale development of marine finfish culture in the Kingdom of Saudi Arabia is the uncertain supply of fish fingerlings of commercially important species. Artificial

breeding of certain marine finfish such as the Asian seabass (*L. calcarifer*) and certain species of groupers (*Epinephelus* spp.) has been successful. However, mass fingerling production of these species is still at the experimental level.

Another constraint to cage aquaculture development is the limited knowledge of suitable cage farming areas, which in the case of the Arabia Gulf may be somewhat limited compared to the Red Sea due to the it low bathymetry. Furthermore, the public is also concerned of the impacts of aquaculture practices on the natural environment particularly in near shore waters. One strategy advocated by the authorities is the development and introduction of offshore cage culture technology.

INSTITUTIONAL REQUIREMENTS FOR ESTABLISHING AND OPERATING A CAGE FARM

Site selection

Amongst the most important consideration in starting an aquaculture project is proper site selection. A good site should comply with the technical requirements to enable proper management of the system. Good sites for cage culture include sheltered shores, bays, straits and lagoons. Adequate water exchange is necessary to ensure stability of the environment and culture conditions. However, it is necessary to avoid areas where there is a large influx of freshwater especially during the rainy season as this could result in sudden changes of salinity values which may cause fish mortalities. The following parameters should be taken into account during a cage culture site survey:

Sheltered area – It is important that sites for cage culture are sheltered particularly from strong winds and strong wave action. Sea areas with wave amplitude greater than 2 m should be avoided except in the case modern offshore floating cages are used. Strong winds and wave action will damage conventional cage structures as well as render maintenance and management work very difficult and dangerous. Ideal sites are those that have a good natural protection.

Current – Water currents play a major role in maintaining good water quality around cage fish farms. An adequate water exchange will ensure a high level of oxygen essential for intensive culture system, while poor water exchange may results in the accumulation of waste products beneath the cages. Excessively strong currents however will stress the farmed fish and force them to utilize excessive energy to maintain their position in the cage. Both the factors can significantly lower growth rates of the fish. A current with a speed of 20–50 cm/sec. is considered suitable for a cage culture project.

Depth – The water depth in a cage culture site should be large enough to ensure proper water circulation and flushing of the waste material. The importance of maintaining the cages off the bottom is also to avoid unnecessary contamination that may result in disease outbreaks among the cultured fish. For small fixed bottom cages it is recommended that at least 2 m separate the bottom of the cage and the sea floor. Sandy-clay bottoms are ideal for fixing such cages.

Dissolved oxygen – Adequate dissolved oxygen (DO) levels are essential for fish to live and grow satisfactorily. It is recommended to determine the surface and bottom DO to ensure that the levels do not fall below 4 ppm which may stress the fish. A DO level of 5 ppm or more is necessary for good growth.

Temperature – The temperature of Saudi Arabian waters do not fluctuate significantly throughout the year. It is generally between 27–32 ^{o}C which allows year round fish culture. Temperatures lower than the optimum value will slow fish growth while extreme values may induce severe mortalities.

Salinity – In the coastal areas of the Kingdom of Saudi Arabia salinity values may reach 35–44 ppt.

Pollution – Pollution in coastal areas usually results from land discharges such as sewage, industrial

wastes, insecticides runoff and the mining discharges. Pollutants which have toxic elements may not be lethal immediately but may accumulate to the lethal point or cause disease outbreaks as a result of stress. A suitable farm site should be far from any such pollution sources. Urban or areas with heavy industrialization should be avoided.

Farm licensing

According to the standards and regulations adopted by the Department of Aquaculture.

Environmental impact assessment and monitoring programme

Environmental impacts as a result of farming activities in the Kingdom of Saudi Arabia is a matter of great concern and specific environmental impact assessment study is required for all coastal projects and is required before a farm licence can be issued. Animal rearing including intensive fish farming has an impact on the natural environment, like all human activity. The major impacts are associated with feeding and nutritional wastes which may affect water quality as a whole and the benthic community beneath the cages as a result of organic matter build-up. These adverse effects may be somewhat reduced through improved feeding management and integrated aquaculture. Environmental monitoring is carried out by the competent authorities under the direct supervision of the Department of Aquaculture through regular field visits and sampling programmes.

INSTITUTIONAL SETUP

The Department of Aquaculture (DoA) is directly linked to the Deputy Minister for Fisheries Affairs and its main task is to control, regulate and supervise all coastal and inland aquaculture operations as well as to support research projects focussed on the identification of the most suitable fish and shrimp species for farming purposes. The DoA also extends support with regards to the identification suitable sites where aquaculture operations can be established. It is also entrusted with preparing and revising short- and long-term aquaculture developmental plans. The Department also conducts market analysis for aquaculture products which are made available to the private sector. The DoA operates five functional units: 1) Freshwater Research Unit; 2) Marine Water Research Unit; 3) Aquaculture Development Unit; 4) Production Follow-up Unit; and the 5) Aquaculture Services Unit.

Governing regulations

The law regulating fishing, investment and protection of living aquatic fisheries resources in the Kingdom of Saudi Arabia was issued as the Royal Decree No. M/9 in 27/3/1408 entrusting the Ministry of Agriculture with the responsibility of supervising and developing this economic sector. The Ministry supervises this industry through the Deputy Ministry of Fisheries Affairs by establishing general policies, planning and designing short- and long-term developmental programmes. The Deputy Ministry issues resolutions and regulating by-laws, and supervises three separate departments: 1) the Department of Aquaculture, 2) the Department of Fisheries and 3) the Department of Aquatic Environment. It also supervises the activities of a number of research centres and the regional fishery offices located on both coasts.

Research, education and training

Applied research, education and training in the field of aquaculture are carried out by a number of fisheries research centres, selected universities and at the King Abdul-Aziz City for Science and Technology (KAST). This latter institution plays a major role in developing freshwater aquaculture through its field stations located in Derap and El-Kasim. All these centres provide technical and extension services to all national aquaculture projects and are: 1) the Fish Farming Centre in Jeddah; 2) the Eastern Province Fisheries Research Centre; 3) The Red Sea Fisheries Research Centre; and 4) the Fish Health and Safety Laboratories in Jeddah and Dammam (currently being established).

Fish Farming Centre

The Fish Farming Centre in Jeddah was established in 1982 under an agreement signed between the Ministry of Agriculture and the Food and Agriculture Organization of the United Nations (FAO). The Centre main focus is on applied research aimed at identifying marine fish and shrimp candidate species suitable for local aquaculture operations, transfer of farming know-how and training. The Centre is located on the Red Sea coast approximately 60 kilometres north of Jeddah. Through its Marine Fish Programme the Centre has succeeded in domesticating several species of commercially important fish species and maintains healthy broodstock of several grouper species, *Siganus*, mullet, seabream and seabass. The current research focuses on mass fish larval/fingerling production and reduction of hatchery operation costs. Under the Shrimp Aquaculture Programme extensive research has been conducted on the Indian white shrimp (*Penaeus indicus*) and the giant shrimp (*Penaeus monodon*). Through its research and extension service the Fish Farming Centre is credited for successfully introducing and promoting shrimp aquaculture in the country. Work has also been carried out on tilapia a species highly tolerant to adverse environmental conditions, extremes levels of temperature and salinity. The farming of this species has expanded throughout the country. The Centre has also succeeded culturing the Sabaki tilapia (*Oreochromis spilurus*) in full strength seawater. Other research programmes focus on live feed organisms, feed formulation and fish diseases.

State of Kuwait:
National review on marine cage aquaculture

by

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EXECUTIVE SUMMARY

Fish culture using marine cages has been carried out in the State of Kuwait since 1992. The Government recognizes the importance of this aquaculture sub-sector as an alternative source of fish food particularly as fish from traditional capture fisheries have not been able to cope with the increasing demand for fish in Kuwait. Despite the fact that the prevailing arid climate with high evaporation rate (especially in the summer months) and the extreme temperature fluctuations are major hurdles, marine fish cage culture being promoted. Fish culture in floating cages is presently being carried out by a Kuwaiti-based shareholding company registered as "Bubiyan Fishing Company". Gilthead seabream (*Sparus aurata*), the European seabass (*Dicentrarchus labrax*) and the endemic Sobaity seabream (*Sparidentex hasta*) are the major species candidates. In addition to these, other local commercially important fish species are being farmed experimentally in cages and these include the yellowfin seabream (*Acanthopagrus latus*), the thinlip grey mullet (*Mugil cephalus*) and the orange-spotted grouper (*Epinephelus coioides*). Though there are 73 cages with a total culture volume of about 116 000 m^3, the actual number of cages currently being used is only a fraction. The reason for this may be attributed to the unavailability of fish fingerlings, unfavourable market trends and unsuitable environmental conditions.

The existing cages are located at Dawhah in the western part of Kuwait Bay. Fingerlings of the gilthead seabream, the European seabass and thinlip grey mullet are mainly imported from Greece, France and Egypt. A newly established company called "Gulf International Aquaculture Company" (GIAC) is also producing some fingerlings using part of the hatchery unit belonging to the Kuwait Institute for Scientific Research (KISR) on rental basis.

Fish production from cages has fluctuated, but annual average production has been around 127 tonnes between 2000 and 2007. Fish culture using marine cages receive all sorts of support from the Government represented by the Public Authority for Agriculture Affairs and Fish Resources (PAAFR). Subsidies are provided to the sector as it has been identified as a potential source of alternative seafood to supply the future demand for fish in the State of Kuwait.

BRIEF HISTORY ON CAGE CULTURE IN KUWAIT

Aquaculture development through experimental trials has been explored by KISR since 1983 and the sector gained momentum in 1990 with the concerted efforts of PAAFR. Marine finfish culture in cages started in 1992 by the "Bubiyan Fishing Company". The company started fish production using 10 cages and then it expanded to 73 cages located at Dawhah in the western part of Kuwait Bay (Figures 1 and 2). At the beginning, 32 skilled persons were employed to look after the cage culture activities and an additional 25 people were engaged in marketing and export activities. The fish production from cages has been unstable and fell in recent years due to high competitive prizes of imported fishes and increasing maintenance cost. Despite these problems, fish cage culture activities are ongoing. Presently, a Kuwaiti general manager is looking after the management aspects of the fish farming operations. A technical manager and about 15 labours are engaged in the day-to-day maintenance work of the cages. The farmed fish that have reached the market size are sold locally through 10 company-owned outlets throughout Kuwait.

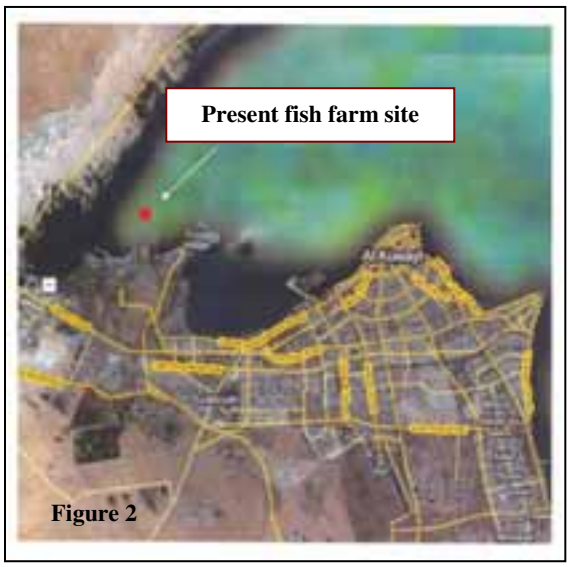

Figure 1

CURRENT SITUATION OF CAGE AQUACULTURE

Description of the national coastline

Kuwait is situated at the north-western end of the Arabian Gulf within the latitude of 28º N and 30º N and longitude of 47º E and 49º E. Kuwait has a total surface area of about 17 818 km^2 with a coast length of about 195 kilometres. Kuwait's marine territorial waters cover approximately 2 540 square nautical miles (8 700 km^2) or just over half of the country's land area. The coastal line extends from the northern bank of Warba and Bubiyan Islands to the South Al-Khiran. The marine waters of Kuwait are characterized by a high finfish and shrimp species diversity.

Fish culture in floating cages commenced in Kuwait in 1992 and even though the production has been stagnating over recent years, this aquaculture sub-sector is receiving increase support from the Government in view of the limited space required and its potential in farming high value species. Highly demanded fish such as the gilthead seabream (*S. aurata*), the European seabass (*D. labrax*) and the Sobaity seabream (*S. hasta*) are major candidates as these species are highly preferred by the Kuwaitis. Further, these species are fast growing, have a phenomenal tolerance to crowded culture conditions and are resistant to extreme temperature fluctuations. Cage fish production is shown in Figure 3; values for 2006 and 2007 have been obtained from the Bubiyan Fishing Company and the remaining data are taken from the Statistic Bulletin of the Ministry of Planning, Kuwait.

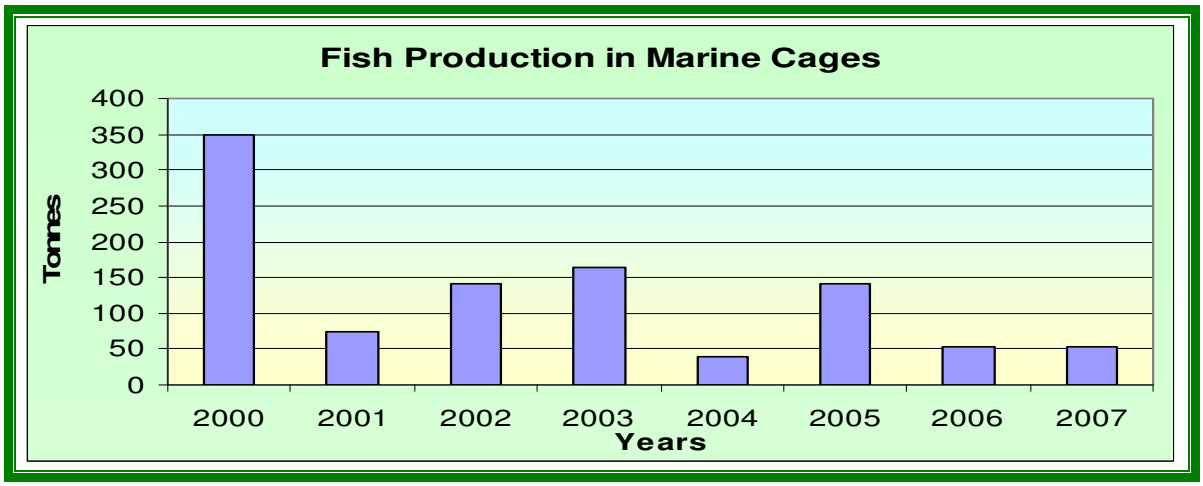

Figure 3

Supply of fish fingerlings

Fish fingerings are entirely imported mainly from France, Greece and Egypt. Recently, Kuwait Institute for Scientific Research has constructed a modern hatchery unit. Part of this hatchery is used on rental basis by a private company (Gulf International Company for Aquaculture) which produces contained quantities of fingerlings of Sobaity seabream (*S. hasta*), yellowfin seabream (*A. latus*) and of the orange-spotted grouper (*E. coioides*) for export (see Figure 4).

Supply of fish feeds

Fish feeds are mostly imported from France and the Kingdom of Saudi Arabia through the ARASCO animal feed company which is the main fish feed supplier in Kuwait (protein and fat levels at 45 and 12 percent, respectively). More recently, fish feeds are manufactured on a small-scale by two Kuwaiti-based companies named Sultan Feed Company'" and Kuwait Animal Feed Factory". With due consideration of the quality in term of fish growth rates, now Bubiyan Fishing Company is getting fish feed in limited scale from these companies.

Figure 4

Figure 5

Type and size of cages

The cages used for fish culture were previously the square type and now are all circular with a diameter of 20 meter and 8 meter depth. The outer rings of the cages are made of high density polyethylene (HDPE) pipes filled with buoyancy materials mainly thermocole and the nets are made of nylon material. These nets are periodically removed for cleaning and painting to avoid marine biofouling from organisms such as barnacles. A general view of the current cage site and replacement of a cage net are shown in Figures 5 and 6, respectively.

Figure 6

CURRENT CONSTRAINTS

Cage fish culture in Kuwait has faced severe problems particularly

during the Iraq war in 2003 when all fishing activities were prohibited in Kuwait waters. The Bubiyan Fishing Company's staff was not allowed to visit the cage site during this time. Almost 50 percent of the cages had been washed away and destroyed discouraging the company to reinvest in new cages. Apart from this extraordinary event, the company has also to compete with local fishing companies that are importing fresh fish from neighbouring GGC (Gulf Cooperation Council) countries and placing them on the market at lower prices. This situation forces the company to keep their fish for longer periods, hence increasing production costs. Furthermore, factors such as the unavailability of fish fingerlings when required and high fish mortality due to a red tide occurrence in 1999–2000 has discouraged investments and development of fish cage culture activities in Kuwait.

CURRENT INSTITUTIONAL REQUIREMENT FOR ESTABLISHING CAGES

The present cage culture site is located in the Bay of Kuwait which is thought to be an important nursery ground for juvenile of many species of shrimps and finfish. The Bay of Kuwait has also rich *Sargassum* beds which are used as a preferred refuge by the most important commercial shrimp species in the area (*Penaeus semisulcatus*). Therefore, in order to protect the Bay with due consideration to such nursery habitats, commercial fishing is prohibited as well as in the three mile zone from the coast in accordance to the Ministerial Decree No. 11 of 1983. The Public Authority for Agriculture Affairs and Fish Resources is considering the relocation of the present and future cage culture activities from the Bay of Kuwait to a new site at Al-Kiran Marine Area as illustrated in Figure 7.

In this regard, the PAAFR has entrusted an Environmental Impact Assessment (EIA) study to the Kuwait Institute for Scientific Research on the transfer of the cages from the Bay of Kuwait to the new site. Based on the initial assessment of the EIA study, a new site at Al-Khiran has been identified as suitable for cage farming.

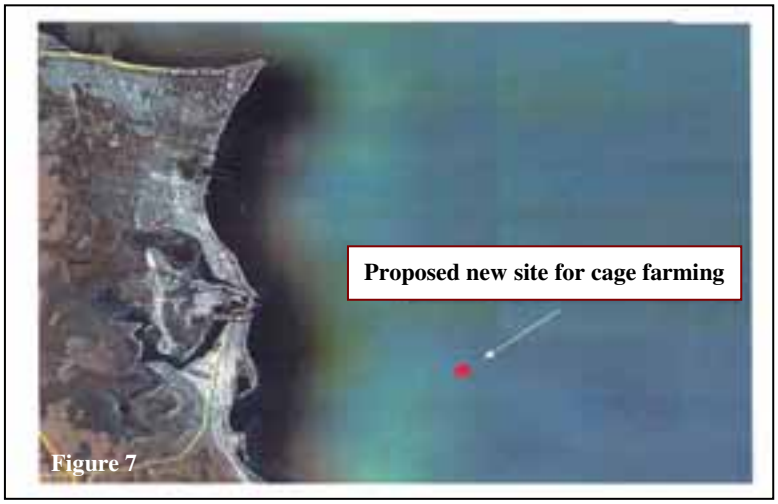

Figure 7

The site at Al-Khiran has the following characteristics (i) the site has a reasonable distant from the mainland and coastguards, (ii) the site has an adequate water depth and reasonable current speeds for natural flushing of the sea bed, and (iii) the site is far from navigational routes and from any petroleum submerged pipe lines. The EIA study is still ongoing and the final decision for the proposed site will be taken once the study is completed.

INSTITUTIONAL DEVELOPMENTAL POLICY

The Public Authority for Agriculture Affairs and Fish Resources (PAAFR) is the responsible authority for regulating cage fish culture activities in Kuwait. The overall fisheries activities in the State of Kuwait are administered under the law No. 46 of 1980. The PAAFR has enacted a specific resolution No. 293 in 2005 for aquaculture development in Kuwait. However, the resolution mainly aims at regulating land-based aquaculture activities. In order to encourage more investment in marine cage culture, PAAFR provides yearly subsidies, such as the one extended to the Bubiyan Fishing Company (KWD 25 000/yr or about USD 88 000). This subsidy is subject to reduction if the company's fish production drops below an agreed amount.

CONCLUSION

Aquaculture is considered as an alternative source of marine fish and has developmental potential in Kuwait. The country's natural fish stocks are under great biological stress and capture production figures have declined in recent years. Hence, aquaculture activities are gaining growing support from the Government. Cage aquaculture is expected to offer investment and employment opportunities in future. Recent developments including the establishment of a marine fish hatchery by the Gulf International Aquaculture Company and the identification of the newly proposed site at Al-Khiran are positive indications of the future development of marine aquaculture in Kuwait. The Bubiyan Fishing Company and other companies are likely to establish large cage operations once the new site is confirmed and accessible.

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State of Qatar:
Marine cage aquaculture – A developmental opportunity?

by

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EXECUTIVE SUMMARY

All types of aquaculture practices are new to the Stare of Qatar and the population mainly relies on wild fish catches as their primary source of fish. Commercial cage aquaculture production has not started and existing aquaculture activities have been conducted by researchers on small-scale freshwater facilities using tilapia.

At present there are no marine finfish species farmed, there is no availability of seed material (both wild-caught or hatchery produced) nor feed (either locally manufactured or imported). The Government of Qatar is nevertheless encouraging investments in offshore cage mariculture mainly as a result of limited land availability for land-based operation. However, the Fisheries Department has yet to propose formal institutional requirements for marine site selection, farm licensing, and environment impact assessment and monitoring programme.

With regards to underground freshwater water resources the Government encourages farmers to use the resource as best as possible for the production of agriculture products as well as fish (e.g. tilapia). Furthermore, the Agricultural Development Department has signed an agreement with the Industrial Bank by which long-term loans (25 years at 1.5 percent interest rate) are given to encourage farmer to establish fish farm. The aim of this policy is for the country to become self sufficient with regards to its domestic demand for fish and particularly freshwater fish.

At present, existing freshwater aquaculture operations employ mostly all-male Asian workers many of which come from India.

Sultanate of Oman:
National review on marine cage aquaculture

by

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EXECUTIVE SUMMARY

Oman has a long coast that faces three different seas with distinct environmental conditions. This, along with other structural and environmental advantages provides a high potential for the development of aquaculture activities. Aquaculture industry is still in its infancy stage but there is a strong commitment from the government to develop this sector in a competitive and sustainable manner that is in harmony with the social, economic, cultural and historic values of the country. Marine cage culture is an important sector of aquaculture in Oman. The first commercial aquaculture production in Oman came from this type of aquaculture. Numerous applications for marine cage culture projects by private entrepreneurs are currently under licensing evaluation. At present, there is only one commercial marine cage farm located in the Muscat Governorate which started production in 2003 (Figure 1). The main finfish species cultured is the exotic gilthead seabream (*Sparus aurata*); other species which have been used include the European seabass (*Dicentrachus labrax*), the thinlip grey mullet (*Liza ramada*) and to less extent the orange-spotted grouper (*Epinephelus coioides*) and the local yellowfin seabream (*Acanthopagrus latus*).

All coastal regions in Oman have their own topographical and environmental conditions which will determine the type of culture methods that can be established. For marine cage culture projects, the most suitable sites are found in the Musandam Peninsula, an exclave of Oman separated from the rest of the country by the United Arab Emirates. The Peninsula has an area of 1 800 square kilometres and the governorate consists of four namely Khasab, Bukha, Daba Al-Bayah and Madha. This region has deep fjord-like inlets (known as "Khawrs") which are suitable for marine cage culture. Currently, there are three private cage farming applications under evaluation in this region.

At present there are a number of rules and regulations that control the process of aquaculture site selection, farm licensing and environmental impact assessment (EIA) requirements for all aquaculture project including marine cage farms. The main regulation that regulates the aquaculture sector is the by-law for aquaculture and quality control of aquaculture products issued in 2004 by the Ministry of Fisheries. With regards to the farm sites these should not conflict with the activities of local fishermen and they should be located away from environmentally sensitive areas such as mangrove swamps, coral reef and turtles nesting sites. The selection process is overseen by a specific aquaculture committee headed by the Ministry of Fisheries and includes members of other relevant governmental authorities.

Protecting the environment is one of the main priorities for the Government and hence a special ministry was established for this purpose. There are different regulations concerning the protection of environment and some of these are related to the development of the aquaculture sector. According to the current laws, any aquaculture project should obtain an environmental permit before starting its operations. Furthermore, there is a special regulation that controls the issuance of environmental approvals for all commercial projects including aquaculture. In this regulation, aquaculture projects are classified under the category of projects that require a detailed EIA study although there are no specific requirements for such EIA studies. The existing requirements for EIA studies are general and many vary depending on the type of the project.

The environment regulations and EIA studies are enforced and effective. For aquaculture, there is a need to develop specific requirements and guidelines for EIA studies which cover all aspects of aquaculture effects on the environment and its interactions with capture fisheries and the surrounding environment.

BRIEF HISTORY OF MARINE CAGE AQUACULTURE IN OMAN

Marine cage culture activities started in Oman in 1997 by a research project conducted by the Ministry of Fisheries in cooperation with a private company. The project was carried out in Bandar Khyran area in Muscat Governorate (Figures 2). The main objective of this project was to test the viability of marine cage culture in Oman. Four small cages (14 m diameter) were used in the project (Figure 3). Two commercial marine finfish species were tested including the exotic gilthead seabream (*S. aurata*) and the endemic Sobaity (*Sparidentex hasta*). The juveniles for both species were imported from outside; the gilthead seabream from Greece and the Sobaity from the Kingdom of Bahrain.

Within 15 months, the gilthead seabream reached the marketable size (300–400 g), while the Sobaity attained up to 600 g in one year. The successful results certainly encouraged the private sector to invest in marine cage farming. This was reflected in the applications from different private companies to use the site and facilities of the research project and also in the applications to establish commercial marine cage culture projects on other parts of Oman.

Figure 1

In 2001, a private company invested in this site and increased the numbers and sizes of the cages. This was done through an agreement with the Ministry of Fisheries, where technical staff of the Ministry received training from the company. The Ministry favours a strong cooperation with the private sector as it believes that such cooperation will lead to a sustainable development of the sector.

Figure 2

The same company also exploited a further site in Muscat (Quriyat region). This project started with three finfish species, the gilthead seabream (*S. aurata),* the European seabass (*D. labrax),* the thinlip grey mullet (*L. ramada*) and later they experimented two local species, the yellowfin seabream (*A. latus),* and the orange-spotted grouper (*E. coioides*). In 2003, the company initiated a capture-based aquaculture activity by fattening the yellowfin tuna (*Thunnus albacores*).

CURRENT SITUATION

Description of national coastline

Oman is located in the southeast corner of the Arabian Peninsula. It has more than 3 165 km of coast from Musandam in the north to Salalah in the south. It faces three seas: the Arabian Gulf, the Gulf of Oman and the Arabian Sea. Oman has 9 regions of which 6 are coastal ones (Figure 3). The total surface area of Oman is approximately 309 500 km^2, which comprises of the continental land and the main islands such as Masirah and Al-Halaniyat. Oman has about 11 topographical areas including mountains, coastal alluvial plains, pediplains and sand dune areas. There are two coastal alluvial plain in Oman; one in Al-Batinah region and the other in Salalah. These plains were formed from the deposition of wadis; mainly fine sand and granules.

Figure 3

The coastal shelf is narrow in the Musandam region and in the area from Muscat to Ra's Al-Hadd and in the south of the country around Salalah. Along these stretches of coastline the 30 m depth contour is just a few miles from the coast. In contrast, along much of the coast of Al-Batinah, Ash-Sharquiyah and Al-Wusta regions, the 30 m depth contour is not reached until 5–10 nm offshore and after 20 nm in the Gulf of Masirah in northern Al-Wusta.

Musandam in the north of Oman has a coast length of approximately 600 km, extending from Tibat in the Arabian Gulf to Daba in the Gulf of Oman (Salm, 1991). The Musandam Peninsula is formed of a series of precipitous peninsulas and headlands enclosing deep fjord-like inlets (Figure 4). This coast includes different type of beaches such as cliffed, rocky, gravel and sandy beaches. The major structural component of the coastline is the limestone cliffs. These cliffs reaching height over 240 m in some places and form about 66 percent of the total coastline (Salm, 1991).

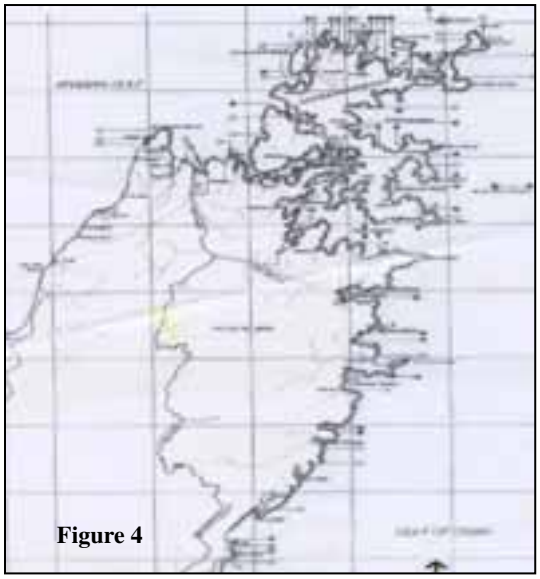
Figure 4

This region is considered as one of the most suitable places for marine cage culture in the country (Al-Yahyai *et al*., 2004). The region has numerous khawrs (fjords) among which Khawr Humzi, Khawr Habalyn, Khawr Shamm (Figure 5), Khawr Najd, Khawr Shisa. These kharws are protected from strong storm and are generally deep.

The coast of Al-Batinah region comprise a wide, fertile coastal plain formed of alluvial deposits leading to brown sandy beaches with occasional outcrops of beach rock (Salm, 1991). In general, the adjacent seas of this coastline are shallow and sandy. Establishing a marine cage farm in this area needs careful study and considerations for the site.

The Muscat Governorate is the capital of the country. Its coastline is characterized mostly by rocky shores with few sandy beaches. There are few protected areas along this coastline such as Bandar Khyran area where there used to be a marine cage culture project. The coast between Quriyat and Daghmar includes a large alluvial plain, which encompasses an extensive delta system and is itself boarded on the landward side by rocky mountain (Salm, 1991). Between Daghmar and Dibab, Fins and Tiwi, there are cliffed shores with scattered rocky reefs. From Dibab to Fins, the shoreline is backed by raised gravel terraces, with cobble or gravel beaches or rocky shores and few stretches of sandy beaches.


Figure 5

The coastline of Sharqiya region varies from one place to another. The coast from Tiwi to Qalhat is characterized by terraces, which are fringed by cobble or gravel beaches or rocky shores with some stretches of sand beaches (Anon., 1985a). This coastline is considered not favourable for land aquaculture development. It consists of cliffs of 5–10 m in height, or gravel beach exposed to strong wave action. The soil is bear rock in some instance, or mostly sandy with gravel and boulders. The distance between the sea shore and the mountain range is small and never more than a few hundred metres. This relatively quick topographical raise will not allow easy development of pond facilities. In the adjacent sea however, there are possibilities for establishing marine cage culture. Cliffed shores are also found in Khawr Al-Hajr, Al-Hadd and Ad Daffah. These cliffs are bordered by deep sea. Along this coastline, there are many areas of Khawrs such as Khawr Jrama and Khawr Al-Hajr. These kharws provide natural habitat for many species.

There are many sandy beaches, which are backed by low rocky mountain such as the ones in Ra's Al-Hadd to Al-Khuwaymah. The Arabian Sea starts from Ras Al-Hadd area (Sharqiuah region) to Dhofar Governorate in the south. During the monsoon period (June-September), the Arabian Sea becomes very rough and its conditions may not favour the development of a marine cage industry.

Al-Wusta region has the second largest land area among Oman's nine regions, with the smallest number of inhabitants. This coastline comprise of different types of environments such as sandy beaches, coastal plains, rocky mountains, sand dunes, shallow near shore seabed with sand-rock substrates and deep rocky seabed (Anon., 1985b). There are many areas of environment interest along this long coastline among which Barr Al-Hikman and Mahout Island are the main areas. Barr Al-Hikman marks the transition from the high-moderate energy coast of the north to the moderate energy coast that extends south to Ra's Madrakah (Anon., 1992). Mudflats and clear lagoons around Bar Al-Hikman are home to large populations of migratory and indigenous bird species. There are also some khawrs areas along this coastline which is also characterized by a large free sabkha area. Very few protected areas along this coast may be suitable for marine cage culture.

Dhofar Governorate has a coastline that stretches for 560 km. It includes sandy beaches, rocky shores and cliffed areas. There are also groups of islands along this coast of which the Al-Halaniyat group of islands are the largest in Oman. The entire coast is exposed to heavy wave action. There are also a number of rocky-gravel plain areas along this stretch of coast such as the ones seaward of Jabal Samhan and in the areas of Sharbitat, Shuwaymiyah and Hasik.

The coastline is characterized by a chain of mountains (e.g. Jabal Qamar, Jabal Samhan, Jabal Qara) interspersed by long sandy beaches, the longest of which extend from Raysut to Mirbat, broken only by a rocky outcrop at Taqah (Barratt, 1984). Raised terraces of gravel and rock border the sea at Sharbitat, the western end of Shuwaymiyah and intermittently from Hasik to Mirbat. Most of the coastline from Raysut to border with Yemen is cliffed or has steep mountains. There are many khawr areas along this coastline especially surround Salalah area.

Salalah plain is a gently sloping alluvial outward plain formed by the depositing of weathered material worked from the adjacent mountains (Anon., 1985b). Alluvial materials are deposited in a sequence manner, coarser materials near the mountain and finer materials towards the coast. Marbat plain lies adjacent to Salalah plain, but it differs in its geomorphology. This plain is covered almost entirely by cemented alluvial terraces and heavily dissected metamorphic rock outcrops.

Dhofar is climatically different from the rest of Oman due to the effects of the monsoon rains which occur between June and September. Temperature is moderate, rarely exceeding 30 ºC. Dhofar divides naturally into three areas: the coastal plain, the mountains and the desert region.

The strongest winds of the year comes at the time of the south-west monsoon from July-September, and the Arabian Sea coast experiences the heaviest wave action during this period. The Gulf of Oman is more protected from large swells and waves year round compared to the Arabian Sea. There has been only limited research into currents along the coast of the country, but the Oman Meteorological Department has good hydrographical, as well as meteorological, modelling capability and has run detailed predictions for seasonal current patterns around the coast.

Farmed and candidate marine species in cages

Currently, there is only one commercial marine cage farm operating in Oman. This project cultures the introduced gilthead seabream (*S. aurata*). The culture of this species was experimented by the aquaculture centre in 1997 and proven to be economically successful candidate. Table 1 shows the different finfish species that have been cultured in cages in Oman. Three species are exotic species and include the gilthead seabream (*S. aurata*), the European seabass (*D. labrax*), and the thinlip grey mullet (*L. ramada*). The seabass and mullet were introduced by the private company in year 2001 and imported with health certification produced by a certified laboratory outside the country. However, due to the encouragement of the government to use the local species, the company carried out culture trials using two local species, the yellowfin seabream (*A. latus*) and the orange-spotted grouper (*E. coioides*) by importing certified seed material obtained from a hatchery operating in Kuwait. The local yellowfin tuna (*T. albacres*) was experimented for fattening in 2003 and proven successful.

Table 1. Cultured species in marine cage culture in Oman

English name	Scientific name	Comments
Gilthead seabream	*Sparus aurata*	Research, commercial
Sobaity seabream	*Sparidentex hasta*	Research
European seabass	*Dicentrarchus labrax*	Commercial
Thinlip grey mullet	*Liza ramada*	Commercial
Yellowfin seabream	*Acanthopagrus latus*	Commercial
Orange-spotted grouper	*Epinephelus coioides*	Commercial
Yellowfin tuna	*Thunnus albacres*	Commercial

There are also other marine finfish candidate species for cage aquaculture in Oman such as Cobia (*Rachycentron canadum*), different species of groupers (*Epinephelus* spp.), the red seabream (*Cheimerius nufar*) and gold-lined seabream (*Rhabdosargus sarba*).

Supply of seeds and feeds

The seeds for all the cultured species are imported from outside the country due to the absence of local hatcheries for marine finfish species. Likewise the feed it is imported from outside the country.

Figure 6

Type and size of cages used

The marine finfish cage culture projects currently use cages made of high density polyethylene (HDPE) (Figures 6 and 7). Theses cage are of different size and capacity according to their uses. Some cages are of 14 m in diameter while most are of 20 m in diameter. The nets used are knotless type, polyimide treated with non-toxic antifouling substances. The depth of the net is usually around 6 meter.

Figure 7

Existing cage farms and applications

Currently there is only one existing marine cage farm in Oman located in Quriyat region (Muscat Governorate). This company relocated all of its cages from Bandar Khyran area to its present site in Quriyat region (Figure 8). The coordinates of the farm are given in Table 2. Eight cages are actively used in the farm. Apart from this operation at present there are three applications for establishing marine cage farms all in Musandam Governorate in the north of Oman.

Table 2. Coordinates of the marine cage farm in Quriyat (Muscat Governorate)

Region	Wilya	Site	GPS reading	
			N	E
Muscat	Qiryat	Qiryat	23 17 00	58 56 17
			23 16 79	58 56 33
			23 17 00	58 60 60
			23 17 17	58 56 42

Past and current production volumes per species

The commercial production from marine cage farm in Oman started in year 2003 (Table 3). European seabream dominate the production throughout the pas years. At the end of year 2007, the company stocked new shipment of European seabream fingerlings in Quriyat site that was imported from Kingdom of Bahrain with a health certificate.

Table 3. Commercial production of cage aquaculture in Oman

Species	2003	2004	2005	2006
Gilthead seabream	331	460	180	81.7
European seabass	13	27	-	-
Thinlip grey mullet	8	-	-	-
Yellowfin seabream	-	13	-	-
Yellowfin tuna	-	14	-	32
Orange-spotted grouper	-	0.222	-	-
Total	352	515.2	180	113.7

CONSTRAINTS & OPPORTUNITIES FOR MARINE CAGE CULTURE DEVELOPMENT

Development of aquaculture in Oman will likely provide opportunities to increase fish production, export revenues and create coastal employment. There are numerous opportunities which would encourage and enhance the development of marine cage culture in Oman, and these include:

- stable government;
- national strategy of economic diversification
- availability of investors ready to invest in the sector;
- availability of suitable sites for cage culture including sheltered inlets with deep waters;
- clean and unpolluted seas;
- availability of infrastructure along the coast;
- availability of local species with good potential for cage farming;
- strong seafood processing sector;
- good access to main markets in the European Union and in Southeast Asia;
- availability of trained human resources (Sultan Qaboos University/Fishermen Training institute); and
- availability of a modern and fully equipped fish quality control centre.

In contrast, there are also a number of constraints that may slow down the development of marine cage culture in Oman, and these include:

- lack of support industries such as feed plans and equipment manufacturers;
- lack of commercial hatcheries;
- large portion of the coast exposed to wave action especially during the monsoon season along the Arabian Sea;
- possibilities of oil spills due to the busy shipping routes through the Strait of Hormuz or from coastal ports and industry; and
- highly fluctuating air temperatures and high water evaporation rates which can induce water temperatures and salinities to rise above acceptable levels for many farmed species.

INSTITUTIONAL REQUIREMENTS FOR ESTABLISHING & OPERATING CAGE FARM

Site selection

Currently, a private company or investor that wishes to develop a marine cage farm must first identify the site where to locate the farm. General information on potential sites, environmental (salinity, dissolved oxygen, etc.) and meteorological data can be obtained from relevant authorities. These authorities include the Aquaculture Centre, the Marine Sciences and Fisheries Centre (Ministry of Fisheries) and the Directorate General for Civil Aviation and Meteorology (Ministry of Transport and Communications).

There are no specific guidelines for selecting site for marine cage farm, but there are few conditions that deal with the issue of site selection in the by-law on aquaculture and quality control of aquaculture products (see Annex 1). According to these conditions, the selected site should not interfere with the activities of local fishing communities and away from natural conservation areas such as mangrove and coral reefs. The site should also be at a reasonable distance from navigation routes. Considerations should also be giving to marine safety such as materials to be used, warning signals and lights.

The Ministry of Fisheries established an aquaculture technical committee in 1996 to review aquaculture projects applications submitted by the private sector. This committee includes members from different authorities including the Ministry of Fisheries, Ministry of Housing, Ministry of Transport and Communications, Ministry of Tourism, Ministry of Trade, Ministry of Environment and Climate Affairs and the Oman Chamber of Commerce and Trade. This committee determines the suitability of any site submitted by an investor. For marine cage culture projects, the Ministry of Transport and Communications will provide information on navigation routes near the proposed site, if any, and determine the conditions to be followed by the investor with regards to marine safety issues.

Realizing the importance of identifying suitable sites for aquaculture, the Ministry of Fisheries has initiated a project to produce a detailed atlas where potential aquaculture sites will be indicated. The atlas will include information on environmental data, size of the sites and other relevant data. Sites for marine cage culture will be indicated in the atlas.

Farm licensing

According to the current regulation (By-law on aquaculture and quality control of aquaculture products), the establishment of fish farms shall not be allowed unless the necessary licences are obtained from the competent authority (Ministry of Fisheries). Clear procedures exist for aquaculture applicants from the early submission stages to the final approval of the licence. These procedures are illustrated in Annex 2. There are eight articles in the by-law on aquaculture that determine the process for obtaining an aquaculture licence including marine cage projects (see Annex 3). These articles also determine the conditions for the licence and the time required to obtain one. When the application is

submitted by an investor and evaluated by all members of the aquaculture committee, a preliminary approval will be issued based on a number of criteria including the financial strength of the company, acceptance of the applicant for the monitoring programme, and clearance that there are no overlapping interests for the specific site by the local fishing communities.

The final permit for the aquaculture project shall contain information such as establishment's name and address, location and its area, type and quantities of the cultured organisms, date of issue, duration, and type of licensing. The by-law also determines the regular licence fees for all aquaculture projects including marine cage farms (see Annex 4). When the operations start, there are other licensing required by investors such as those for importing fish fingerlings, feeds, drugs and equipments. At present the Ministry of Fisheries will coordinate with other relevant ministries to obtain all the necessary permits.

Environmental Impact Assessment (EIA)

Environmental permit

Protecting the environment is a priority for the Government of Oman. Therefore, the Ministry of Environment and Climate Affairs (MECA) was established as the governmental authority responsible for the protection of environment. There are numerous laws focused on the protection of the environment. The law on the Conservation of the Environment and Prevention of Pollution is the main one and provides the framework for environmental protection in Oman. The law was issued by the government in 1982, and subsequently amended by the Royal Decree No. 114/2001 on 14/11/2001. Many regulations and ministerial decrees have been issued by MECA for the enforcement of this main law. According to this law, no establishment of any source or area of work shall be started before obtaining an environmental permit confirming its environmental soundness. This also includes aquaculture projects.

The Ministerial decision 187/2001 for organizing the Issuance of Environmental Approvals and the Final Environmental Permit is an important regulation and it includes aquaculture projects (see Annex 5). This regulation details the necessary requirements and the approval system for environmental impact studies (EIA). In this regulation, all industrial/commercial establishments have been classified into three categories according to the materials used in the production process, production capacity and the likely degree of their impact to the environment. Each category has its own environmental conditions according to the level of environmental impact arising from its construction and operation. Aquaculture projects are classified in the third category, which requires a detailed EIA study.

According to the regulation, the owner of an establishment (including aquaculture facility) shall apply to MECA for environmental approval. The Environmental Impact Assessment (EIA) study will be submitted with the application and the ministry official will then inspect the proposed site to determine the environmental conditions that must be fulfilled. Only at this point the preliminary approval is given to the establishment to commence the construction process. The approval will include specifications on environmental conditions to be fulfilled prior to starting the operation and is valid for one year and renewable for a similar period. The final environmental permit is given to the establishment after fulfilment of the conditions stated in the preliminary environmental approval and shall be valid for two years and renewable for a same period or other specified period.

There are fees against the issuance of the environmental approval and the final environmental permit. Depending on its nature of activities as evaluated by the competent authority, the establishment is bound to conduct an Environmental Audit (EA) by specialized companies approved by the competent authority according to the requirement of the ISO 14000 series for environmental management system, every two years from the date of receiving their final environmental permits.

General and technical guidelines for environmental permit

There are no specific guidelines for EIA study for aquaculture. The existing guidelines are rather general and were prepared by MECA. Aquaculture activities have been included in marine and coastal projects which also includes commercial ports, fishing harbours, marine bridges, marinas and clubs and artificial lakes. The general and technical requirements for this group of projects are listed in Annex 6. Among the various requirements there is one that states that aquaculture projects should used local species as far as possible and to avoid natural areas such as coral reefs, khawrs, and mangrove areas.

EIA study

According to the requirements established by MECA, there are specific criteria for projects that require a detailed study on environmental impact. These criteria are:

- Projects with considerable adverse impacts on the social or natural environment or those which have impacts on an area larger than the project site.
- Large projects with major capital investment or manpower and projects which cover large areas.
- Projects which use large quantities of chemicals, hazardous substances or that run operations and activities which might cause health hazards.
- Projects with potential adverse impacts on natural, cultural, social, historical, heritable, aesthetic, scenic or industrial resources.

The EIA process is base on the following guiding principals:

- EIA is a process to help decision makers to protect, conserve and manage Oman's environment according to the principal of sustainable development, thereby achieving or maintaining human well being, a healthy environment and a sound economy.
- The EIA process should ensure that the individual, company or government agency proposing a project considers its effect on the health, economy and culture of the surrounding communities as well as its impacts on the air, land and water.
- The EIA must be applied as early as possible in a project's planning stage and before irrevocable decisions are made.
- Public information as an important component of an open and balanced EIA process.

There are few criteria that can be applied to determine the appropriate level of EIA study. These include type and magnitude of the project, location and sensitivity and likelihood, nature and magnitude of the potential impacts. In order to evaluate the nature of the impacts of the project, there are several aspects that need to be considered and these include; project type, site sensitivity, possibility of irreversible destruction of nature habitats, cumulative environmental impacts, sustainable use of renewable resources, impacts on human health and safety and effectiveness of mitigation measures.

The applicant for any commercial project including aquaculture should consult MECA to establish the scope of the study and to focus the study on significant issues and concerns. The key features of EIA study is illustrated in Annex 7.

The MECA will review and evaluate the EIA to ensure that all significant impacts are addressed and conclusions of the EIA study are derived through the required planning steps. The complete EIA study documents become part of the application package for an environmental permit. After the review is completed the Ministry will either:

- accept the conclusion of EIA and issue an Environment Permit;
- request a further study; or
- request re-application for an alternative proposal.

The data and information that should be included in the EIA are outlined in Annex 8. This information describes environmental assessment, project site and its environment, different impacts and mitigation measures.

Environmental monitoring programming

Currently, there is no clear separate monitoring programme for aquaculture. A monitoring programme is under preparation by the Environmental Monitoring Section of the Aquaculture Centre. The Fish Quality Centre under the Ministry of Fisheries established in 1998 is responsible for increasing the quality of exported Omani marine products. The centre also conducts regular inspection visits to fisheries companies which include aquaculture projects to ensure that they comply with national and international regulations for quality. All company should obtain a quality control number before it can start its operation. The process for this number includes application of a HACCP system.

In order to meet the international standards required for the aquaculture export products, the Fish Quality Centre established a new laboratory for residual analysis. This laboratory is equipped with LC-MS/MS for the analysis of banned antibiotic like Chloramphenicol, nitrofuran metabolites, tetracyclines and sulfa drugs. This Centre also prepared a national residue monitoring plan in conformity with the European Council Directive 96/23/EC and requirements for submission of residue monitoring programme.

INSTITUTIONAL DEVELOPMENT POLICY

National plans and targets

The Ministry of Fisheries has prepared National Strategic Plan for Sustainable Aquaculture Development in the Sultanate of Oman in cooperation with the Food and Agriculture Organization of the United Nations (FAO, 2007). The overall purpose of this Strategic Plan is to provide guidance to the government on public and private action that will promote the development of a viable and sustainable aquaculture sector, in a way that is consistent with national priorities. This strategic plan outlines the opportunities and constraints in the aquaculture sector in Oman. It also recommends the suitable species and culture methods for the country based on the local conditions.

The aim of the Ministry of Fisheries is to develop the aquaculture sector in a competitive and sustainable manner in harmony with the social, economic, cultural and historic values of the country. The development objectives of this sector include:

- Develop an aquaculture industry that ensures food security to the population, provides employment, generates export earnings and contributes to diversification of the economy.
- Ensure economic and environmental sustainability of the developing aquaculture industry, with good environmental stewardship and social equity.

According to this strategic plan, the guiding principals (or policy framework) are:

- Government shall encourage responsible development of aquaculture and establish aquaculture specific policies and regulations.
- Commercial development of aquaculture is the responsibility of the private sector. The public role is to provide an enabling, transparent and efficient regulatory and supporting framework for responsible development.
- Aquaculture is a legitimate user of land and water resources; it should have equitable access to these natural resources.
- Streamlining and coordination of government policies and regulations and a transparent decision-making process are critical for success.
- A decision-making process that is transparent, efficient and participatory is necessary to avoid conflict and facilitate compliance.
- Development should employ a precautionary approach to avoid and minimize environmental impacts and promote integration with the ecosystem.
- Development projects should be assessed according to agreed-on environmental standards in line with existing environmental regulations of the expert agency.

This strategic plan recommends the following strategic steps to promote sustainable development of aquaculture in Oman:

- Create an appropriate legislative and regulatory framework.
- Create an enabling administrative framework.
- Support commercial aquaculture development.

Subsidies and financing policies

Currently, there is no policy for aquaculture subsidies. With regards to financing, there are soft loans for companies working in fisheries sector including aquaculture company. Authorized company can apply for this type of loan from the Oman Development Bank. The amount of loan depends on the capital of the company and its location (inside or outside the Muscat Governorate).

Production for domestic markets or exports

The marketing of the production depends on the company policy and its objectives. Most of the previous commercial production from marine cage culture project in Oman was for export and lower quantity products were destined for domestic market.

Employment and gender issues

The current marine cage operation employs a total of 14 persons of which eight are Omani. The Omani cover both administrative as well as cage site jobs. The Government encourages Omanization in all the projects from different commercial sectors. The Ministry of Manpower is the main governmental authority responsible for proposing and implementing manpower general policies in line with the state economic and social objectives. The Ministry also drafts laws regulating the labour market and the vocational training sector and issues regulations and decisions to ensure their implementation for the protection of the national labour force. The Ministry is also responsible to develop training curricula according to the approved vocational criteria and levels, awarding qualifications, encouraging on-the-job-training and following graduates to ensure that they utilize the available job opportunities.

The Ministry of Labour has established a national labour force register which includes all relevant data and information on the labour force and thoroughly monitors data and information changes. There are plans to increase the percentage of Omani people in all production and services sectors. These plans were prepared in cooperation with the private sector.

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ANNEX 1

National regulation concerning site selection

Article (13): Preliminary approval for all commercial aquaculture projects shall be granted based on the following:

- The financial ability of the establishment to implement the project.
- Acceptance of the applicant to follow-up and inspection visits of government staff to ensure that the applicant is committed to the technical guidelines dictated by the competent aquaculture authority.
- There are no negative interactions with the activities of local fishermen, and there are no adverse impacts on natural conservation areas, mangroves and coral reefs.
- The water inlets for land-based projects shall be far from the drainage outlets to water pollution.
- Commercial aquaculture permits shall not be provided for sites located in proximity of busy navigational routes.
- Marine safety conditions regarding materials employed, the used of appropriate warning signals and lights in the project shall be taken due consideration.

ANNEX 2

Procedures for obtaining licence for aquaculture project (including marine cage farm)

Competent authority Directorate General of Fisheries Research, Ministry of Fisheries

Documents required

1. Application letter requesting to establish an aquaculture project addressed to the Directorate General of Fisheries Research (Head of Aquaculture Committee).
2. Application form.
3. Preliminary overview of the project.
4. Feasibility study.
5. Environmental Impact assessment (EIA) study.
6. Registration documents of the company.
7. Other documents that may be required following the evaluation of feasibility study or in case government fund are required.

Steps

1. Provide documents 1, 2 and 3 to the Directorate General of Fisheries Research (Head of Aquaculture Committee).
2. The application and proposed site will be evaluated by the technical staff of the Ministry.
3. In case there are no technical objections on the application and proposed site, the application will be forwarded to the Aquaculture Committee.
4. In case of an approval from the Aquaculture Committee, the applicant will be notified with the preliminary approval along with conditions from each government authority.
5. The applicant should then submit documents 4, 5, 6 and 7 to the Aquaculture Committee for further evaluation.
6. It may be required to adjust these studies according to the comments of Committee's members.
7. A recommendation will be forwarded to the Minister of Fisheries for final approval of the proposed aquaculture project.

ANNEX 3

Regulations concerning farm licensing in the aquaculture by-law

Article (12): The establishment interested in establishing an aquaculture project shall submit its application to the competent authority using the specifically designed application form for this purpose. The application shall contain the following:

- Name of the region and of the willayait (district), the exact locating of the proposed project site, its size of the area, and information on how the land is obtained.
- Type of the aquatic organism to be farmed, source of the seed material and quantities required.
- Expected starting date of the project, duration and estimated costs.
- Quality of water to be used in the project, quantity and source and method of discharge if the project is land-based.
- Type of aquaculture system (fixed, movable or floating cages).
- A recent socioeconomic feasibility study if the project is intended to be of commercial size.

Article (13): Preliminary approval for the commercial aquaculture shall be granted based on the following:

- The financial ability of the establishment to implement the project.
- Acceptance of the applicant to the follow-up and inspection visits of the Ministry personnel to make sure that the applicant is committed to the technical guidelines dictated by the competent authority in aquaculture.
- No effects on local fishermen from the project, in addition to the natural conservation areas, mangroves and coral reefs.
- The water inlets for land-based projects shall be far from the drainage outlets to avoid pollution.
- Commercial aquaculture permit shall not be provided for sites closer to the crowded navigational routes.
- Marine safety conditions regarding material used, warning signals and lights in the project shall be taken into consideration.

Article (14): The establishment that has obtained a preliminary approval for its application shall be responsible to obtain all required permits for the execution of the project from the relevant and competent authorities.

Article (15): The preliminary approval shall be cancelled if the establishment fails to obtain the required permits from the relevant and competent authorities within one year for experimental aquaculture and two years for commercial aquaculture projects.

Article (16): The establishment shall be notified officially in written in the event of any contravention of its operations; the competent authority shall cancel the permit, if the establishment fails to resolve the contravention in one month.

Article (17): The aquaculture permit shall contain the following information:

- Establishment's name and address.
- Exact location and its surface area.

- Species and quantities of cultured organisms.
- Date of issue, duration, and type of licensing,
- Any other project-specific information required by the competent authority.

Article (18): The experimental aquaculture period shall be for 2-years, while commercial undertakings will be granted periods of 10-years. These periods can be extended.

Article (19): The competent authority will issue annually renewable 1-year permits for experimental and commercial.

ANNEX 4

Fees fixed on fish farms licences

Fee	**Amount in omani rials**
First – Experimental aquaculture:	
- Fees for preliminary approval.	5 rials.
- Fees for issuance or renewal of the permit.	20 rials.
Second – Commercial aquaculture:	
- Fees for preliminary approval.	10 rials.
- Fees for issuance or renewal of the permit.	40 rials.
- Supervision fees.	One percent from the total value of the annual production starting after 5 years from production, calculated from the actual prices of the fish specified in the executive by-law of the Marine Fishing Law.
Third – Other fees:	
- Fees for transferring the permit.	10 rials.
- Fines for late renewal of the permit.	Two rials for the experimental project permit, 4 rials for the commercial project following 60 days from the expiry date of the permit.
- Fees for compensation	5 rials.
One rial for a Permit Application Form.	

ANNEX 5

Regulation for organizing the issuance of environment approvals and the final environment permit

Article (1): In the application of the provisions of these regulations, the words and phrases shall have the following meanings unless stipulated otherwise:

Environmental approval shall include:

– Preliminary environmental approval:

To he granted to the establishment to commence the construction process and the approval shall include specifications environmental conditions to he fulfilled prior to starting operation and shall be valid for one year and renewable for a similar period.

– Temporary environmental approval:

To be granted to industrial establishment located outside an industrial areas specified by the competent authorities and to projects complementary to infrastructure ones. The approval, in all cases, shall he valid for one year and renewable for similar periods until the existence of an industrial area or completion of the infrastructure project as appropriate.

– Environmental permit to infrastructure projects:

To he granted to infrastructure projects not requiring follow-up after completion of the construction. The approval shall he valid for one year and renewable for similar periods until completion of the project.

– Final environment permit:

To he granted to the establishment after fulfilment of the conditions stated in the Preliminary Environmental Approval and shall be valid for two years and renewable for a similar period or other specified periods.

Article (2): The establishments, subject to the provisions of these regulations, shall be classified into categories according to the materials used in production, production capacity and the degree of their impact on the adjacent environment as indicated in the attached annex. Every category stated in the said annex shall have its own environmental conditions according to the level of environmental impact arising from its construction and operation.

Article (3): The owner of an establishment shall apply to the Ministry on the form approved by the Ministry and in addition enclose an environmental impact study prepared by a consulting office approved by the Sultanate, if required by the Ministry.

Article (4): The Ministry official shall as a preliminary step toward issuance of the environmental approval inspect the proposed site to determine the environmental conditions that must be fulfilled.

Article (5): The owner of the establishment shall be bound to implement the required conditions and shall inform the Ministry of the same and after ensuring that all conditions were implemented prior to issuance of environmental approval or final Environmental Permit.

Article (6): Fees against the issuance of the environmental approval and the final environmental permit as per the attached table shall be collected.

Article (7): The establishment mentioned in the attached annex if the nature of their activities so require – as evaluated by the Ministry – shall be bound to conduct an Environmental Audit (EA) by specialized companies approved by the Sultanate according to the requirements of the ISO 14000 series for environmental management system, every two years from the date of receiving their final environmental permits.

Article (8): Without prejudice to the penalties stipulated by the mentioned Law on Conservation of the Environment and Prevention of Pollution, the Ministry may close down the establishment if the activity is practiced without environmental approval or final environmental permit or after their expiry dates.

Annex - Dividing the establishments into categories

Category One

1 Small block factories (less than 10 000 tonnes)
2 Carpentry, blacksmith and aluminium workshops
3 Flour and spice mills
4 Ready made clothes factories
5 Tissue paper industry
6 Foodstuff and coffee packaging (less than 500 tonnes)
7 Tissue paper factories (cutting-up to 2 million packets)
8 Water filtration and distilled water (less than 10 million litters)
9 Furniture factories
10 Bakeries and sweets manufacturing (less than 1 000 tonnes)
11 Ice plants (less than 5 000 tonnes)
12 Gas cylinder storage and sale
13 Car wash and oil change workshop
14 Small poultry farms
15 Small printing press

Category Two

1 Chemical plants
2 Pharmaceutical factories
3 Detergents factories
4 Marble, tiles and ceramic plants
5 Oil and gas projects
6 Power stations projects
7 Textile and spinning factories
8 Quarries
9 Plaster production
10 Perfumes and air fresheners
11 Petrochemical plants
12 Aluminium factories
13 Chalk plants
14 Water purification and desalination stations
15 Organic fertilizers
16 Tanning projects and leather industries
17 Crushers and screens
18 Mining
19 Large block factories (10 000 tonnes and more)
20 Large-scale printing press (3 000 tonnes and more)

Category Three

1 Poultry farms
2 Water treatment stations
3 Slaughter houses
4 Dairy production
5 Marine clubs, harbours and bridges
6 Artificial lakes
7 Water supply networks
8 Storage and recharge dams
9 Livestock sheds
11 Agriculture production and animal fodder
12 Fisheries packaging
13 Commercial and fishing ports
14 Fish farming
15 Roads
16 Commercial and residential complexes
17 Hospitals and health centres
18 Permanent and temporary worker's camps
19 Petrol stations

Table - Issuance of environmental approvals and the final environmental permit fees

No.	Type of activity	Fees in omani rials
1	Preliminary Environmental Approval: Category One Category Two Category Three	 3 5 7
2	Temporary Environmental Approval: Category One Category Two Category Three	 3 5 15
3	Environmental Permit for Infrastructure Projects	
4	Final Environmental Permit Category One Category Two Category Three	 5 10 30

ANNEX 6

General and technical requirement regarding environmental impact assessment of marine and coastal projects group

This group includes the following projects: commercial ports and fishing harbours, marine bridges, marinas and clubs, aquaculture, artificial lakes, and other projects specified by the Ministry*

General requirements that apply to all projects listed within this group

- The applicants should submit the completed form for Environmental permit and if necessary attach an Environmental Impact Assessment Study (EIA).
- Submission of a letter from the project owner.
- Submission of the project design (all concerned government approvals shall be incorporated along with the application).
- The applicant/owner is fully legally and financially responsible for any environmental impacts during construction, operation and post-closure phase of the project, including cost of mitigation measures, created by the actions or lack of action of its employees, contractors, subcontractors, payment of compensation, settlement of claims, etc.
- If possible, the company should avoid locating the project in areas of dense vegetation.
- If applicable, the company shall notify the Air and Noise Pollution Section of the Ministry on the intention of using explosives.
- The company should ensure that the proposed location comply with coastal set backs specified in the Ministry's regulation.
- The applicant should provide the designated Ministry's staff with unrestricted access to the project site to ensure that all relevant environment impacts of the projects are being considered.
- The company shall collect solid waste and dispose of it on sites approved by the local Municipality.
- The company shall ensure that domestic wastewater is treated and discharged in accordance with the Ministry's regulations.
- The company shall submit for review and approval a monitoring reporting programme that should include but not limited to relevant environmental statistics, information about spills, progress of the project and implementation of mitigation measures.
- The company shall control construction dust with water spraying or other method approved by the Ministry.
- The company shall collect spent oil in sealed drums and store them in concrete lined sites.
- Based on the nature of the project and its location the Ministry may include additional requirements.

(*) Ministry refer to the Ministry of Environment and Climate Affairs

Technical conditions for aquaculture

- If applicable, the company shall utilize in its breeding programme only fish indigenous to Oman.
- If applicable, the company shall submit a certificate stating that imported fish species are free from any diseases.
- The company shall not dispose at sea any fish waste without prior approval of this Ministry.
- Aquaculture projects shall not be established in khawrs, mangrove area, coral reefs and other environmentally vulnerable areas.
- Herbivorous species will be used as much as possible.
- Based on the nature of the project and its location the Ministry may include additional requirements.

ANNEX 7

Key features of environmental impact assessment study

Scoping

- Specifying the component of the proposed project and the environmental impacts that should be included in an EIA study.
- It includes determination of the environmental impacts to be mitigated and residual effects that are critical to make decision regarding the project.
- During scoping, the proponent in consultation with the Ministry should determine who is interested in the project, what their concerns are, and how the concerned parties should be involved in EIA.

Developing an EIA

- A scoped EIA should include the following elements which should be properly documented:
- Project description,
- Site description and environment-baseline study,
- Evaluation of the project, and
- Mitigation measures and risk assessment.

Project Description

In the project description, the proponent should describe relevant parts of the project components and activities, including:

- Location (using maps of appropriate scale),
- Physical layout and design,
- Size and capacity,
- Pre-construction activities,
- Construction plans and scheduling,
- Staffing and support,
- Facilities and services,
- Operating procedures and decommissioning plans,
- Required off-site activities or projects,
- Estimates of the types and volumes of solid and liquid waste and gaseous emissions, and
- Life span of the project, etc.

Site description and environment-baseline study

The description of the site should identify the most important environmental features of the study area and explain the reasons for selecting geographical limits of this area. The proponent should focus only on those elements of the environment that are relevant to the project. Before any assessment of future impacts can be made, the description must identify the existing physical, biological, social and legal characteristics of the site and its environment. This work is called baseline study. The baseline study should involve gathering and evaluating information from existing sources and collecting field data. The existing sources of information may include database, reports, experts from government organization, previously developed EIA, indigenous people (Traditional Ecological Knowledge), local community, industry and academia, aerial photos and satellite imagery. New information can be acquired through fieldwork, interviews and monitoring.

Evaluation of project's environmental impacts
At this stage, the proponent should use information about the project and the existing environment at the time of the study and identify and assess any potential environmental impacts. The proponent should also compare the site and timing of the project activities with the local sensitivities, seasonal activities and availability of the impacted elements of the environment (population of endangered species, limited supply of resources, available land, etc.). Types of impacts to be evaluated include:

- Cumulative and indirect environmental impacts.
- Impacts on socioeconomic conditions.
- Impacts on physical and cultural heritage.

The proponent should propose and evaluate reasonable alternatives to the project and their impacts. While evaluating the environmental impacts, the proponent should also determine whether the environmental impacts are harmful, significant and likely.

Mitigation measures and evaluating associated risks
The proponent should identify technically and economically feasible methods to avoid or reduce negative impacts and enhance positive effects. The following approaches can be used to mitigate likely significant harmful impacts:

- Direct prevention – by avoiding sensitive areas.
- Reduction – by adjusting work schedules, pollution control devices, changes in design, etc.
- Restoration and remediation measures – by removing temporary roads, re-grading, re-planting, establishing artificial reefs, relocating of coral, site cleanup, etc.
- Compensation-financial or in-kind payments to affected people to compensate them for loss of use or enjoyments.

The proponent should develop in consultation with the Ministry a follow-up programme for monitor efficiency of mitigation measures.

Final assessment
The proponent should evaluate through a net effect analysis, each project alternative or part of a project alternative in light of its advantages and disadvantage. The analysis should include a description of residual impact remaining after all mitigation measures are applied.

ANNEX 8

Data and information to be included in the environmental impact assessment study

Information describing the EIA

- Scope of the project and scope of the EIA

Information describing the project

1. Purpose and physical characteristics of the project including details of proposed access and transport arrangement and members to be employed and where they will come from. This should also include:
   - technological options
   - landscaping
   - design
   - project location options
   - infrastructure and utilities
   - air emission sources/data
   - size, construction, and appearance of building and installations
   - all anticipated discharge to the environment
   - time scale and schedule of the project
   - location and project layout plans, maps, diagram and photographs

2. Land use requirements and other physical features of the project:
   - existing land use
   - land-take during construction
   - land-take during operation
   - land-take after use has ceased
   - land-take reserved for future development
   - land-take for ancillary development, housing and recreation
   - land-take for new roads, amenities, screen planting and bunting walls

3. Production processes and operational features of the project:
   i) Type and quantities of raw materials, energy and other resources consumed.
   ii) Details of types, locations and land use requirements (including access roads) of all natural resource requirements and time-scale of consumption:
      - During construction, including extraction/production of aggregates, quarrying, borrow pits, etc.
      - When operational including raw materials, especially minerals used as part of the process.

   iii) Residual and emissions by type, quantity, composition and strength including:
      - discharge to water
      - emission to air
      - noise-day and night during construction and operation
      - vibration
      - light (i.e. effects on turtles for instance)
      - radiation and heat emission during day and night

- deposit/residues to land and soil

iv) Methods of transportation, handling and storage of raw materials, chemicals, fuels and final products.
v) Details of generation, handling, storage, management and disposal of toxic and hazardous wastes.
vi) Details of types, handling and disposal of radioactive materials.

4. Main alternative sites and processes considered, where appropriate and reasons for final choice.

5. Any other information relevant to the project.

6. Annexes should include the following:
   i) Process flow-diagram indicating points of effluent discharge and nature of emissions to atmosphere from various point sources, including noise and solid and hazardous waste generation,
   ii) Estimated air emission and their predicted levels of concentration from all significant sources,
   iii) Composition, characteristics and quantification of all envisaged industrial and domestic effluent discharge; atmospheric emission and solid and hazardous wastes including provision for, and impact assessment of their disposal locations and practices in accordance with legislation,
   iv) List of machinery with noise level,
   v) Flow-diagram of wastewater treatment systems,
   vi) Design details and calculations of stack/chimney (if any),
   vii) Details of other modelling studies (if any), and
   viii) List of chemicals and raw materials with quantities and data sheets for the chemicals.

Information describing the site and its environment

Physical features

1. Population-proximity and numbers,
2. Flora and fauna (including habitats and species) - in particular protected species and their habitats,
3. Soil – agricultural quality, geology and geomorphology,
4. Water aquifers, watercourses, shoreline and marine resources and including any existing discharge their type, quantity, composition and strength,
5. Air, climatic factors, air quality, noise emissions, odours, dust, etc.,
6. Architectural and historic heritage, archaeological sites and features and other materials assets,
7. Landscape and topography, and
8. Recreational uses.

Legislative framework

The information under this section should include:

- All statutory designations such as national nature reserves, sites of special scientific, areas of outstanding beauty, etc., and
- References to all relevant regulations/Ministerial Decisions and local and national planning policies applying to the site and surrounding area.

Assessment of effects

This section should include direct and indirect, secondary, cumulative, short-, medium- and long-term, permanent and temporary, positive and negative effects of the development.

1. **Impacts on human beings, buildings and man made features**
   - Changing in population arising from the development and consequential environmental impacts
   - Visual impacts of the development on the surrounding area and landscape
   - Levels and impacts emissions from the development during normal operations
   - Impacts of the development on local roads and transport
   - Impacts of the development on buildings, the architectural and historical heritage, archaeological features and other human artefacts

2. **Impacts on flora, fauna and geology**
   - Loss of, and damage to habitat, trees and other plant and animal species including marine
   - Loss of, and damage to geological, paleontologoical and physical features
   - Loss of plants or trees constituting a visual asset the landscape
   - Existing environmental effects that may already have put the fauna and flora at risk
   - Other ecological consequences

3. **Impacts on land**
   - Physical effects of the development, e.g. change in local topography, effect of earth moving on stability, soil or breach erosion, etc.
   - Impact of cut and fill, deep foundations and piling on the natural drainage
   - Impacts of chemical emissions and deposits on soil of sit and the surrounding land
   - Land use/resource impacts

4. **Impacts on water**
   - Impacts of the development on the drainage pattern of the area
   - Changes to other hydrographical characteristics, e.g. ground water level, watercourses, flow of underground water, pollution, etc.
   - Impacts on coastal, estuarine hydrology
   - Impacts of pollutants and waste on water quality

5. **Impacts on air and climate**
   - Emissions from existing and approved future sources of air pollution that may have already created or will create stress on the environment
   - Levels and concentrations of chemical emissions and their environmental impacts
   - Impacts of particular matter on human, plants and other elements of the environment
   - Offensive odours
   - Any other climatic impacts

6. **Other direct and secondary effects associated with the project**
   - Impacts from traffic related to the development
   - Impacts arising from the extraction and consumption of materials (especially minerals such as stone, aggregates, sand, clay, etc.), water, energy and/or other resources required by the development
   - Impacts of other development associated with the project, e.g. new roads, sewers, housing, power lines, etc.
   - Impacts specific to the construction period such as construction camps
   - Impacts of association of the development with other existing or proposed development
   - Any other secondary impacts

Environmental Management Plan (EMP) – Mitigation measures

This section should include all measures that have been incorporated into the project design to reduce or to eliminate significant potential environmental impacts during all phases of the project

1. A description of the measures to be taken to prevent, reduce, remedy or compensate harmful impacts of the project, e.g.:
   i) site planning
   ii) technical measures such as process selection, recycling/reuse of waste material and waste utilization processes
   iii) aesthetic and ecological measures such as mounding, design and taking advantage of topography, landscaping, tree planting

2. Compensation for harmful impacts such as compensation for loss of use (grazing land, access, etc.) and subsidizing community projects.

3. Details of possible contingencies, their impacts on the environment and mitigating measures including the maintenance programme.

4. Details of safety and emergency response procedures and contingency plans.

5. Risk assessment and management.

6. Proposals for an environmental monitoring programme.

7. Site restoration after use.

Conclusion and additional information

This section include:

- conclusion,
- definitions and abbreviations,
- information sources, consultations, public participation, and
- references.

United Arab Emirates: Status of cage aquaculture development

by

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EXECUTIVE SUMMARY

Commercial cage aquaculture commenced in 1999 and it is expected that an increasing number of fishermen and private entrepreneurs will be lured into this business area in the near future. Various incentive schemes such as provision of subsidized gear, free supply of fingerlings and training for local fishermen are under consideration by the Ministry of Environment and Water. The deteriorating of the marine environment is considered one of the major constraints to the development of the sector while suitable areas for cage aquaculture are in strong competition with other developmental projects, e.g. resorts, housing and commercial buildings).

BRIEF HISTORY OF MARINE CAGE CULTURE

The history of marine cage aquaculture in the United Arab Emirates (UAE) dates back to 1999 when about 20 circular cages were installed in the coastal waters off the coast of Ras Al-Khaimah by a private company (ASMAK) which then moved them to Dibba on the east coast in 2001. The first finfish species cultured were the Sobaity bream (*Sparidentex hasta*), the gilthead seabream (*Sparus aurata*), and the European seabass (*Dicentrarchus labrax*). Eventually, local fishermen also started to keep in locally made cages located in the lagoon area of Umm Al-Quwain to stock commercially important juvenile bycatch fish. This practice was initiated in order to abide by the Federal Law No. 23 of 1999 regarding the exploitation, protection and development of living aquatic resources in the waters of the UAE. Along the west coast, many of such cages are used mainly for stocking grouper juveniles (Hamoor).

THE CURRENT SITUATION

The coastline – The United Arab Emirates has a coastline of about 700 kilometres on the west and east coasts facing the Arabian Gulf and Gulf of Oman in addition to the coastline surrounding the numerous islands belonging to the country. The country has a continental shelf area of approximately 51 400 km^2. The shelf area is wider and shallow on the western coast and relatively narrow on the east coast. Wind is predominantly from Northwest.

Farmed species – The endemic Sobaity seabream (*Sparidentex hasta*) and the introduced gilthead seabream (*Sparus aurata*) are the main species selected for commercial cage culture. The orange-spotted grouper, *Epinephelus coioides*, is also reared to some extent in floating cages.

Seed and feed supply – Hatchery-produced juveniles of Sobaity and gilthead seabream are air lifted from exporting countries. More recently Sobaity juveniles have been produced at the Marine Resources Research Centre, Umm Al-Quwain, and supplied to farmers operating cages off the Dibba coast. With regards to the orange-spotted grouper all seed material (Juveniles) are wild-caught.

Type and size of cages – The cages used for commercial farming of Sobaity seabream and the gilthead seabream are the circular type with a diameter of about 20 m (60 m circumference) and a net depth ranging between 8–13 m. These structures are imported from Norway and installed about one mile off

the coast. The traditional cages used by fishermen measure 2.5x2.5x2 m in size and are constructed locally.

Number of existing farms and cages – Presently there is only one commercially cage culture project which operates 60 functional cages. There is no official record regarding the number of traditional cages used by the fishermen. Furthermore, there are a series of protected area around the Fujairah region on the east coast as well as other locations along the west coast where fenced aquaculture is being carried out.

Past and current production – The production details of Sobaity and gilthead seabreams for 2005 and 2006 are given in Table 1.

Table 1. Production values from cage aquaculture for 2005and 2006 in tonnes

Year	Species	Production
2005	Sobaity seabream (*Sparidentex hasta*)	37.30
	Gilthead seabream (*Sparus aurata*)	785.83
2006	Sobaity seabream	119.59
	Gilthead seabream	767.38

CURRENT CONSTRAINTS AND OPPORTUNITIES

Cage aquaculture has significant developmental potential and can partly alleviate the increasing national demand for marine fish and fish products. This aquaculture sub-sector needs special attention and incentives from the government in order to ensure a significant raise in production outputs. The deteriorating marine environment is considered to be one of the major constraints hindering the development of this industry. Furthermore, suitable areas for cage aqua culture are becoming limited due to space competition with other developmental projects along the coast of the country.

INSTITUTIONAL REQUIREMENTS FOR ESTABLISHING AND OPERATING CAGE FARM

Site selection – Site selection is an important technical aspect in cage aquaculture culture which may be responsible for the future viability of the operation. Cages should be placed in areas where seawater conditions are optimum, have a suitable depth, have an acceptable tidal flow and tidal range, be sheltered from intense wind and wave action and away from industries discharges and other pollution sources. The water depth should be adequate to keep the nets off the bottom and to allow adequate water exchange and flushing beneath the cages. Good water exchange is important to replenish oxygen required by the fish.

Farm licensing – According to the Federal Law No. 23 (1999), Articles 8 to 12, in order to obtain a fishing licence all fishing boats, gear and equipment used must be of the approved type and centrally registered. This regulation is also applicable to vessels used in cage farming operations. However, to date no specific law is in force for licensing aquaculture cage.

Environmental impact assessment (EIA) – The principal wastes from fish farm cages include uneaten feed, faecal material, and chemicals and therapeutics residues, if used. Approximately 70–80 percent of the feed nutrients are released back to the environment enriching the surrounding waters particularly if the surrounding currents are weak. This may have an effect on the planktonic activity as nutrient rich waters may lead to algal blooms. Furthermore sediment accumulation may also deteriorate the water quality and have negative effects on benthic organisms. The authorities therefore

do recognise the importance of undertaking regular environmental monitoring programme although currently no specific laws regulates such activities or demand specific actions to the fish farmers.

INSTITUTIONAL DEVELOPMENT POLICY

National plans and targets – The national fisheries policy supports all systems of aquaculture provided they are environmentally friendly and do not negatively interact with the ecological balance of the marine environment.

Subsidies and financing policies – The Government has adopted various schemes to promote fisheries in the country mainly by providing subsidized crafts and gear, free service of marine engines, etc. As a result of the declining capture landings and increasing production costs the authorities expect that in the near future an increasing number of fishermen will shift to aquaculture as well as attract new entrepreneurs. Various schemes such as providing subsidized gears, free supply of fingerlings and training for local fishermen are currently under the consideration by the Ministry of Environment and Water.

Production for domestic markets and exports – At present the main production from aquaculture derives from farming the exotic gilthead seabream. Almost the entire production is exported to European Union countries. However, as the population grows and sectors such as tourism expand, there will be an increasing demand for fish particularly for those commercially important endemic species. The future development of cage aquaculture in the United Arab Emirates may lay on the ability of the sector to produce significant quantities of endemic finfish species highly demanded in the local market.

REFERENCES

Federal Law on Fisheries. 1999. Exploitation, Protection and Development of the Living Aquatic Resources in the waters of the United Arab Emirates, Ministry of Environment and Water, UAE.

National Climatic Report. 2006. Department of Atmospheric Studies, Ministry of Presidential Affairs, United Arab Emirates.

Photos illustrating cage aquaculture in the United Arab Emirates. *Top row* – artisanal and traditional floating net cages for confining wild-caught juveniles of commercially important finfish species (mainly the orange-spotted grouper - *Epinephelus coioides*); *Middle row* – Commercial cage aquaculture using imported circular and flexible structures off the coast of Dibba; and *Bottom row* – Cage aquaculture using a fixed cage culture structure.