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An aquaculture strategy for Malta

Preparatory study and recommendations prepared for the Ministry of Resource and Rural Affairs, Government of Malta

Final Draft Report Annexes

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Annex 1 - Terms of reference

1. Background Information

1.1 - Beneficiary Country
Malta

1.2 - Central Government Authority
Department of Contracts

1.3 - Contracting Authority
Malta Aquaculture Research Centre, Ministry for Resources and Rural Affairs

1.4 - Relevant Country Background
The aquaculture industry in Malta started in the late 1980s with the culture of marine finfish in offshore cages. The annual aquaculture production increased dramatically during the 1990s from 60 tonnes in 1991 to a peak of 2,300 tonnes in 1999. this was composed mainly of sea bream and sea bass and was produced through the operation of 4 commercial farms. By the year 2000, production dropped to about 1,000 tonnes with most farms switching to tuna penning operations due to a fall in prices for sea bass and sea bream. The market for these species is expanding once again. Current annual production stands at around 1,000 tonnes, valued at about $6million, and this is expected to continue increasing in the coming years. Maltese aquaculture produce is almost entirely exported to European and Asian markets. There are no commercial marine hatcheries in Malta and fingerlings are imported from hatcheries in other Member States. However, the wet lab facilities at the Fisheries and Aquaculture Branch include a pilot marine hatchery.

The production of bluefin tuna (*Thunnus thynnus*) through penning has been increasing over the past few years. The fattening of this species around the Maltese islands started in the year 2000 with one farm producing 300 tonnes. Production reached a peak of 7,000 tonnes in 2007 with five farms in operation. The live tuna are exclusively imported from foreign purse seiners fishing in the Mediterranean. Once harvested, the fattened fish are re-exported mainly to Asian markets.

1.5 - Current State of Affairs in the Relevant Sector
In 1988, the Ministry of Food, Agriculture and Fisheries established the National Aquaculture Centre (NAC) at Fort St. Lucian, which was merged with fisheries research to form the Malta Aquaculture Research Centre in 2001. The primary aim of the NAC was to pioneer and assist the development of fish farming as a new industrial activity in Malta. Today the Malta Aquaculture Research Centre (MARC) is the research hub for aquaculture and fisheries activities.

The first commercial sea-based enterprise started to operate in 1991 with the production of sea bream and sea bass. Currently, sea bass, sea bream, meagre and bluefin tuna are farmed around the Maltese islands, however the only hatchery remains to be the pilot hatchery at the MARC in Fort San Lucjan, Marsaxlokk and most of the fingerlings for production remain to be imported. In 2008, the gross output of aquaculture had a value of € 81.7 million.

Recently, the MARC has shown significant progress with good results in amberjack breeding and now Malta can boast that it is among the leaders in this field in the Mediterranean area. While the prices of sea bass and sea bream are constantly low, the bluefin tuna fattening industry is under a lot of pressure from international bodies due to very strict control of the bluefin fisheries, so it is essential to develop techniques for the aquaculture of new species. A strategy is required to prepare for this imminent increase in production of the amberjack and any other species that may be produced on a commercial scale.

The current National Policy on aquaculture was endorsed by MEPA in 2004. It states that the longterm viability of the aquaculture industry depends on species diversification and technological innovation. Moreover, it states that development in aquaculture necessitates a development permit as established by the Development Planning Act Chapter 356 and its subsidiary legislation. Aquaculture is also subject to environmental regulations published under the Environment Protection Act 2001.

The need for a detailed strategy for aquaculture development is highlighted as Malta needs to streamline this industry and program for future requirements such as the increase in production expected with the development of techniques for new species, the infrastructure for this production increase and the resulting socio-economic effects.

1.6 - Related Programmes and Donor Activities
Not applicable

2. Contract Objectives and Expected Results

2.1 - Overall Objectives
The overall objectives of the project of which this contract will be a part are as follows:
- ☐ To lay down a structured path for sustainably developing aquaculture in Malta,
- ☐ To identify the domains that are essential for a profitable and sustainable industry in Malta.

2.2 - Specific Objectives
The objectives of this contract [which are not necessarily those of the project] are as follows:
- ☐ Review of the present status of the aquaculture industry in Malta,
- ☐ Establishing a production target,
- ☐ Identification of sites or zones for aquaculture development,
- ☐ Consultations,
- ☐ Supporting research needs,
- ☐ Identifying the financial sources for supporting research needs,
- ☐ Streamlining of licensing and procedures,
- ☐ Fish health control,
- ☐ Diversification of fish products and improving marketability,
- ☐ Non-finfish production potential,
- ☐ Conformity with EU Directives and other international organisations' regulations.

2.3 - Results to be Achieved by the Consultant
In line with the objectives highlighted in 2.2 above, the results shall be a study leading to a more sustainable aquaculture industry.

3. Assumptions and Risks

3.1 - Assumptions Underlying the Project Intervention
No delays will occur in this tendering procedure which will delay the start of the study. Good cooperation between the successful bidder, Contracting Authority, and other bodies working on the project, including other external consultants. The successful bidder's team is adequately experienced and qualified for the project's requirements. The successful bidder is assumed to be flexible and capable of respecting strict deadlines.

3.2 – Risks
The lack of suitably qualified bidders. Difficulty for the successful bidder to obtain feedback from persons, authorities and/or other bodies which he might need to consult with. Failure to meet the deadline as specified by the Contracting Authority.

4. Scope of the Work

4.1 – General
4.1.1 Project Description

Malta must look forward to produce fish that are cultured completely by aquaculture so that the industry can be sustainable and not dependent on wild-caught fish. Japanese research institutes and companies are creating sustainable farms for bluefin tuna and this will shrink the quantities required from other countries, already shown by the much lower prices that are currently paid. The market for aquaculture products changes quickly and Malta has to look forward to be dynamic and have enough options and different species for culture so that the quantities of fish produced can be maintained through diversification. A drastic change in market demands is expected in the coming years.

The recent production of bluefin tuna, sea bream and sea bass has shown that Malta is capable of producing around 8,000 tons. The emergence of "new species" for production to diversify the local aquaculture produce is imminent and Malta should plan for the production of a "new species" every 5 to 10 years. The amberjack and meagre are likely to be candidates for diversification in the immediate future. Presently the lifecycle of the amberjack has been closed and is being tweaked for commercialisation whilst a few tons of meagre are already produced annually. Bluefin tuna eggs have also been collected from cultured fish in the Mediterranean area so the pathway to the production of bluefin tuna juveniles has already started. The Japanese are currently producing hundreds of thousands of bluefin tuna juveniles, showing that the production of bluefin tuna juveniles can be feasible. With diversification in mind, Malta seeks to make better use of the sea water resources whereby entrepreneurs will be encouraged to invest and aquaculture will be looked at as a long-term investment. The Aquaculture Strategy for Malta shall strive to identify the farming of aquatic organisms with an economic significance and show the potential of this industry, while giving due consideration to environmental issues. The strategy will lead the industry to a sustainable growth and shall cover the period from 2011 to 2025. It has to identify the domains that are essential for a profitable and sustainable industry in Malta.

4.1.2 Geographical Area to be covered
Malta and the surrounding seas.

4.1.3 Target Groups
The fish farming industry and the government (Ministry for Resources and Rural Affairs).

4.2 - Specific Activities
1. Review of the present status of the aquaculture industry in Malta

The status and socio-economic impact of the aquaculture industry must be assessed both in its current form and with the proposed increase in production biomass. New species and new technologies suited for the Maltese environment must be clearly identified to increase the opportunities for expansion and diversification, taking due consideration of the fact that Malta is at the forefront of amberjack and bluefin tuna production technology in the Mediterranean area.

2. Establishing a production target

A possible production target is to be proposed for a given deadline suggested to be 2025. The criteria on which such a target is estimated need to be fully evaluated by means of a SWOT analysis. It is also important to identify the infrastructural needs that will be adequate for the proposed increase in production.

3. Identification of sites or zones for aquaculture development

A detailed description of the parameters (bathymetry, currents, bottom type, depth) of the proposed zone / zones including the sustainability of the zone for aquaculture and potential environmental conflicts / problems must be studied. The basis for discussion with the other stakeholders such as the Malta Environment and Planning Authority must be formulated so as to assess the environmental impact of the proposed increase in aquaculture production. The risk factor that needs to be considered for farming operations in such sites / zones must be taken into consideration, i.e. low risk and easily insured or high risk and impossible to cover by insurance.

4. Consultations

The report recommendations need to be extensively discussed with all the relevant stakeholders including MEPA, the Agriculture and Fisheries Division, the Malta Maritime Authority, the Federation of Maltese Aquaculture Producers and the local councils or any other stakeholder with social or commercial interests. This is to be done taking due cognizance of the European Commission's position with regards to the integrated maritime policy in the European Union, i.e. Maritime Spatial Planning (MSP).

5. Supporting research needs

The report will identify the human resource and infrastructure requirements to develop an effective applied research and development program that will support the development of the industry in an effective manner. This will include the preparation of an organisational chart that incorporates the different branches such as research, enforcement and support services for Malta.

6. To identify the financial sources for supporting research needs

The report should recommend potential sources of funding required to support the required research needs as described in the previous point.

7. Streamlining of licensing and procedures

The study will address the need for a one-stop-shop for the licensing of both existing and new developments. This will review and advise on current legislation for the promotion of aquaculture developments as well as on the mechanism of execution of any recommendations coming out of the strategy document.

8. Fish health control

The report is to make recommendations on health control issues especially where zoning for commercial development is recommended. These recommendations must be formulated for any of the present or proposed aquaculture sites, especially if aquaculture zones containing more that one farm will be developed.

9. Diversification of fish products and improving marketability

The report will make recommendations on the ways to improve the marketability of products through product diversification. Alternate ways to market the products should be identified clearly; indicating the investment required, as well as the advantages and disadvantages of such new ways for marketing. Potential new target markets for Malta's aquaculture products must be identified. Recommendations are to be made as to how to improve the consumer image thus reducing the negative publicity of aquaculture.

10. Non-finfish production potential

The report must take into consideration any potential for other non-finfish species/products that can be produced in Maltese waters. This should allow for potential high value activities that may need restricted facilities near shore or on land, for example pearl, sea urchin, coral farming.

11. Conformity with EU Directives and other international organizations' regulations

All recommendations should take due cognizance of current EU directives and legislation. The Communication from the Commission to the European Parliament COM (2009) 162 "Building a sustainable future for aquaculture. A new impetus for the strategy for the sustainable development of European Aquaculture." must be adhered to. Directives from other international organisations such as the UN (FAO), ICCAT and others must be fully taken into consideration.

4.3 - Project Management

4.3.1 Responsible Body

The Malta Aquaculture Research Centre (MARC) within the Ministry for Resources and Rural Affairs.

Management Structure

The successful bidder will answer directly to the Head of the MARC, which in turn responds directly to the Permanent Secretary, MRRA.

4.3.3 Facilities to be provided by the Contracting Authority and/or other parties

No facilities are to be Made available by the Contracting Authority for the fulfilment of this contract.

5. Logistics and Timing

5.1 – Location

The successful bidder will be working from his own premises.

5.2 - Commencement Date & Period of Execution

The intended commencement date is as soon as the contract is awarded and the period of execution of the contract will be four (4) months from this date. Article 19.1 of the Special Conditions will determine the actual commencement date and period of execution.

6. Requirements

6.1 – Personnel

6.1.1 Other Experts
CVs for experts other than the key experts are not examined prior to the signature of the contract. They should not have been included in tenders.

The Consultant shall select and hire other experts as required according to the profiles identified in the Organisation & Methodology <and/or these Terms of Reference>. For the purposes of this contract, international experts are considered to be those whose permanent residence is outside the beneficiary country while local experts are considered to be those whose permanent residence is in the beneficiary country.

The Consultant should pay attention to the need to ensure the active participation of local professional skills where available, and a suitable mix of international and local staff in the project teams. All experts must be independent and free from conflicts of interest in the responsibilities accorded to them.

The selection procedures used by the Consultant to select these other experts shall be transparent, and shall be based on pre-defined criteria, including professional qualifications, language skills and work experience. The findings of the selection panel shall be recorded. The selection of experts shall be subject to approval by the Contracting Authority.

Note that civil servants and other staff of the Public Service of the beneficiary country cannot be recruited as experts. See sub-article 9.5 of the General Conditions.

6.1.2 Support Staff and Backstopping
The Programme coordinator shall be responsible to provide all support staff and backstopping as part of the global price of the contract.

6.2 – Accommodation
Office accommodation of a reasonable standard and of approximately 10 square metres for each expert working on the contract is to be provided by the Consultant.

6.3 - Facilities to be provided by the Consultant
The Consultant shall ensure that experts are adequately supported and equipped. In particular it shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities. It must also transfer funds as necessary to support its activities under the contract and to ensure that its employees are paid regularly and in a timely fashion. No facilities are being provided by the Contracting Authority as part of this service contract or transferred to the contracting Authority/beneficiary country at the end of this contract. If the Consultant is a consortium, the arrangements should allow for the maximum flexibility in project implementation. Arrangements offering each consortium partner a fixed percentage of the work to be undertaken under the contract should be avoided.

6.4 – Equipment
No equipment is to be purchased on behalf of the Contracting Authority / beneficiary country as part of this service contract or transferred to the Contracting Authority / beneficiary country at the end of this contract. Any equipment related to this contract which is to be acquired by the beneficiary country must be purchased by means of a separate supply tender procedure.

7. Reports

7.1 - Reporting Requirements
An interim progress report must be prepared after the first two (2) months from the award and signing of the contract.

8. Monitoring and Evaluation
8.1 - Definition of Indicators
The successful bidder shall have his/her performance measured and evaluated against milestones and objectives set out in Section 2.2 of these terms of reference.

8.2 - Special Requirements
Not applicable.

Annex 2. Aquaculture sites, consents and facilities in Malta

1 Malta Aquaculture Research Centre (MARC)

The MARC carries out experimental work at a cage facility in Marsaxlokk Bay, directly in front of the MARC facility at Fort St. Lucjan, Marsaxlokk. It is currently used primarily for the rearing of amberjack broodstock and has an amberjack nursery site, in support of current research and development activities devoted to the establishment of rearing techniques for amberjack in Malta. The water depth at the site varies between 10-15m. It is proposed to keep this site for continuing research work and holding broodstock.

Figure 1. View of Marsaxlokk Bay, showing location of MARC and experimental cage site

2 Pisciculture Marine de Malte (P2M)

P2M was the first commercial aquaculture operation to become established in Malta, starting operations in 1991. The bulk of production is carried out in St. Paul's Bay, with smaller quantities produced at Mellieha Bay. There is also a small inshore nursery site positioned at the mouth of Mistra Bay, close to the existing shore site.

Figure 2. View of St. Paul's bay showing production and nursery cage sites operated by P2M

Grow-out has traditionally been carried out in circular cages constructed from floating rubber oil hoses, although it is hoped to replace these with Fusion Marine circular HDPE plastic cages.

The conditions of the production permit for P2M are limited to the use of a specific area of seabed for a period of 46 years, and there is no maximum production tonnage limit. Since 2002, however, production capacity has effectively been limited since any expansion of the existing seabed area, or any movement or changes to cages within the existing concession, requires a permit from MEPA. Such a permit is unlikely to be granted given the shallow nature of the site, the presence of Posidonia beds, and the proximity to the shore. The existing seabed concessions are capable of an annual production of around 1000 tonnes of seabream, seabass and meagre, with a maximum stocking density of 17kg/m^3 employed.

Mistra Bay

A small, inshore cage site close to the shore base at Mistra Bay is operated primarily as a nursery site for juvenile fish immediately following delivery. Initially fish are stocked in a raft of 'Jetfloats', which consist of plastic cube-shaped floats linked together by way of plastic connecting pins to form cage collars, and after a short period transferred to a line of plastic circular cages for further ongrowing before transfer to St Paul's Bay and Mellieha.

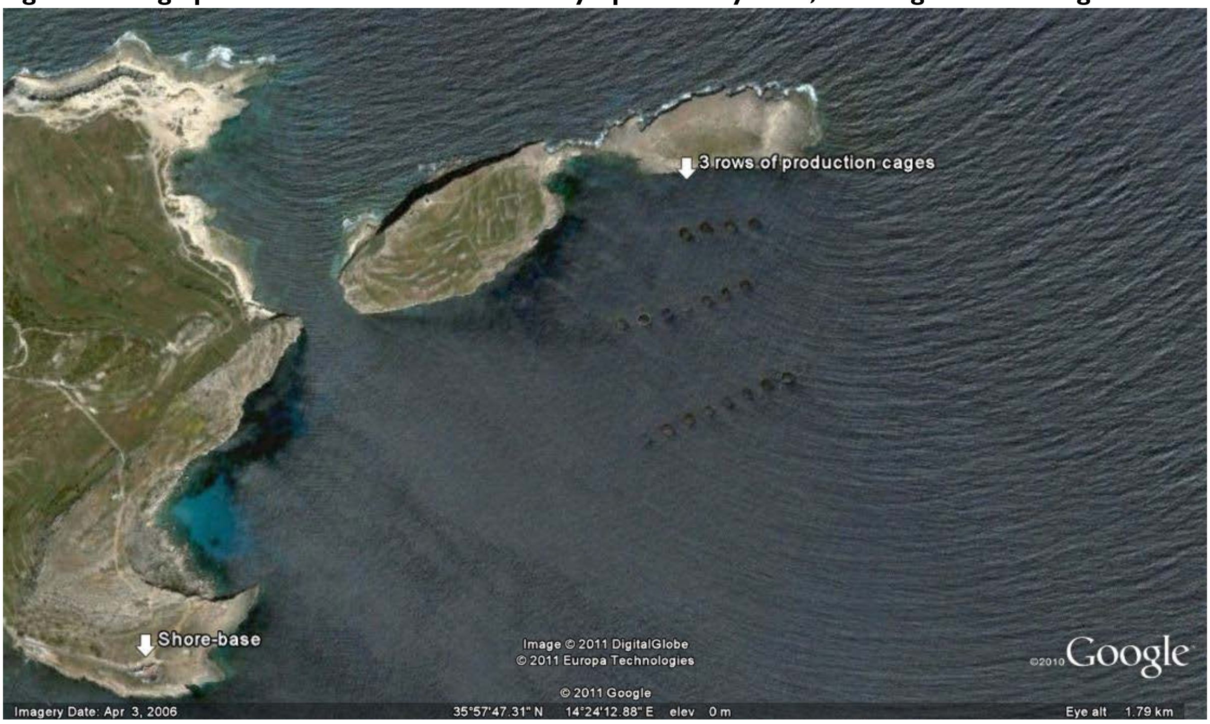
According to fish size, the cages are fitted with small-mesh nets designed for juvenile fish. Such nets require sheltered inshore waters as the small mesh size has significant resistance to water flow and so excessive wave action and current speed leads to deformation of the net shape and volume and stress and physical damage to the fish stock.

Figure 3. View of Mistra Bay, showing nursery cages and work boats adjacent to shore base operated by P2M

St. Paul's Bay

The cage site at St. Paul's Bay is situated in water at a depth of approximately 25-30m, immediately to the south of St. Paul's Islands. This provides shelter from the prevailing north-westerly winds but does result in some exposure from north-easterly and easterly winds.

Figure 4. Cage production site in St. Paul's Bay operated by P2M, showing 3 lines of cages



This cage site is therefore relatively well protected from storm action and is located just over 1km from the shore base, allowing efficient servicing from shore and a high level of security.

Mellieha Bay

Figure 5. View of Mellieha Bay showing location of P2M cage production site

The P2M production cage site at Mellieha Bay consists of 5 Fusion Marine 60m circumference cages moored approximately 400m south of the Armier headland on the north side of the bay, in approximately 25-30m depth. This location affords shelter from the prevailing north-westerly winds but is exposed to north-easterly and easterly winds. This cage site is serviced from the shore base at Mistra Bay, which is located at a distance of 4.5km.

3 Fish & Fish Ltd (F&F)

F&F commenced operations in 1993/1994, initially producing seabass at a cage site located approximately 500m off the Delimara peninsula in south-east Malta. Production shifted to seabream in 1995. In 2001 the company developed cage facilities for tuna penning and, as a result, the tuna penning site was relocated approximately 790m further offshore.

F&F currently has permits for the production of up to 300 tonnes of seabass and seabream, and up to 1200 tonnes of bluefin tuna. The current ICCAT allowance for this facility is 1500 tonnes of bluefin tuna (ICCAT). Actual production of seabass and seabream has been negligible in recent years, with the company concentrating on its tuna penning activities. Production of tuna over the past 2 years has been in the region of 800-900t p.a..

Existing production facilities consist of a group of 4 x 70m circumference Fusion Marine plastic circles for seabass and seabream production, with a total permitting allowance of 8 cages at this site. Tuna penning cages consist of 8 x 50m diameter 3-ring Fusion Marine circles moored in a single mooring grid.

Figure 6. Google Earth view of SE coast of Malta, showing location of Fish & Fish production cages

4 Malta Fishfarming Ltd (MFF)

MFF commenced the production of seabass and seabream in 1994, employing Farmocean semi-submersible cages and plastic 'Floatex' circles at a production site off the Delimara peninsula off the south-east coast of Malta, approximately 1.25km north of the Fish & Fish production cage site. Like F&F, MFF diversified their production to include tuna penning operations in 2001, and relocated the tuna penning cages an additional 900m further offshore in 2002, to an area with a seabed depth of around 50m. All Farmocean cages have now been replaced with plastic circles, including 10 x 90m 3-ring HDPE cages.

Current permits granted by MEPA allow for the total production of 500 tonnes of finfish, comprising 350 tonnes of bluefin tuna and 150 tonnes of seabream. The tuna penning operation has an ICCAT production consent of up to 1500 tonnes of bluefin tuna. Tuna penning operations are currently modest, with a production of around 200 tonnes in 2010. MFF is the only other significant producer of seabream in Malta, and has a joint venture with MARC for the production of seabream juveniles to be on grown at the MFF site.

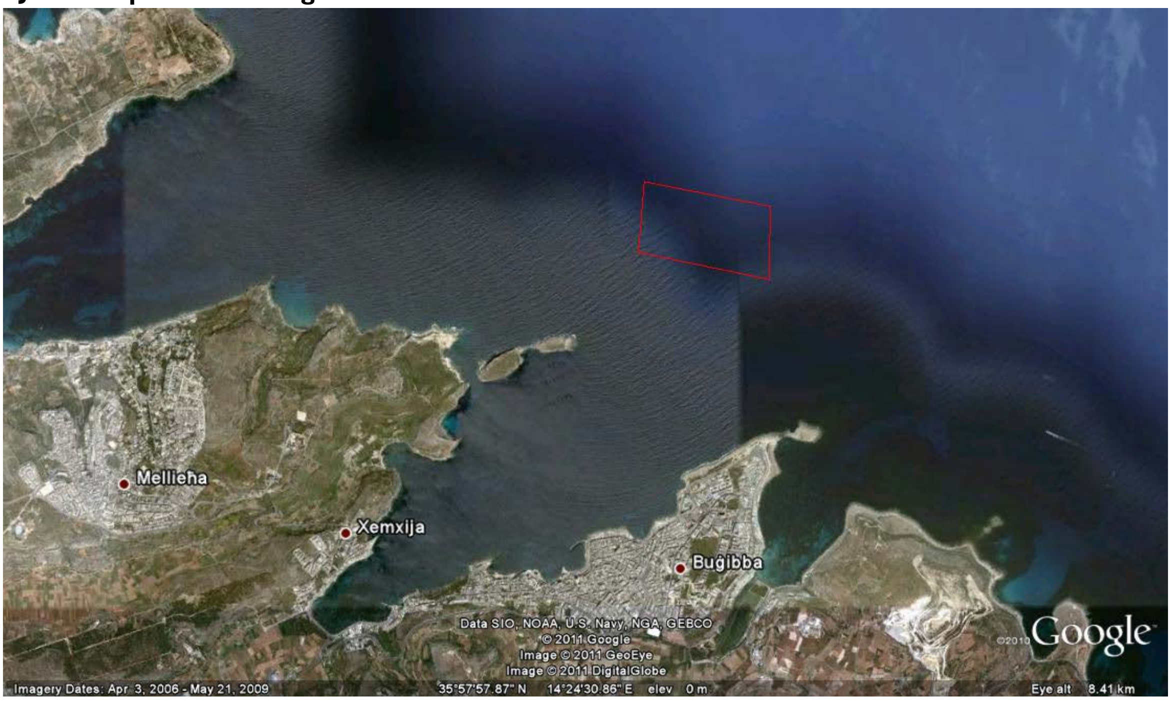
Figure 7. Google Earth view of the south-east coast of Malta, showing location of MFF production cages

5 AJD Tuna Ltd (AJD)

AJD was established in 1999 by Azzopardi Fisheries Ltd as the first tuna penning operation in Malta, with a site approximately 3km off the north-east coast of Malta, close to St. Paul's Bay. In 2002, AJD purchased Malta Mariculture Ltd, an aquaculture operation based in the Comino Channel with permits for the production of both seabream and bluefin tuna.

5.1 St. Paul's Bay site

Figure 8. Google Earth view of the north-east coast of Malta, showing approximate location of AJD Tuna production cages



The production site off St. Paul's Bay is located approximately 2km offshore, at a depth of 50m. This site is devoted to tuna penning operations, and has an ICCAT consent for the production of 2500 tonnes of bluefin tuna. The site is equipped with 9 x 50m diameter plastic circular cages. Production in 2010 was around 2200 tonnes.

5.2 Comino Channel site (ex. Malta Mariculture Ltd)

This site was originally established by Malta Mariculture Ltd in 1994 for the production of seabass and seabream, employing Dunlop Tempest II square rubber-hose cages. It was then purchased by a group of local investors before being sold to Azzopardi Fisheries in 2002. By that time the Dunlop cages had been replaced by plastic circular cages and a permit for the production of both seabass/seabream and bluefin tuna secured. The existing site is some 500m further west than the original site. This site currently has a MEPA permit for the annual production of 350t tuna and 150t bass and bream, and an ICCAT consent for 800t tuna.

Figure 9. Google Earth view of the north coast of Malta, showing the location of the AJD Tuna Comino Channel production cages

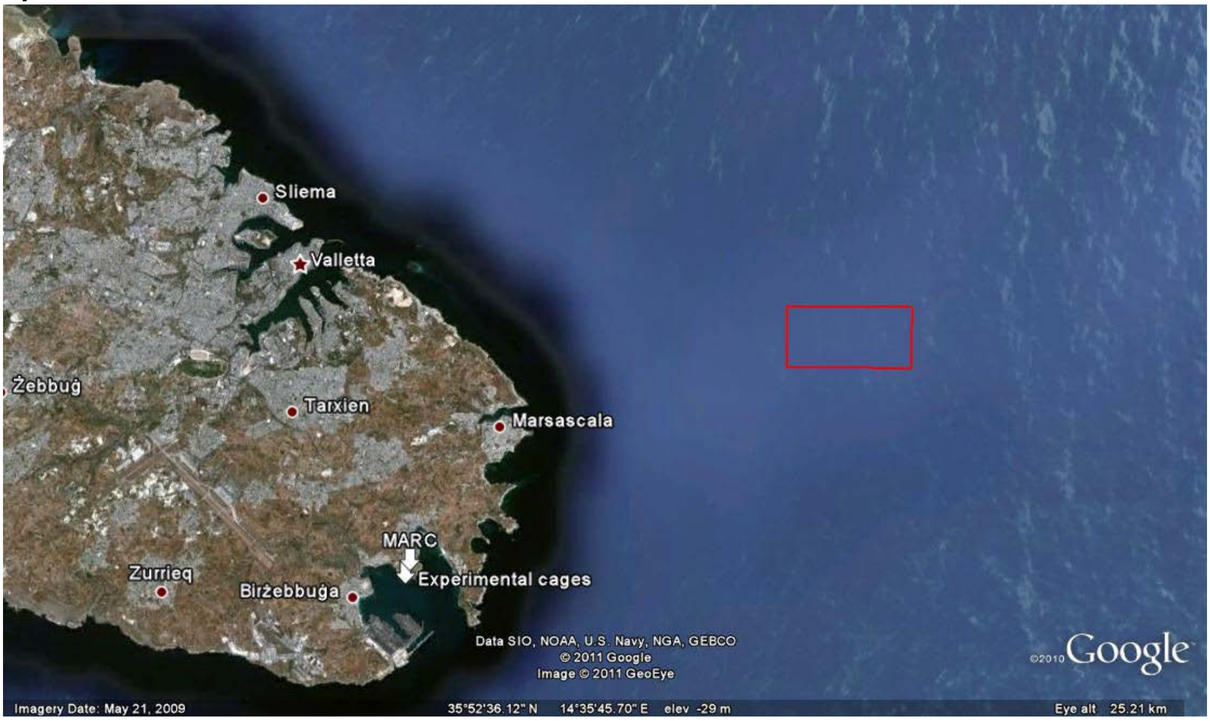
6 Malta Offshore Aquaculture Zone

In 2005 MRRA established a new aquaculture zone off the south-east coast of Malta, primarily to address the large number of permit applications to establish tuna penning operations received between 2000 and 2005. It was realised that few suitable inshore locations were available for such establishments, and it was felt that moving the operations further offshore would go some way to address certain conflicts which had emerged between various stakeholders of marine resources in Malta and the tuna penning industry. The zone presently allows for the establishment of 4 tuna operations, each with an ICCAT consent of 1500t, 3 of which have been allocated. The legal status of the aquaculture zone is currently uncertain, following repeated objections to the planning application of the zone by certain local government councils.

The aquaculture zone occupies an area of 3km by 3km, located 6km east of Marsaskala on a gently shelving seabed with a depth of 70-95m, although only the northern half is presently utilised. It is currently shared by three tuna penning operations – Ta' Mattew Fish Farms Ltd, Mare Blu Tuna Farm Ltd and Deep Sea Ltd each with an ICCAT production capacity and MEPA production permit for 1500 tonnes of bluefin tuna. Although each site is supposed to be separated by at least 1km, it is understood that this is closer to 700m due to the extent of each farm and the need to stay within the zone. The total permitted production capacity of the aquaculture zone is understood to be 9000 tonnes (6 x 1500t sites).

The aquaculture zone is considered extremely exposed by industry standards. It is afforded some shelter from the west but is totally open to all other directions with a significant fetch. The site is regularly exposed to gales of Beaufort Scale force 7 and above several times a year, producing wave heights of 7m and more. Very strong wind-driven currents are also prevalent at the site, reaching speeds of over 3 knots on occasion. Because of these extreme conditions, two of the operators (Ta' Mattew and Mare Blu) have experienced total losses of cages and fish stock over the past few years.

Figure 10. Google Earth view of the east coast of Malta, showing location of south-east aquaculture zone



6.1 Ta' Mattew Fish Farms Ltd

Ta' Mattew Fish Farms Ltd has a MEPA permit capacity of 1500 tonnes, matching its ICCAT production allowance. After a total loss of cages and stock after bad weather encountered during December 2009 the cage and mooring system was redesigned. Existing production cages consist of single-hose HDPE 50m diameter circles, with a total of 5 cages in place during 2010 and a total of 3 stocked cages planned for 2011. Each cage is moored independently with radial moorings for extra security.

Total production in 2010 was around 320 tonnes, the minimum considered necessary for viability. The main constraint on future production is the lack of fish for stocking due to low ICCAT quotas. Ta' Mattew see much potential in the cage production of amberjack, and expect to shift some production to amberjack in the future.

6.2 Mare Blu Tuna Farm Ltd

Mare Blue Tuna Farm Ltd was established in 2006 as a collaboration between Maltese investors and the Spanish tuna penning operation Fuentes Group. The company employs the use of 50m and 90m diameter twin-pipe cages, with a total of 13 cages currently moored at the production site.

In the first year of production a total of 1,500 tonnes of bluefin tuna were produced. However, the company experienced a total loss of stock during a storm in October 2007, with an estimated 1400 tonnes of tuna lost. After a complete redesign of the entire mooring system production continued and in 2008 and 2009 amounted to approximately 1000 tonnes per annum. The company decided not to stock fish during 2010, but intends to restock during 2011. Mare Blu are open to the production of other species of finfish, but recognise that the extreme conditions prevailing at the offshore aquaculture zone limit their potential.

6.3 Deep Sea Ltd

Deep Sea Ltd is a second site established by the same consortium between Maltese investors and the Fuentes Group, with a production permit of 1500 tonnes of bluefin tuna. No cages have been installed at the site to date, and there has been no production to date.

Annex 3

NATIONAL POLICY ON AQUACULTURE

Prepared: 31st March 2004

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1. PREAMBLE

Aquaculture

During the past three decades, aquaculture[1] has become the fastest growing food sector and is an increasingly important contributor to national economic development, the global food supply and food security. This contribution to economic development was recognised within the conclusions of the "Conference of Aquaculture in the Third Millennium"[2] This has earned aquaculture a position as a legitimate user of resources.

The objective of this document is to formalise the Government's policy with respect to this emerging industry, and provide a holistic national strategy with respect to aquaculture development in Malta.

[1] As defined in the Draft Aquaculture Operations Regulations [Fisheries Conservation and Management Act (CAP. 425) 2004], *Aquaculture involves the farming of aquatic organisms including fish, molluscs, crustaceans, other invertebrates and aquatic plants. It implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators. It also implies individual or corporate ownership of the stock being cultivated.* This statement is consistent with the principles adopted by FAO, 1999.

[2] Refer to Appendix.

2. AQUACULTURE IN MALTA

In 1988, the Ministry of Food, Agriculture and Fisheries established the National Aquaculture Centre (NAC) at Fort St. Lucian, which was merged with fisheries research to form the Malta Centre for Fisheries Sciences in 2001. The primary aim of the NAC was to pioneer and assist the development of fish farming as a new industrial activity in Malta. The first commercial sea-based enterprise started to operate in 1991, and by February 2004 a total of thirteen development permits have been issued; five farms are currently active with respect to the production of fish species i.e. sea bass, sea bream and tuna.

Before 2000, aquaculture was focused exclusively on production of sea bream and sea bass; for EU markets (approximately 95% of total production), particularly Italy. Since the year 2000, the aquaculture industry redirected its interests mainly on the fattening of Bluefin tuna, the main export of which is to Asian markets with Japan being the prime consumer. The export of fresh tuna produce is economically attractive due to the high value added associated with this product.

Market trends indicate that revenue from tuna will no longer be as lucrative given increased competition from other Mediterranean countries. However, Malta retains an advantage due to its strategic geographical location (i.e. due to its proximity to the tuna fishing grounds), the available infrastructure, as well as the quality of the workforce. Market trends are indicative of a revival in the case of sea bream and sea bass, following the slump caused by over-production by a number of Mediterranean countries in the mid 1990's. Competitiveness through cost effectiveness, marketing improvements and quality are the criteria for the survival of this industry.

The Malta Centre for Fisheries Sciences (MCFS) currently coordinates with, and offers expertise to the regulatory agencies regarding fisheries (including aquaculture). The work of the MCFS also involves research and development with respect to species diversification, fish nutrition, environmental issues and fish health, with the final objective of promoting the industry and directing development according to a strategy that is economically and environmentally sustainable.

3. Establishing a Competitive Industry

The principle aquaculture products of the European Union (EU) are fish (trout, salmon, sea bream, sea bass) and molluscs (mussels, oysters and clams). Aquaculture production within the EU rose from 642,000 tons in 1980 to 944,000 tons in 1990 and reached 1,315,000 tons in 2000. This constitutes only 3% of world aquaculture production (Brussels, 19.9.2002 COM (2002) 511 final).

Over the last decade, capture fisheries production has remained more or less constant, whereas the net contribution from world aquaculture to the global harvest has increased to more than 31%. It is generally accepted that further increase in aquatic produce will originate from aquaculture (FAO, 1997).

The EU has also set the ambitious objective of increasing employment in aquaculture by 8,000 to 10,000 full-time job equivalents over the period 2003 – 2008. In 1998, aquaculture in the EU employed an equivalent of 57,000 full-time jobs.

Maltese aquaculture exports consisted of 1,100 tons of sea bream and sea bass, having a monetary value of LM1.7 million in 2003; 1,855 tons of Bluefin tuna with a monetary value of LM9 million were exported in 2002. Approximately 90 MT of locally produced fresh aquaculture fish along with 1,500MT of wild caught fish is being sold in Malta. Aquaculture in Malta is producing a value that surpasses the production value of the cattle, pig and poultry industries.

Aquaculture is also a significant foreign currency earner due to its exports. The availability of locally produced quality fish protein also has a positive impact on the tourist infrastructure; otherwise most of the necessary fresh fish would be imported. Importation would result in lower quality fish offered in restaurants and hotels. It is noted that in major Italian and Greek markets, the consumption of bream and bass is directly related to the tourist season, i.e. kg / bed-night.

It has long been recognised that the long-term viability of the aquaculture industry depends on species diversification and technological innovation. It is evident that the major economic benefit is registered in those initial years during which the technologies for culturing different species are developed.

Once overseas competing operators develop the production of that same species, a drop in market prices would result through mass production and smaller scale producers may then be out-competed by enterprises having multiple, larger-scale sites. The aquaculture industry is one where the major benefits for smaller scale producers lie in the adoption and development of emergent technologies, species diversification, and in the selection of specific market niches.

A strategy for the economic sustainability of the industry is expected to:

i. increase the emphasis with respect to quality of the produce;
ii. promote environmental sustainability of operations; and
iii. promote the diversification of the species cultured.

Competitiveness of the local aquaculture sector requires effective control and improvement of operational standards, and investment in research and development for diversification of species cultured and of new production technologies.

The fundamental issue is the maintenance of competitiveness, productivity and sustainability. Further development of the aquaculture industry must take an approach where farming technologies, socio-economics, the use of natural resources and governance are all coordinated so that sustainability can be achieved.

4. REQUIREMENTS OF THE AQUACULTURE INDUSTRY

The aquaculture industry makes use of aquatic and land resources for the rearing of organisms. A land base is generally essential even if the culture system may be based at sea.

Land areas may be required for various needs such as:

- offices
- hardware / dry / cold stores
- packing / processing plants
- ice making facilities
- areas for the assembly / disassembly / maintenance of cages
- net mending, net washing, net drying
- berthing facilities for sea vessels
- hatcheries
- on-growing facilities

In the case of a land based farm, the greater part or all of the on-growing facility and the offices, storage areas, packing plant etc., will be on land.

In the case of a sea based operation, an area of sea would be needed for the various operations, including the infrastructure to culture the species concerned. The sea depth and location required is dependent on the type of species cultured. Inshore and sheltered sites may also be required, for the rearing of smaller sized fish species or juveniles or any other species of plants or animals that may require inshore areas for their proper growth.

For the above reasons the aquaculture industry has to compete with various land and marine activities for the areas required. Marine activities that are in competition with aquaculture include shipping and bunkering, tourism and other recreational activities.

5. Environmental Considerations

Environment impact assessments requested in Malta prior to any development, as well as the monitoring rituals established for existing operations are amongst the most serious in the Mediterranean. The monitoring programmes rigorously follow most of the recommendations made by international institutions. Over the past three years, a significant amount of monitoring data has been collected, and may now be used as a basis for the assessment of the potential impacts of proposed aquaculture developments. A review of the environmental impacts caused by aquaculture operations is available within the 'State of the environment report' (2002).

All development permits issued with respect to aquaculture had imposed environmental monitoring of aquaculture operations within permit conditions. The required environmental monitoring is carried out at the expense of the individual operators. Rigorous environmental monitoring programmes are the means by which the industry can demonstrate that operations are environmentally sustainable.

Analysis of the environmental data collected to date has shown that the presence or absence of environmental impacts is closely linked to site-specific circumstances, or to the quality of operational practices. Impacts also vary according to the nature of the aquaculture activity.

Monitoring programmes and the relationship between the different types of ecosystem and the operation need to be further refined.

6. National Policy on Aquaculture Development

Legislation in Aquaculture

Aquaculture development is regulated by Part IX of Chapter 425, Fisheries Conservation and Management Act of 2001 and by subsidiary legislation (Aquaculture Operations Regulations) 2004 [presented with this policy] and (Aquaculture Regulations) 36.34 (LN73 of 1990) issued under the Prevention of Disease Ordinance Chapter 36 and covered by Chapter 437 Veterinary Services Act and Animal Welfare Act Chapter 439. The issue of operating permits is the direct responsibility of the Fisheries Conservation and Control Division.

Development in aquaculture both on land and within the waters necessitates a development permit as established by the Development Planning Act Chapter 356 and its subsidiary legislation. Aquaculture is also subject to environmental regulations published under the Environment Protection Act 2001.

The local legislation directly affecting the aquaculture industry pertains to the following Departments and Authorities:

- **Food and Veterinary Division** regulates the veterinary aspects of production, including animal health and welfare, fish processing and packaging, and related operations involving fishing vessels, factory, ships, plants and fish markets.
- **Malta Maritime Authority** regulates and manages the port and marine activities, maintenance of good order in Maltese waters, safety of navigation, and prevention and control of pollution.
- **Malta Environment and Planning Authority (MEPA)** regulates the development on land and sea via issues of development permits, and management of the Environmental Impact Assessment (EIA) process, biodiversity conservation, and regulates the dumping of wastes or discharges into the marine environment, as well as the prevention and control of pollution.

International Commitments

Aquaculture development must have regard for International Treaties and Conventions acceded to and ratified by Malta and should keep in view the general policies outlined in the Code of Conduct for Responsible Fisheries, mainly in its Article 9, the Bern Convention, the Barcelona Convention, CITES and others that may from time to time form part of Malta's portfolio of international agreements.

Having regard for the above portfolio of international agreements, the major areas of concern are the conservation of species / genetic diversity and ecosystem integrity. Aquaculture developments should cooperate in the elaboration, adoption and implementation of international codes of practice and procedures for the management of aquaculture operations with respect to various environmental concerns.

Use of Resources

Aquaculture development must make rational use of available resources, adopting the principles of environmental sustainability. Activities in the marine environment shall be managed and developed in accordance with the regulations and policies of the various agencies, following the principles of integrated coastal zone management.

Environmental Aspects

Aquaculture developments require appropriate environmental assessment prior to initiation, and require monitoring programmes; these shall have the objective of minimizing adverse ecological changes and related economical consequences resulting from water use, land use, discharge of effluents, use of drugs and chemicals and other related activities. The inputs of chemicals that are hazardous to human health and the environment are regulated and need to be registered and monitored during each operation. Safe, effective and minimal use of therapeutics, hormones, drugs, antibiotics and other disease control chemicals should be ensured. These programmes have to be approved by the relative Environment, Fisheries and Veterinary Authorities, according to the remits of the relative agencies.

Aquaculture developments must necessarily comply with all local, regional and global management systems aimed at conservation of species.

Whenever possible aquaculture developments should support research and the development of culture techniques for endangered species to protect, rehabilitate and enhance endangered stocks.

Aquaculture development must ensure that the choice of species, siting of activity and its management would have minimal negative effect on adjacent ecosystems.

The use of non-indigenous species in aquaculture developments necessitates special plans to ensure security and a nil effect on local ecosystems.

Aquaculture development must conserve genetic diversity and maintain the integrity of aquatic communities and ecosystems by appropriate available management. Efforts should be undertaken to minimize potential harmful effects of aquaculture.

Conduct

The selection and use of appropriate feeds, feed additives and fertilizers, including manures should be given the right attention. Food safety and product quality of aquaculture products have to be assured by the right management practices before and during harvesting, processing, storage and transport.

Steps should be taken to minimize the spread of disease and the effects of escaped farmed fish on wild stocks.

In order to minimize risk of disease transfers and other adverse effects on wild and cultured stocks, aquaculture developments must adopt appropriate practices in the genetic improvement of broodstock, the introduction of species and in the production, sale and transport of eggs, larvae or fry, broodstock or other live materials.

Aquaculture developments must participate in all local, regional and global data collection systems and necessarily supply requested data to the relevant Fisheries, Veterinary and Environment Authorities.

Socioeconomic Aspects

Aquaculture development must make sure that it does not affect livelihoods of local communities. Interaction with other activities or developments should be considered, and a reasonable balance must be reached regarding the use of resources by the different activities.

The areas used for all aquaculture operations, whether land or sea based, require property rights.

7. STRATEGY

The relevant authorities will endeavour to fulfil the policy on aquaculture and shall follow appropriate strategies for the different sectors. The Ministry for Rural Affairs and the Environment will review and make recommendations on the National Policy after five years.

Procedures

Requests for Aquaculture development (both land and marine, or marine only?) will be administered by the Fisheries Conservation and Control Division, which shall liaise and coordinate proposals with the relative Regulatory Authorities as appropriate.

Strategy for the Development and Management of Marine Installations

(i) Marine installations occupying large areas used for the culture of large fish shall be located in designated areas, located as far out from the coast as the species cultured and available technology allows.

(ii) Marine installations occupying limited areas involving small fish that necessitate sheltered waters shall be located to avoid significant visual impact as much as possible, and the best use of available areas.

(iii) Marine installations involving filtrating marine resources, algae and invertebrates shall be given priority on the use of inshore available areas.

Strategy for the Management of Land Developments

(i) Land bases related to marine installations shall be restricted to industrial areas and other appropriate sites.

(ii) Land installation involving complete cycles / on-growing.

(a) Making use of completely closed systems shall be restricted to industrial areas, former quarries etc. These could be located in the countryside on the same basis as new agricultural buildings.

(b) Making use of open systems shall be restricted to areas outside the water protection zone or in areas where their effluent can be properly managed.

References

Brussels (2002). Communication from the commission to the council and the European parliament. A strategy for the sustainable development of European aquaculture. (Brussels, 19.9.2002 COM (2002) 511 final.

FAO (1999). Consultation on the application of Article 9 of the FAO code of conduct for responsible fisheries in the Mediterranean region: Synthesis of the National Reports (TEMP/RER/908/MUL). FAO, Rome.

FAO (1997) Press Release 97/10. Fish production reaches new record thanks to aquaculture while likely increase of future demand calls for sound measurement measures. FAO, Rome.

APPENDIX

The 'Conference on Aquaculture in the Third Millennium' recognised that, amongst other things:

- During the past three decades aquaculture has become the fastest growing food-producing sector and is an increasingly important contributor to national economic development, the global food supply and food security.
- There has been a significant increase in commercial and industrial aquaculture, both in developed and developing countries, that has contributed to food supply, export income and trade.
- The potential of aquaculture to contribute to food production has not yet been realised across all continents.
- Aquaculture can be an entry point for improving livelihoods, planning natural resource use and contributing to environmental enhancement.
- Responsible aquaculture practitioners are legitimate users of resources.
- Education and research will continue to make a significant contribution to the growth of aquaculture.
- Some poorly planned and managed aquaculture operations have resulted in negative impacts on ecosystems and communities.
- Aquaculture has also been negatively impacted by other unplanned activities.
- Effective national institutional arrangements and capacity, policy, planning and regulatory frameworks in aquaculture and other relevant sectors are essential to support aquaculture development.

The Conference declared that:

- The aquaculture sector should continue to be developed towards its full potential, making a net contribution to global food availability, household food security, economic growth, trade and improved living standards.

- The practice of aquaculture should be pursued as an integral component of development, contributing towards sustainable livelihoods for poor sectors of the community, promoting human development and enhancing social well-being.
- Aquaculture policies and regulations should promote practical and economically viable farming and management practices that are environmentally responsible and socially acceptable.
- National aquaculture development processes should be transparent and should take place within the framework of relevant national policies, regional and international agreements, treaties and conventions.
- In pursuing development, States, the private sector, and other legitimate stakeholders should co-operate to promote the responsible growth of aquaculture.
- Strengthened regional and inter-regional co-operation should increase the efficiency and effectiveness of aquaculture development efforts.
- All parties formulating improved policies and implementing practices for aquaculture development should consider and where appropriate, build on the FAO Code of Conduct for Responsible Fisheries."

Annex 4. Financial support measures for aquaculture in the FOPM

One of the main objectives of the FOPM is "to improve the competitiveness of the fisheries, aquaculture and processing establishments sector by improving the structure and its working environment."

Four priority axes are given, of which Priority Axis 2 has most relevance to aquaculture, referring to "aquaculture, processing and marketing of fishery and aquaculture products".

Specific objectives for Priority Axis 2 include:

- To reduce the negative impact on the environment
- To achieve diversification of cultivated species
- To increase the competitiveness of aquaculture operations
- To enhance the processing and packaging facilities of the aquaculture and fisheries industries
- To enhance the promotion and marketing of species and products of interest to the market

Further to these objectives, certain support measures are defined. Under Measure 2.1" Productive investments in aquaculture", the following actions are deemed eligible for support:

- Investment in new equipment aimed at modernizing current establishments as well as enhancing security
- Investment in the construction of a land-based hatchery
- Investment in the construction of new establishments and the required equipment
- Investment in new equipment aimed at mitigating any possible negative impacts of aquaculture operations
- Investment in the development and commercialisation of new species
- Investment in the development and implementation of new aquaculture methods aimed at reducing environmental impact
- Spatial planning/mapping of aquaculture sites

Importantly, one of the criteria for eligibility states that benefiting operations cannot use capture based stocks, which appears to rule out support for tuna operations.

Under Measure 2.2: "Aqua-environmental measures ", the action eligible for support is:

- The implementation of aqua-environmental methods aimed at protecting and enhancing the environment and producing more eco-friendly aquaculture products

No guidance is given regarding what such methods might be, although there is scope for compensation for revenue lost as a result of such methods.

Under Measure 2.3:" Investments in processing and marketing", which relates to both fisheries and aquaculture, the following actions are deemed eligible for support:

- Investment in facilities and equipment including both hardware and software with the aim of achieving one or more of the objectives as per Article 35 (1) of the EFF Regulation
- Investment in refrigeration vehicles and other refrigeration equipment necessary for the operations of enterprises operating at wholesale level
- Investment in health, hygiene and safety measures
- Investment in the marketing of products originating from local landings and aquaculture
- Investment in the development of brand names for local products

Other measures relate mainly to the fishing industry e.g. vessels, port developments, whilst others potentially cover both fishing and aquaculture e.g. Measure 3.2: "Development of new markets and promotional campaigns".

Annex 5. Legislation concerning aquaculture in Malta

(Source: FAOLEX, ECOLEX, Fisheries Operational Programme for Malta 2007-2013)

Chapter 499. Authority for Transport in Malta Act, 2010.

Chapter 504. Environment and Development Planning Act, 2010.

Chapter 437. Subsidiary Legislation 95. Animal Health Requirements for Aquaculture Animals and Products thereof, and on the Prevention and Control of Certain Diseases in Aquatic Animals Rules, 2009

Chapter 449, Subsidiary Legislation 55. Food Safety (Temperature Control) Regulations, 2008.

Chapter 226, Subsidiary Legislation 01. Ship-Source Pollution Regulations, 2008.

Chapter 504. Subsidiary Legislation 79. Environmental Impact Assessment Regulations, 2007.

Chapter 449, Subsidiary Legislation 35. Materials in Contact with Foodstuffs Regulations, 2003.

Chapter 449. Subsidiary Legislation 25. Fish Packing and Processing Establishments Regulations, 2002.

Chapter 449, Subsidiary Legislation 27. Registration of Food Handlers Regulations, 2002.

Chapter 449, Subsidiary Legislation 31. Hygiene of Food Regulations, 2002.

Chapter 449, Subsidiary Legislation 32. Food Safety (Sampling Procedures) Regulations, 2002.

Chapter 356. Development Planning Act, 2002.

Chapter 504. Subsidiary Legislation 41. Quality Required of Shellfish Waters Regulations, 2002.

Chapter 439. Animal Welfare Act, 2002.

Chapter 425. Fisheries Conservation and Management Act, 2001 (No.II of 2001).

Chapter 449, Subsidiary Legislation 18. Residues in Meat Regulations, 1998.

Chapter 449, Subsidiary Legislation 19. Maximum Residue Limits in Veterinary Medicinal Products Regulations, 1998.

Chapter 425. Subsidiary Legislation 06. Marine Vegetation Licence Regulations (Legal Notice 66 of 1997).

Chapter 504. Subsidiary Legislation 03. Development Permission (Method of Application) Regulations, 1993.

Chapter 449. Food Safety Act, 1992.

Chapter 352. Ports and Shipping Act, 1991.

Chapter 36. Subsidiary Legislation 34. Aquaculture Regulations, 1990.

Chapter 35. Subsidiary Legislation 10. Fees for Abattoir and Veterinary Services Regulations, 1980.

Chapter 449, Subsidiary Legislation 07. Sale of Fish Regulations, 1978.

Chapter 271. Marine Pollution (Prevention and Control) Act, 1977.

Chapter 36. Subsidiary Legislation 26. Prohibition of Sale of Sea-Food Regulations, 1973.

Chapter 234. Merchant Shipping Act, 1973.

Chapter 226. Territorial Waters and Contiguous Zone Act, 1971.

Chapter 194. Continental Shelf Act, 1966.

Chapter 146. Agriculture and Fishing Industries (Financial Assistance) Act, 1956.

Chapter 35. Subsidiary Legislation 01. Fees Leviable by Government Departments Regulations, 1925.

Chapter 36. Prevention of Disease Ordinance, 1908.

Aquaculture Operations Regulations, 2008

Annex 6

Details of planning applications for coastal fish farms in Malta

Company	Site	Council	Case No.	Decision date	Description	Permit conditions online?	EIS on-line?	PDS on-line?	Status
F&F		Marsaxlokk	PA/00481/93	22/07/1993	Installation of marine cages for fish farming				approved
MML	S Comino Channel		PA/04052/92	30/09/1993	Proposed agricultural complex				approved
MFF	Munxar Reef	Marsaxlokk	PA/00910/94	06/07/1995	Fish farm	yes			approved
AF	Triq Ras in-Newwiela (Gozo)	Sannat	PA/07379/98	18/05/2000	Tuna Penning in offshore cages, feed storage, fish packing for export and all other activities normally carried on land base to be carried aboard vessel at sea		yes		withdrawn
AF	Sikka l Bajda	Mellieha	PA/07377/98	16/10/2000	Tuna Penning in cages,feed storage,fish packing for export and all other activities normally carried out on land base to be carried out aboard vessel at sea	yes	yes		approved
AF	S Comino Channel	Ghajnsielem	PA/01741/01	05/07/2001	To substitute part of the breeding of sea bream with tuna	yes	yes		approved
J Muscat	Il-Mejjiesa	Mellieha	PA/01534/98	13/09/2001	Offshore fish farm				withdrawn
F&F	Il-Hofra z-Zghira	Marsaxlokk	PA/02240/01	13/09/2001	Tuna penning site (A) Relocation of existing fish farm approved in PA 481/93 by approx 790m further offshore from site to a depth of 50m (B) To substitute 350 tns of existing licensed production of sea bass/bream with tuna (C) To sanction mooring blocks	yes	yes		approved
K Cole	Benghajsa Reef	Birzebbugia	PA/06330/99	26/04/2002	Setting up of a tuna penning farm and including also a land base at Ricasoli Industrial Estate				refused
MFF	Munxar Reef	Marsaxlokk	PA/02528/01	11/10/2002	(1) To move the entire operation approx 900m further offshore from the existing operation and from a depth of 35m to an average depth 45 to 50m. (2) To replace 350t of the existing licenced 500t of sea bream/bass with blue fin tuna as the farmed species				approved
F&F	Il-Hofra z-Zghira	Marsaxlokk	PA/00040/02	12/08/2004	To extend tuna penning site and operation. To include mooring of cages adjacent to approved row of cages, increase production by 350 tonnes of blue fin tuna. Relocation of licensed seabream / bass cages.	yes		yes	approved
MRRA	SE of Malta	Marsascala	GF/04084/03 PA/00087/04	22/12/2005	Development of an aquaculture zone south-east of Malta		yes	yes	appeal made

AF=Azzopardi Fisheries; F&F= Fish and Fish Ltd; MFF=Malta Fish Farming Ltd; MML=Malta Mariculture Ltd; MRRA=Ministry for Resources and Rural Affairs; EIS=Environmental Impact Statement; PDS=Project Development Statement

Source: http://www.mepa.org.mt/results?category=2&catstring=Coastal&subcategory=6&subcatstring=Fishfarms&pending=false

Annex 7. Diseases of existing and potential new farmed finfish species in Malta – aetiology, status, treatment, and prevention

1. Bacterial diseases

1.1 Vibriosis

Vibriosis is caused by *Vibrio anguillarum,* a gram-negative bacterium known to affect over 50 species of fish in brackish and saline waters throughout the world. It mostly affects seabass in the Mediterranean region, but also potentially other species. It affects fish of all sizes and is typically a stress-related disease, occurring after handling, during bad weather, especially thunderstorms, and in the early and late summer when water temperatures are variable. The incidence of Vibriosis is thus significantly affected by husbandry practices.

Vibriosis normally manifests itself as a haemorrhagic septicaemia, externally apparent as extensive skin haemorrhages on the head, belly, an inflamed anus and haemorrhages on the base of the fins. The belly is often swollen, eyes exophthalmic and gills pale. Internally the liver is pale and often haemorrhagic, the spleen is enlarged, the kidney often congested and the gut filled with clear fluid. If seabass fry are affected, the symptoms are sometimes limited to lethargy and a dark colouration. The disease is easily diagnosed with standard bacteriological techniques and rapid diagnostic kits. Although all sizes of fish may be affected, young seabass are most susceptible, and losses may reach 15% in single outbreaks, 25% over a growth cycle and even higher in the hatchery.

Vaccination is now recognised as a highly effective control measure for this disease, with a typical protection level of up to 85% for combined immersion and injection protocols. Consequently, all seabass juveniles should be vaccinated by immersion prior to delivery to sea cages. In the event of an outbreak, oral antimicrobial treatments using such products as oxytetracycline, oxolinic acid and Tribrissen are effective, although repeat treatments are often necessary.

1.2 Pasteurellosis

Since its isolation in 1963 from striped bass in the US, this disease has emerged as a concern throughout the world. Previously known as *Pasteurella piscicida* it has, since 1995, been known as *Photobacterium damsela* subsp. *piscicida,* although the disease is still commonly referred to as 'pasteurellosis' by aquaculturists. The disease is a serious problem in Japanese amberjack culture, being responsible for occasional losses of over 50% of stock, and is therefore a potential disease of greater amberjack *Seriola dumerili.* It is a gram-negative bacterium with a single serotype, making vaccine development and use theoretically viable. The disease occurs throughout the Mediterranean region and in cage farms typically occurs during the summer months, preferring water temperatures in excess of 20°-22°C.

This disease affects seabream during the hatchery and nursery phases, and can be a serious problem for fish between pre-weaning and a weight of around 6g (hatchery losses are more serious due to the low effectiveness of vaccines in very young fishes). Because many Mediterranean hatcheries use bore-hole water supplies, this disease can cause mortalities in hatcheries throughout the year since it is pathogenic at temperatures as low as 18°C. It rarely causes problems once fish exceed a weight of around 20g. Seabass, however, appear to be most susceptible to this disease during their first summer at sea, at a size range of between 5g and 40g.

Losses in hatcheries can be severe, with entire batches of bream juveniles being lost. In cages, losses are maximised when small fish (seabream of 2-6g, and seabass of 5-35g) are stocked during the early summer, when losses can reach 25-35% of the stock.

The disease itself, usually referred to as 'pseudotuberculosis' of 'fish pasteurellosis', manifests itself as numerous white bacterial colonies, known as pseudotuberculi, throughout the internal viscera, particularly the kidney and spleen. An acute form of the disease, however, may cause a darkening of the body, focal gill necrosis and an enlarged spleen without the appearance of pseudotuberculi. The chronic symptoms are distinctive, and identification is easily confirmed with the aid of commercial test kits.

Treatment of post-weaned fish is effective with the use of oral antimicrobials such as oxytetracycline, oxolinic acid and 'Tribrissen', although repeat treatments are often required. Treatment during the larval phase for seabream is far less effective, and highlights the need for effective disease control and sanitary measures to be employed in the hatchery. All juvenile fish delivered to cage farm should be carefully screened prior to delivery to avoid the introduction of diseased fish, and effective health management procedures employed at the cage farm to minimise losses.

Vaccination has been shown to be feasible, although immersion vaccines are not as effective as intra-peritonial injection. Despite this, since mostly small fish are affected, hatcheries should carry out immersion and long-bath vaccination with commercially-available vaccines to reduce the incidence of this disease during and after transfer to cages. Further research work is currently underway to improve the efficacy of immersion vaccines.

1.3 Flexibacter (fin rot, eroded mouth syndrome)

This disease is caused by the bacterium *Flexibacter maritimus*, a chemo-organotrophic gram-negative bacterium which infects the gills, body surface, eggs and larvae of a number of fish species including seabass and seabream. In cage culture in Malta the disease is associated with poor water quality and high water temperatures, and affects both seabass and seabream shortly after transfer to the cages. Seabass are typically infected on the tail and caudal peduncle, leading to erosion and necrosis of those parts, whilst seabream more typically are susceptible to 'eroded mouth syndrome'.

The bacterium is rod-like, occasionally forming filaments as long as 100µm in length which are visible under the microscope using an oil-immersion lens and a x100 objective. The appearance of these distinctive cells, together with the symptoms of the disease, are the main diagnostic methods. A selective agar medium is required for in vitro isolation of this bacterium.

Treatment is effective with both bath and oral treatments of antimicrobial compounds, and are most effective if treated early, at the first signs of the disease.

1.4 Mycobacterium

Mycobacteriosis has been raised as a potential threat to the seabass culture industry in the Mediterranean and Red Sea by a number of workers (Toranzo, Margariños & Romalde, 2005). It is a chronic wasting disease that is known to affect seabass in addition to a wide range of other fish species. It is of particular concern as it remains asymptomatic for a long period, is untreatable and, although mortalities are low, it renders fish unmarketable. It is also has the potential to cause disease in humans. Control measures are confined to strict health screening on introduced fish stock and stock culls should the disease be identified.

Mycobacteriosis has been identified on only 2 occasions in Malta, in a large seabass and a single amberjack, both of which have been attributed to the use of bait fish as a food source, and Mycobacteriosis has not been identified as a problem in the Maltese aquaculture industry to date.

2. Parasitic diseases

2.1 Protozoa

Certain protozoa, such as the ciliates *Trichodina*, *Colponema* and *Scyphidia* are ecto-commensal species which use various fish organs, such as gills and skin, as a substrate for attachment whilst they feed on suspended bacteria. Their attachment then causes a pathology, particularly of gill tissue in larval and juvenile fish in the hatchery and soon after transfer to cages. The presence of these types of protozoa are normally indicative of eutrophication or poor water quality. Consequently, avoidance of this problem is possible through the employment of optimum husbandry methods and the maintenance of a high level of water quality. Treatment can be effected by the use of bath treatments of formalin, and hatcheries typically carry out a regular 'prophylactic' treatment with formalin to control the background populations of protozoa during hatchery production.

Trichodina is encountered occasionally in juvenile seabass and seabream in Malta, and is easily controlled with the aid of formalin bath treatments.

Other protozoa, such as the flagellate *Ichthyobodo,* are more pathogenic in that they feed directly on cellular debris and thus can cause a pathology if present in high numbers. Such parasites are often present in very low numbers and are relatively harmless, but may increase in numbers under certain circumstances and become pathogenic. Again, regular bath treatments with formalin are usually sufficient to control this parasite.

Ichthyobodo is occasionally encountered in juvenile seabass and seabream in Malta, and is easily controlled with the aid of formalin bath treatments.

Some protozoa are obligate parasites of fish which directly cause pathology, such as *Cryptocaryon irritans* and *Amyloodinium ocellatum.* These parasites have been recorded as causing pathology in a number of hatcheries in the Mediterranean region but are not known to cause problems in cage culture in Malta.

A number of intra-cellular protozoan parasites have been identified in fish cultured in the Mediterranean, especially in seabass. Most appear to have few if any ill-effects, at least when present in small numbers.

Haemogregarina bigemina infests the red blood cells of seabass. This parasite appears to be transmitted by way of a crustacean host, probably a small fish louse, either after ingestion as a food item or from transmission into the bloodstream during parasitisation from the louse. Either way, this suggests that *Haemogregarina* is unlikely to become a serious pathogen of cage-reared seabass which rely on the provision of pelleted feeds and are rarely infected with sea lice. No incidences of this parasite have been recorded in the Maltese aquaculture industry to date.

2.2 Myxozoa

A number of Myxozoan parasites have been found in cage stocks of seabass and seabream, including various forms of *Ceratomyxa* and *Leptotheca* which do not appear to cause any ill effects. Some species, however, are disease-causing and represent a significant threat to aquaculture operations in Malta since there are currently no effective means of control and the frequency and severity of outbreaks appears to be on the increase. Direct mortalities are generally low, but growth can be severely affected in heavily infested fish. The following are known to cause disease in cage fish stocks in Malta:

Enteromyxosis (Myxidium)

This endoparasitic disease is caused by *Enteromyxum leei,* which was previously better-known as *Myxidium leei* until a systematic revision was carried out on the Myxozoa group of organisms in 1994. Previously considered as Protozoans, the Myxozoa are now included in the Phylum Cnidaria, along with hydrozoans and jellyfish. Most forms have a complex life-cycle comprising vegetative forms in two hosts – an invertebrate, usually an annelid, and a vertebrate, usually a fish. These vegetative forms exist as spores, usually 10-20µm in size and so are easily visible under the microscope.

In the Mediterranean region *Enteromyxum leei* affects most sparids, including *Sparus aurata,* and seabass, and fish of all sizes. The sharp-nosed bream *Diplodus puntazzo* is particularly susceptible to this disease, and high losses have been recorded with this species. The disease occurs throughout the year, but is commonest in the warmer months. Symptoms include skin damage (discolouration, scale loss, non-haemorrhagic ulceration) and lack of appetite. Chronic infections may lead to emaciation. Internally the intestine is filled with a creamy mucus and the intestinal mucosa is inflamed and haemorrhagic. The liver is inflamed and the gall bladder grossly distended with dark brown bile. This condition is often accompanied by secondary bacterial infections. Diagnosis is based on the presence of distinctive spores in the bile ducts, gall bladder and gut of the affected fish. Mortalities are severe in sharp-nosed bream, typically around 30% but sometimes much higher, and normally around 10-20% in gilthead seabream. Seabass appear to be little affected, unless grown in close proximity to affected sparids. There are also likely to be considerable financial losses due to lost growth in affected stocks.

There are currently no effective treatments for this disease. The incidence of the problem can be reduced by strict health control measures, such as the regular removal and correct disposal of mortalities and to rear fish in areas of high water exchange where possible.

Sphaerospora dicentrarchi and *Sphaerospora testicularis*

Both of these species of Myxozoan are known parasites of seabass in the Mediterranean. *S. dicentrarchi* in particular is very common in cultured seabass, and infects the connective tissue of the gut, gall bladder and kidney, whilst *S. testicularis* infects the testis. Both parasites appear to have an invertebrate intermediate host since inland ponds and inshore cages show a higher infection rate than offshore and submersible cages. This theory is also supported by the fact that newly transferred fish juveniles are free of infection (fish of 10g or less are rarely infected), and the presence of this parasite then increases in number with fish age (Fiorovanti et al, 2004). Light infestations of either species of *Sphaerospora* are unlikely to cause any ill effects. However, heavy infestations of *S. dicentrarchi* are thought to lead to enteritis in affected fish, and may lead to lost growth or losses from secondary bacterial infections. *S. testicularis* will have less of an effect on cultured seabass, since most fish are harvested prior to sexual maturity. This parasite may represent a problem in hatchery-reared broodstock, however, by damaging the testis of mature male fish.

Polysporoplasma sparis

This Myxozoan parasite infects the kidney of gilthead seabream and has been recorded in a number of locations around the Mediterranean, including Spain, Greece and Malta. It appears to be most common in pond-based aquaculture operations, suggesting an intermediate invertebrate host is present in the life cycle. Very few fish below 50g in weight have been found to be infected. This parasite may cause significant damage to the kidney tissues, and a loss of growth associated with infestation has been demonstrated (Paluenzela et al, 1999).

Polysporoplasma is regularly encountered in seabream stocks in Malta, but appears to cause few apparent problems. The potential loss of growth performance is cause for concern, however.

2.3 Crustacea

A number of crustaceans are known to parasitize marine fish in the Mediterranean, although few are known to cause a significant pathology amongst cultured fish. Seabass appear to be susceptible to a number of parasites, including *Caligus minimus* infecting the buccal cavity and *Lernanthropus kroyeri* infesting the gill tissue. Because transmission is direct control measures aimed at preventing the entry of such parasites into the rearing system represent the most effective method of control against parasites of this type.

Isopodosis

This disease is caused by an infestation by the Cymothoid isopod *Cerathoa oestroides,* a relatively large crustacean which lodges in the mouth of affected fish. It is a serious problem in farmed seabass in parts of the Mediterranean, especially Greece and Turkey, but has not been recorded in Malta to date. This parasite appears to have infected farmed seabass from wild fish species, as seabass has not been recorded as one of the natural host species in the wild. All farmed fish species may be susceptible to some extent, but the structure of the mouth appears to be an important factor in parasite incidence. Seabream are occasionally infected, for example, but the mouth shape does not appear suited to the parasite. Small seabass are typically infected with larval parasites, which then grow to adulthood along with the host, so that adult fish are infested with large adult parasites. Because of higher growth rates at warmer water temperatures, infestations appear to be highest during the summer months, but parasites are present year-round.

Infection appears to be direct. Adult female parasites releases around 400-600 larvae, which then swim to other potential fish hosts and remain infective for around 7 days. When they attach on to the exterior of a fish, the larval isopod then crawls into the operculum and lodges in the buccal cavity, where it feeds on the blood of the host fish. Many larval parasites may infest the mouth of a single fish, but there is strong competition between the parasites, so that only 2 isopods will settle into the mouth of a single host fish, eventually growing into a mature pair.

Heavy infestations of small fish may lead to low mortalities caused by physical damage to the head and gills. Larger fish suffer from anaemia and localised physical damage to the mouthparts and buccal cavity, but more significant is the loss of feeding caused by the blockage of the mouth by the parasites, which may reach 6cm in length, accompanied by chronic stress and a susceptibility to secondary bacterial infections. Also significant are financial losses from fish rejected at harvest due to unsightly deformities of the mouth or the visible presence of the parasites themselves. Infestation rates may exceed 50% in heavily affected stocks of seabass, and the mortality amongst smaller fish may reach 15%. Growth losses are difficult to quantify but may reach 20% of the expected biomass of the harvestable stock.

Treatment is possible by bathing affected stocks of fish in formalin or proprietary pyrethroids such as deltamethrin, but bath treatments are time-consuming, difficult and lead to significant stress of the fish stocks. This direct means of transmission means that the incidence of this parasite can be reduced by reducing stocking density, siting cages in areas of high water exchange, and keeping nursery sites separate from grow-out facilities.

Parasitic isopods are very rarely encountered in Maltese aquaculture operations, possibly because most farms are sited in exposed locations and thus not susceptible to infection. Both *Ceratothoa* and the external parasite *Anilocra* are very occasionally encountered in caged seabream stocks but are not currently a problem.

2.4 Monogenea

A number of species of monogenean trematodes are known to cause disease problems in the Mediterranean region. *Furnestia echeneis* is known to infest the gills of gilthead seabream and has been associated with bacterial gill disease in this species. Other species, including *Microcotyle,* are also known to cause problems in seabreams, particularly in marine hatcheries. Seabass are susceptible to infestation by *Diplectanum aequans.*

Monogenean gill infestations are rather uncommon in the Mediterranean region, particularly in cage culture of seabass and seabream. They may be more prevalent in pond or tank culture, however, and may become a problem with captive broodstock held reared in tanks. In Malta monogenean flukes occur regularly on caged fish stocks, especially seabass, but are normally present in very low numbers and do not require control measures. These parasites are normally controllable by the use of formalin bath treatments if necessary.

Zeuxapta seriolae

This trematode has emerged as a significant pathogen of hatchery and cage-reared amberjacks during pilot scale production in Malta. It infests the gills of a number of species of *Seriola* and has emerged as a serious problem in kingfish (*Seriola lalandi*) production in Australia (Mansell, 2005). Although bath treatments are quite effective, the parasite is aggressive and mortalities can reach significant levels before treatments can be carried out. Bath treatments are currently the main means of control, using either formalin or hydrogen peroxide, but such control methods may be problematic in large cages in exposed environments. In Malta some success has been achieved with the use of oral treatments of the anthelminthic product praziquantel, which offers a more effective treatment strategy for amberjack stocks held in cages in offshore environments. Experience in Malta suggests that control is effective if carried out early, but mortalities may reach levels of up to 20% if treatment is delayed.

2.5 Digenea

Blood flukes of the genus *Sanguinicola* are known to cause disease in a number of fish species, both freshwater and marine, and have been found to cause both high mortality and reduced growth. Their occurrence in farmed fish stocks in the Mediterranean was first recorded in gilthead seabream in Spain in 1998 and this parasite is now found throughout the Mediterranean region (Padros et al, 2001). The parasite causes localised inflammatory responses in fish tissues such as the gills (where eggs are deposited) and the kidney. It has been found in both seabream and, less frequently, in meagre in Maltese fish farms. It does not appear to lead to direct mortalities but is thought to affect growth rates and occasionally renders affected fish unmarketable.

Nutritional diseases, including systemic granuloma, chronic inflammation of viscera and lipoid liver degeneration.

A number of fish health issues have occurred which are thought to be due to nutritional problems, either caused by poor feed storage or an inadequate diet for the fish species cultured. For example acute mortality of gilthead seabream due to systemic granuloma has been recorded in the Mediterranean region in the past, thought to be associated with long-term feed storage. In most cases the use of high-quality feeds and correct feed storage is sufficient to eliminate the problems. Some nutritional problems often emerge when a new species of fish is cultured, due to a poor understanding of the exact nutritional requirements of the species of fish in question, and such issues may be expected in the future mass production of such species as amberjack and bluefin tuna. Such problems are normally resolved, however, with further research and development.

3. Viral diseases

3.1 VNN

Nodavirosis, otherwise known as Viral Nervous Necrosis (VNN) or Viral Encephalopathy and Retinopathy (VER), is a severe viral disease of seabass and other related fish species, such as Sciaenids and groupers. Gilthead seabream are not affected, but may act as asymptomatic carriers. It is known throughout the warmer waters of the world, and is a particular problem with grouper and barramundi culture in the Indo-Pacific.

Fish are affected at all sizes, but mortalities are most severe amongst smaller fish and entire batches of fish can be lost to this disease in hatcheries. The disease occurs at temperatures above 24°C in cage farms, but may affect hatcheries using borehole water supplies at temperatures as low as 18°C throughout the year. Most infections of cage-reared stocks arise from the introduction of infected juveniles, and so careful screening of juveniles and the use of reputable hatcheries with strict biosecurity management protocols in place is vital in reducing the incidence of this disease.

In the hatchery, affected larvae and juveniles stop feeding and die very quickly in large numbers. Some fish show distended swimbladders, visible congestion of the brain and abnormal swimming behaviour. Larger fish become sluggish and dark in colour and exhibit the same abnormal swimming behaviour. Internally, body organs appear normal and the gut is normally empty. Mortalities are chronic and persistent. Diagnosis is made by observations of fish behaviour and the results of autopsy of affected fish, and can be confirmed by histology and PCR tests.

Mortality rates appear to vary considerably. Affected batches of larvae and small juveniles in the hatchery may incur losses of 100%, whilst losses of 2-3g juveniles newly transferred to cages may reach 50%. Larger fish are less severely affected, with typical losses amounting to 15-20% over the entire growth cycle.

There are currently no vaccines available for this disease, although research and development is currently underway to produce a vaccine. There are no treatments for this disease. It is known that wild fish may either act as asymptomatic carriers of this virus or may actually suffer from the disease. Consequently, there will be a risk of auto-infection from wild fish surrounding cage farms once the disease has been introduced to the location through the introduction of infected juveniles. Despite the severity of this disease problem, no control measures are currently in place.

3.2 Lymphocystis

Lymphocystis is a common non-lethal viral disease affecting a very wide range of fish species, both freshwater and marine. In Mediterranean aquaculture it occurs most frequently in small seabream during the nursery phase and after introduction to cages. It manifests as small white growths covering the fins and body surface of the fish which can then develop into larger, cauliflower-shaped growths. Although not normally directly lethal, the growths may lead to impaired swimming, feeding or respiration and may lead to secondary bacterial infections. There is no treatment for this condition, and most fish recover after around 4 weeks following the appearance of symptoms.

4. Diseases of unknown aetiology

4.1 Winter disease syndrome

A disease of gilthead seabream in the Mediterranean region. It occurs during low winter temperatures, and affected fish float at the water surface with severely distended abdomens. Fish are typically affected at a weight of 100-200g, and the problem may then spread to both smaller and larger fish. Outbreaks normally occur when water temperatures drop below 14°C and may persist until temperatures increase the following spring. Mortalities are low and chronic, typically amounting to around 5% of stock. In addition to the swollen abdomen, affected fish also normally exhibit a swollen, red anus. Internal examination reveals a grossly distended intestine filled with a clear fluid. The liver is usually pale, the spleen enlarged and the gall bladder distended.

The disease is now thought to be multifactorial in aetiology, probably arising from the combined action of low temperature, nutritional imbalance, immunosuppression and the presence of *P. anguilliseptica.*
Control measures involve improving nutrition and general fish health, and maintaining a water temperature above 18°C.

Winter Disease Syndrome has been recorded in Malta since seabream production commenced in 1990. Interestingly, few farm operations in Malta now record significant incidences of this disease, suggesting that improvements in feed formulation or general husbandry may have reduced the problem to insignificant levels.

4.2 'Red spot disease'

A newly emergent disease of gilthead seabream, known as 'red spot' disease, was recorded during 2010 on a number of offshore cage facilities off the Mediterranean coast of Spain (pers. comm., M. Tsagkarakis). To date it has not been recorded elsewhere in the Mediterranean but does appear to have spread between farms in close proximity in the area. It appears to be a chronic problem causing few mortalities but leading to rejection at harvest due to the presence of unsightly red lesions on the bodies of affected fish. Aetiological studies are ongoing and a cause of this disease is yet to be elucidated.

5. Risk of transmission of disease from pelagic fish used as a feed supply for tuna penning operations

Tuna penning operations use very large quantities of frozen pelagic fish as a feedstuff for the tuna stock. The feeding of penned tuna with such pelagic fish is necessary in order to boost the levels of oil in the tuna flesh and so improve the flesh condition to a level required by the sushi and sashimi industry in Japan and elsewhere. In the Maltese tuna penning industry, oily pelagic fish are sourced from a number of countries in the North Atlantic, including Spain, the Netherlands, Morocco, the US, and over 20,000 tonnes of pelagic fish can be imported into Malta on an annual basis for this purpose. The use of frozen fish products as a fish feed necessitates that it is discharged into the marine environment, and there is, therefore, a risk of transmission of pathogens from such fish to either the caged tuna stock or wild fish in the vicinity of the tuna pens that habitually feed on fish debris passing through the cage net.

The species of pelagic fish typically used for feeding penned tuna are Atlantic mackerel (*Scomber scombrus*), Atlantic herring (*Clupea harengus*) and European sardine (*Sardina pilchardus*), in addition to smaller quantities of squid. It is important to note that herring are susceptible to VHS, a viral disease listed in Commission Directive 2008/53/EC of 30 April 2008 amending Annex IV to Council Directive 2006/88/EC as a notifiable disease, and therefore may be capable of transmitting this disease to other susceptible fish species. Bluefin tuna (*Thunnus thynnus*), however, is not considered a susceptible species to VHS according to available data. Research carried out by the Fisheries and Aquaculture Service of Murcia, Spain between 2006 and 2009, involving the analysis of over 400 specimens of wild fish in the vicinity of the tuna pens and penned tuna failed to detect the presence of any pathogenic viruses (Peñalva et al, 2009).

Annex 8. Listed diseases

Commission Directive 2008/53/EC of 30 April 2008 amending Annex IV to Council Directive 2006/88/EC.
Annex IV. Disease listing. Part II: Listed diseases

EXOTIC DISEASES

	Disease	Susceptible species
FISH	Epizootic haematopoietic necrosis	Rainbow trout (*Oncorhynchus mykiss*) Perch (*Perca fluviatilis*)
	Epizootic ulcerative syndrome	Genera: *Catla, Channa, Labeo, Mastacembelus, Mugil, Puntius* & *Trichogaster*
MOLLUSCS	Infection with *Bonamia exitiosa*	Australian mud oyster (*Ostrea angasi)* Chilean flat oyster (*Ostrea chilensis*)
	Infection with *Perkinsus marinus*	Pacific oyster (*Crassostrea gigas*) Eastern oyster (*Crassostrea virginica*)
	Infection with *Microcytos mackini*	Pacific oyster (*Crassostrea gigas*) Eastern oyster (*Crassostrea virginica*) Olympia flat oyster (*Ostrea conchaphila*) European flat oyster (*Ostrea edulis*)
CRUSTACEANS	Taura syndrome	Gulf white shrimp (*Penaeus setiferus*) Pacific blue shrimp (*Penaeus stylirostris*) Pacific white shrimp (*Penaeus vannamei*)
	Yellowhead disease	Gulf brown shrimp *(Penaeus aztecus*) Gulf pink shrimp (*Penaeus duorarum*) Kuruma shrimp (*Penaeus japonicus*) Black tiger shrimp (*Penaeus monodon*) Gulf white shrimp (*Penaeus setiferus*) Pacific blue shrimp (*Penaeus stylirostris*) Pacific white shrimp *(Penaeus vanammei*)

NON-EXOTIC DISEASES

	Disease	Susceptible species
FISH	Viral haemorrhagic septicaemia (VHS)	Herring (*Clupea* spp.), whitefish (*Coregonus* spp.), pike (*Esox lucius*), haddock (*Melanogrammus aeglefinus*), Pacific cod (*Gadus macrocephalus*), Atlantic cod (*Gadus morhua*), Pacific salmon (*Oncorhynchus* spp.), rainbow trout (*Oncorhynchus mykiss*), rockling (*Onus mustelus*), brown trout (*Salmo trutta*), turbot (*Scophthalmus maximus*), sprat (*Sprattus sprattus*), grayling (*Thymallus thymallus*).
	Infectious haematopoietic necrosis (IHN)	Pacific salmon (*Oncorhynchus* spp.), rainbow trout (*Oncorhynchus mykiss*), Atlantic salmon (*Salmo salar*).
	Koi herpes virus (KHV) disease	Carp (*Cyprinus carpio*)
	Infectious salmon anaemia (ISA)	Rainbow trout (*Oncorhynchus mykiss*) Atlantic salmon (*Salmo salar*) Trout (*Salmo trutta*)
MOLLUSCS	Infection with *Marteilia refringens*	Australian mud oyster (*Ostrea angasi*) Chilean flat oyster (*Ostrea chilensis*) Olympia flat oyster (*Ostrea conchaphila*) Asiatic oyster (*Ostrea demselammellosa*) European flat oyster (*Ostrea edulis*) Argentinian oyster (*Ostrea puelchana*)
CRUSTACEANS	White spot disease	All decapods crustaceans

Annex 9. Calculations and assumptions needed to produce species-specific economic analysis

1. Estimating output for each tuna vs. closed cycle species

Gross output in this industry consists of 3 line items - sales, changes in stock, and other receipts (composed mainly of insurance payouts). However, NSO only provides species specific information for sales. The total values for changes in stock and other receipts therefore needed to be apportioned between tuna and closed cycle species. This was done by using information provided by NSO through an ad-hoc request, which provides details for 3 farms that produce only tuna. This detailed information was provided for the four year period 2006-2009. Over these four years these "only tuna" farms produced 63% of total output and accounted for 68% of tuna sales and are therefore relatively representative of tuna production as a whole. Ratios from these farms could therefore be used to estimate some parameters for the remaining tuna production which originates from mixed farms (farms producing multiple species).

The table below summarises the information available through NSO and highlights the output related data that needed to be estimated or apportioned.

Table 1: Analysis of NSO output data available

Estimating output of Tuna vs. other species - analysis of information available

	Values for farms producing only tuna	Total for production of all species	All Tuna estimate	Non-tuna estimate
Sales €	NSO data available	NSO data available	NSO data available	NSO data available
Sales Kg	NSO data available	NSO data available	NSO data available	NSO data available
Change is stock €	NSO data available	NSO data available	**Apportionment needed**	**Apportionment needed**
Change in stocks KG	NSO data available	**Estimate needed**	**Estimate needed**	**Estimate needed**
Other revenue (e.g. insurance)	NSO data available	NSO data available	**Apportionment needed**	**Apportionment needed**

Source: NSO new release and NSO data obtained from ad-hoc request

Estimating and apportioning values for change in stock

The table below illustrates in detail how the total change in stock value has been allocated to tuna and other species production, as well as how the Kg change in stock value was estimated.

Table 2: Method used to apportion change in stock

Apportioning change in stock to each species

		2006-2009
Total change in stock / sales (€) for pure tuna farms	A	15.3%
Total tuna sales (€'000)	B	288,324
Apportioned tuna change in stock value (€'000)	C= A*B	43,989
Change in stock value for all species (€'000)	D	44,874
Apportioned change in stock for non-tuna species (€'000)	E= D-C	885
Avg. selling price for tuna (€/Kg) (Note 1)	F	21.2
Estimated tuna change in stock value (Kg'000)	G= C/F	2,072
Avg. selling price for non-tuna (€/Kg) (Note 1)	H	4.0
Estimated non-tuna species change in stock value (Kg'000)	I = E/H	222
Estimated total change in stock (Kg'000)	J = I + G	2,294

Note 1 : Selling price excludes % average profit margin

Source: Internal analysis based upon NSO data

Apportioning "other revenue"
The table below illustrates in detail how "other revenue" was apportioned between each species group.

Table 3: Apportioning "other revenue"

Apportioning other revenue to each species

		2006-2009
Total "other revenue" (€'000)	A	14,942
"Other revenue" originating for farms producing only tuna (€'000)	B	12,032
Remaining unapportioned "other revenue" (€'000)	C = A-B	2,910
Total sales less sales from farms producing only tuna (€'000)	D	120,390
Total tuna sales from farms producing multiple species (€'000)	E	93,563
"Other revenue" apportioned to Tuna (€'000)	F=B+C*E/D	14,293
"Other revenue" apportioned to non-tuna (€'000)	G= A-F	649

Source: Internal analysis based upon NSO data

2. Analysis and adaptation of reference study results

The method used to produce this analysis may be summarised in the following three steps:

1. Analysis of information provided by the NSO on the costs of pure tuna farms to separate output figures for Tuna, as opposed to all other species.
2. Establishing a reference cost structure of closed-cycle species in Malta; and
3. Application of the cost structure produced in step 2, to the species-specific output in step 1, in order to estimate the full costs of other species. By subtracting this amount from the total costs as provided by NSO, the remaining portion of costs are specific to tuna production.

Using data from interviews and through a separate study (Barazi-Yeroulanos, L., 2010), it was possible to estimate more detailed cost structure for closed cycle species in Malta, and therefore isolate the tuna numbers by process of deduction. This weighted average cost structure was later adapted to reflect certain actual historic figures which were given separately for each species by NSO, as well as passing certain reclassifications in order to change the format of the cost structure from one showing accounting profit to one which estimates the gross value added of the species group. The methodology used for this two-step process is set out in below:

Establishing a reference cost structure for closed-cycle species in Malta
Based upon interviews and external studies it was possible to establish a cost structure for bream production in Malta. No reliable information is available for production of other species in isolation. It was therefore assumed that the cost structure established for bream is also applicable to all other closed cycle species. Bream in fact accounted for 80% of sales from all closed cycle species in 2009.

Based upon these assumptions, the table below illustrates the cost structure used to represent all non-tuna production in Malta, before the adjustments and reclassifications mentioned above, compared to the historic average for all species.

Table 4: Comparison of historic cost structure for all species, vs. non-tuna reference amounts (before adjustments and reclassifications)

Comparison of historic cost structure for all species, vs. non-tuna reference amounts (before adjustments and reclasifications)

	Historic averages for all species	Reference amounts for non-tuna species
Output	**100.0%**	**100.0%**
Stock fish	34.5%	12.9%
Food	20.3%	47.0%
Labour	4.2%	13.5%
Packing & marketing	4.6%	11.1%
Other variable costs	13.4%	1.2%
Total marginal costs	**76.9%**	**85.9%**
Contribution	**23.1%**	**14.1%**
Fixed costs	**12.6%**	**9.2%**
Forex	**3.6%**	-
Total costs	**93.1%**	**95.0%**
Profit	**6.9%**	**5.0%**

Source: Internal analysis based upon NSO data, interviews and data from reference study (Barazi-Yeroulanos, L., 2010)

Analysis and adaptation of reference study results

The reference study figures were adjusted to reflect a gross value-added view. In this respect, the following adjustments were made:

- NSO data was available for stocking costs of other species and therefore such historical data was used instead of the value constructed through interviews. The balancing difference was passed through profits.

- In the reference study, rent and interest payable are treated as fixed cost items. However, in economic terms, rent and interest form part of gross value added, as they represent payments for factor income (i.e. payments for the four prime resources of production – capital, land, labour and entrepreneurial management). They have therefore been reclassified from fixed cost and included below the GVA line as part of "Other GVA". Estimates of these variables were obtained from the NSO figures for 2006-2009, where other GVA represented 1.1% of output.

- In the reference study, depreciation is a fixed cost item. However, in economic terms, depreciation (aka gross capital consumption) is part of gross value added, and removing depreciation from GVA yields net value added. For the sake of simplicity, and in order to avoid unnecessary assumptions when forecasting future scenarios, the economic analysis is performed in GVA terms thereby requiring an adjustment to the reference study's fixed cost value to remove depreciation. Depreciation is based on the average depreciation between 2006-2009, which accounted for 2.94% of output. The balancing difference was passed through profits.

Furthermore, in order to better evaluate the economic contribution of the different species groups, assumptions were needed depending on whether a specific cost is sourced domestically, or whether it is being imported. These assumptions were based upon interviews which suggested that the large majority of fish stock and all of fish feed are imported. For simplicity's sake, the minor amount of fish stock produced in Malta is ignored, and all fish stock is therefore assumed to be imported.

The table below illustrates these adjustments and assumptions further.

Table 5: Adjustments passed to reference study amounts (2006-2009 amounts)

Adjustments and reclassifications passed to reference study figures

	Original	Adjusted	Adjust-ments	Notes	Import/ Domestic
Gross output at market prices	100.0%	100.0%			
Less intermediate consumption					
Stock fish	12.9%	10.4%	-2.5%	**n1**	Imported
Food	47.0%	47.0%			Imported
Other variable costs	1.2%	1.2%			Domestic
Packing & marketing	11.1%	11.1%			Domestic
Fixed costs	9.2%	5.1%	-4.0%	**n2+n3**	Domestic
Forex costs	0.0%	0.0%			Other
GVA					
Compensation to employees	13.5%	13.5%			
Other GVA (rent and interest)	n/a	1.1%	1.1%	**n2**	
Profits (Gross entrepreneurial income) (N4)	5.0%	10.4%	5.4%	**n1+n3**	

n1: NSO data for cost of stock fish is split by type of fish, and therefore actual amount was used
n2: Reallocation of rent & interest to below GVA line, as "Other GVA"
n3: Reallocation of depreciation, to below GVA line, as part of "Gross entrepreneurial income"
n4: Gross entrepreneurial income refers to profits before depreciation

Source: Internal analysis based upon NSO data, interviews and data from reference study (Barazi-Yeroulanos, L., 2010)

The table above shows the value for the average amounts between the years of 2006 to 2009. The economic analysis was also performed individually for the 2008 and 2009. Not all variables were however flexed according to the specifics for each year. The adjustments passed to produce the analysis for the individual years are summarised below.

- The cost of fish stock and its impact upon profit margins was revised based upon the data for each year.
- The estimates for depreciation, rent and interest were however kept constant at average rates.

3. Application of reference study amounts to output data

Each line item as described above was multiplied by the output estimate of the non-tuna species group in order to obtain the actual value for each line item. This amount was subtracted from the total figure, with the remaining portion attributable to the production of tuna. This is illustrated in the table below.

Table 6: Application of adopted cost structure to the species-specific output estimates

Illustration of step 3

Non-tuna output estimate €'000s (2006-2009) (A)	**28,361**

	Imported intermediate costs	Domestic intermediate costs	Forex losses	Compensation to employees	Other GVA	GEI
Cost structure adopted for all non-tuna species as a percentage of output (B)	57.5%	17.5%	0.0%	13.5%	1.1%	10.4%
Resulting non-tuna estimates (C = A*B) €'000s	16,301	4,962	-	3,839	311	2,948
Total figures as provide by NSO (D) €'000s	205,417	99,383	13,331	15,649	4,108	37,079
Estimates for Tuna production (E = D - C) €'000s	**189,116**	**94,421**	**13,331**	**11,810**	**3,797**	**34,131**

Source: Internal analysis based upon NSO data, interviews and data from reference study (Barazi-Yeroulanos, L., 2010)

Annex 2
Method used to adjust 2007 multipliers.

The 2007 economic impact assessments used an input-output model in order to estimate the indirect and induced inpact of the industry as at that date. An input-output model simulates the successive economic expenditure rounds that are caused by changes in the final consumption of a product and measures the indirect and induced GVA that is generated through such expenditure rounds.

Indirect GVA is largely governed by the composition and extent of domestic intermediary supplies. Though it may be assumed that the composition of supplies may have remained relatevely static over 2008 and 2009, the level of domestic intermediaries as a percentage of output has changed significantly.

Induced GVA, is largely governed by the amount of wages and profits generated both directly and indirectly by the industry, as well by household's marginal propensity to consume as opposed to save. Some changes in the marginal propensity to consume of the average Maltese householde may have occurred in 2008 and 2009, however this is likely to be minimal. On the other hand, the significant shifts in profit levels between 2007 and 2009 completely alters the induced impacts that may be expected from the aquaculture output in 2008 and 2009.

In order to account for such movements the 2007 GVA effect (total GVA as a % of output) was ignored, and instead the indirect and induced effects were expressed as a fraction of the factors that most govern their magnitude – domestic intermediate supplies and direct GVA. This allowed the mutlipliers to flex according to the changes that occur in 2009 and 2008, particularly with respect to the industry's profit margins. The table below illustrates this mechanism further by showing how the 2007 ratios were constructed and applied to estimate the indirect and induced effects of the industry.

Table 7: Adjusting 2007 multipliers to reflect change in industry

Method used to adjust 2007 economic multipliers

	2007 NSO data (as per study) (€'000s)	% applied to flexing mechanism	Resulting flexing mechanism
Output	**128,846**		
Imported Intermediaries	73,946		
Domestic Intermediaries	24,649	100%	24,649
Direct GVA	**30,252**		
of which:			
Salaries	4,159	100%	4,159
Profits	22,967	100%	22,967
Other	3,126	100%	3,126
Amounts relevant to economic multipliers			**54,901**

	Original estimated impacts	Ratio to flexing mechanism
Indirect+induced GVA (€'000s)	23,194	30/71
Indirect+induced H.Income (€'000s)	11,497	9/43
Indirect+induced employment (no of FTEs)	767	7/501

Source: Internal analysis

Annex 10. Consultation views and issues

The following views and issues arose out of interviews with consultees during the course of the study.

1 Industry views and issues

1.1 Strategy

- The industry needs a strategy, reviewed every 5 years
- Without a strategy, long term planning and investment are not possible
- There needs to be a proper framework and a level playing field for all producers
- The industry needs to be attractive to overseas investors
- Government is reluctant to support the aquaculture industry - low priority compared with others e.g. shipping, tourism
- There has been no consultation by regulators with industry regarding strategy
- One producer envisages a 10,000t vertically integrated industry to achieve a viable economy of scale

1.2 Planning

- Planning process lacks flexibility regarding "permitted development rights" e.g. minor changes to cage positioning
- Planning process takes far too long (2 examples of packing plants taking 4-5 years for a decision on change of use)
- MEPA appear to accept that bass and bream can be cultured closer to shore, but are adamant about seeing tuna move further offshore

1.3 Environmental impact

- The negative perception of MEPA regarding environmental impact in St Paul's Bay (SPB) is considered unjustified by the operator concerned - there are many other impacts on SPB besides aquaculture e.g. sewage discharges, boat moorings, run-off from agricultural land
- The operator in SPB is ranked 1st out of 10 similar Mediterranean farms regarding food conversion ratio, demonstrating good management
- Regarding benthic monitoring, need to have a definition of what constitutes deterioration
- What purpose does present environmental monitoring process actually serve in terms of controlling the industry? Is water quality monitoring really necessary every month?
- Cost of monitoring is very high

1.4 Zoning and siting

The existing SE Zone:
Farms outside the Zone:

- Farms not in the Zone are not prepared to move
- The Zone is too exposed to risk moving there in one step
- Risk from shipping – 5 collisions so far – insurance a problem
- Risk from strong currents – no prior study done
- Depth too great to inspect moorings by diver
- No consultation with the industry regarding the setting up of the Zone, no strategic EIA done
- No room for more farms in the Zone
- Some confusion over sizing and number of farms allowed in the Zone

Farms in the Zone had the following comments:

- Concept of zone is OK
- Zone is good for environmental conditions
- High risk to keep fish over the winter
- No protection from NW at 6km out, would prefer 3 km; currents a problem

- Difficult to service (distance from port)
- Concession is only for 5 years and then renewable, but what if change of policy? No security
- They pay more in rent than inshore sites but have higher risk – not fair!
- Permit only allows tuna, would like to try amberjack

The proposed NE Zone:
- There was support from one producer for the proposed NE Zone, viewed as an opportunity to move an existing site in the Comino channel and to increase production
- Other farms were against the proposal, one expressing the view that if they were forced to move they would choose to cease operation
- For one inshore farm growing bass and bream, moving into more exposed waters would pose serious problems in servicing and feeding

Alternative Zones:
- There was one suggestion for a new zone extending out 2km from the SE coast, encompassing the two existing near shore sites and a possible hatchery site. This would require moving bunkering area 4 further offshore
- The establishment of any new zones must coincide with chart revision (every 4 years?) to avoid ship collisions

1.5 Tuna ranching

Issues regarding tuna ranching were divided between operational considerations and those to do with negative impacts (oil slicks, smells). Operational considerations:
- For most growers, uncertainty in the supply of fish due to ICCAT quotas and fishing restrictions is the biggest issue. If they can't buy enough, not worth doing at all
- One grower cited a minimum of 300-450t a year to justify operating
- One grower chose not to stock in 2010 due to uncertainty over fish supply
- Ship collisions are a major threat, especially 40-70m vessels from non EU countries (lax standards)
- There have been 2 complete losses of farms in the SE Zone in storm conditions
- High risk business: uncertainty over fish supply, risks of growing, reliance on one market
- Concern was expressed regarding the Japanese market given advances there in closing the production cycle - if they can produce enough themselves, no need to buy from the Mediterranean
- Uncertainty following the earthquake: how will demand be affected? No power and water to maintain coldstores in Japan
- Whilst growers are in favour of regulation, there is widespread concern that ICCAT has now become too strict e.g. problem of having to pay for ICCAT observers even for a small harvest
- Too many wealthy NGOs who can put up more of a fight than fishermen, and who have no knowledge of the subject

Negative impacts:
- The issue of oil slicks and smell from feeding baitfish is recognised, but is considered to be less of a problem than it used to be
- Peak feeding coincides with the peak tourist season, increasing risk of conflict
- The SPB tuna site is considered a problem by some, generating negative publicity (complaints from passing pleasure craft)
- Tuna guts and heads were disposed of at sea, now must be crushed and disposed of onshore

1.6 Public relations

- One bass and bream grower not growing tuna considers that negative publicity for aquaculture only started when tuna farming began in 2000
- There is no distinction in public perception between bass and bream and tuna, thus tuna issues impact unfairly on bass and bream culture
- One tuna farm has tourists visiting farm every day in summer, less often in winter, and offers free diving in cages

1.7 Other points

- All growers are interested in alternative species, especially amberjack
- Amberjack seen as a good culture species with good market prospects
- One grower and marketer considers portion size amberjack (400-600g) the best for the market; larger fish for steaking compete less favourably with swordfish
- Meagre is also a good culture species but market acceptability is poor
- There is a need for a hatchery, but according to one grower it should preferably be independent to avoid conflicts of interest
- At least 2 growers have aspirations to further process fish in Malta, particularly with regard to blast freezing of tuna and other species

2 Other stakeholder views and issues

2.1 Regulators

- The Agriculture and Fisheries Regulation Directorate wishes to have all aquaculture sites located in zones controlled by MRRA, in water depths >50m.
- A draft legal notice was prepared by MRRA in 2001 giving control of all aquaculture sites to MRRA, with farms then having concessions from MRRA (rather than MEPA etc). This notice is now said to be imminent.

2.2 Environmental monitoring company

- Regarding environmental impacts from tuna farms: no impact on water quality, impact on benthos if any only under cages, occasionally further away
- Tuna feeding practices have improved
- Enforcement has declined since start of tuna farming, was very strict at first
- Farms have persuaded MEPA to reduce monitoring as no perceived impacts
- Posidonia no longer monitored, but needs long term monitoring
- Environmental monitoring system for tuna the best in the Mediterranean
- The 2002 posidonia survey is not accurate (side scan v video)
- No connection made between biomass on sites and impacts
- No views on carrying capacity

2.3 MEPA

- Main issues: location of farms, negligent feeding (especially in early 2000s), smell where close to bathing areas, benthic and water quality impacts
- For tuna sites, accepted that there are no impacts on water column, and benthic impacts limited mainly to sea bed under cages
- Impacts on sandy/gravel substrates better than on photophilic
- Bass and bream sites in SPB however are considered to have an impact on posidonia, in one opinion up to 1 km from cages; side scan survey of Mellieha Bay shows gaps in posidonia
- In one opinion, the proposed NE Zone has significant issues, outcome doubtful
- SEPA protocols were consulted when considering monitoring for Malta
- No specific benchmarks for aquaculture impacts, or external advisory input
- Posidonia is primary indicator species
- If developments are in <40m water, posidonia likely and thus Appropriate Assessment necessary
- Regarding planning application (PA) response times, MEPA must now respond within 52 weeks of submission of PA and EIA
- Bunkering zones need to be moved (seabed damage) but up to Malta Transport (MT)
- Water Management Catchment Plan – considering various aspects of aquaculture; one issue is moving aquaculture offshore; some content on aquaculture already drafted
- Marine Strategy Framework Directive – getting all available data on Maltese waters, started 1st March
- The aquaculture strategy is thought to need a Strategic Environmental Assessment (SEA)

2.4 Adviser on proposed wind farm at Is-Sikka L-Bajda

- See PDS on MEPA website for details of Is-Sikka L-Bajda project
- Will occupy large area of bunkering area one, in water depths 10-37m
- Space for farm will be leased from Government
- Want to find ways of reducing costs of offshore wind e.g. shared use with aquaculture
- Risks: damage to cabling from anchors, risk of service boats colliding with masts (higher insurance costs)
- EIA due end 2011; foundations occupy only 0.2% of seabed in area
- Timeframe: installed by 2016

2.5 Malta Tourism Authority

- Cages occupy key tourist sites e.g. Mistra, Mellieha, Comino
- Major complaints from diving companies regarding benthic impact in SPB
- Divers make up 5% of visitors to Malta
- Visual impact an issue for Maltese leisure takers (e.g. boats passing SPB on way from Valletta to Gozo)
- Availability of farmed fish in local restaurants is positive
- National Aquarium Project in SPB an opportunity to educate people about aquaculture
- Tourism numbers increasing each year, no evidence of negative impacts from aquaculture (backed up by survey)

2.6 Local Councils

2.6.1 Marsaskala

- Tuna guts coming ashore
- Less of a problem now as processing boat further out
- Smell and oil slick with onshore wind
- Oil sticks to boats, bathers – causes rash
- Smells worse in summer, get more complaints in Aug and Sep as east wind more common
- Diving companies say seabed is ruined
- Not able to distinguish between species in cages
- Council has no jurisdiction over sea – down to MT
- One good point is local fishermen catch wild fish near cages
- Prefer no aquaculture, but if at all only offshore
- Want to promote tourism and high class villas in area; summer residences important
- Population grows from 11,000 to 30,000 in summer

2.6.2 St Paul's Bay

- No major issues with aquaculture
- Occasional smells from food with onshore wind, but rare
- Occasional one-off incidents e.g. fish head coming ashore
- AJD tuna farm does not affect SPB
- If any problems, write in paper, but none recently
- Employment from aquaculture is positive
- Fish come from all over Malta to Azzopardi Fisheries and Connies Fish shops in SPB
- Pop grows from 20,000 to 60,000 in summer, people staying longer

2.6.3 Mellieha

- Emphasised major importance of tourism to local economy
- Mellieha is a Mediterranean Destination of Excellence
- Pop grows from 9,000 to 30,000 in summer
- 6000 hotel beds with 2000 more planned
- 15,000 a day use beach in summer
- Trying to get Blue Flag status for beach, now has 70% acceptance, needs 100%
- Issue is litter and facilities rather than water quality which is 100%

- Bay good for bathing as sandy and shallow to 200m out
- Cages in Mellieha Bay not a particular problem
- AJD tuna cages - responds to enquiries well, no issues
- Very upset about proposed new P2M packing plant
- Should be in industrial zone, not a rural area next to a Natura site
- Thinks MEPA/MRRA made bad decision
- Council got extra conditions attached to permit e.g. visitor attraction
- Would prefer no aquaculture – too much risk of damage to image of Malta as a tourism destination
- Comino site not good – too close to Blue Lagoon
- Accepting of windfarm

2.7 Malta Transport (Ports and Yachting Directorate)

Main concerns are safety and navigation, and proper marking of sites. The aquaculture strategy needs to address:

- Maintenance of farms
- Responsibility of operators – don't comply with conditions, take short cuts
- Unlit and drifting buoys (even at SE Zone which is Government responsibility)
- There have been a lot of claims from ships passing through farms which were not marked/lit
- Some farms are in the wrong place compared with permit e.g. Comino
- No proper governance of the industry
- Pollution: white fat floating in water, bad smell, oil said to stop hair growing
- Last summer witnessed oil at 2 locations, one at St Julians
- Worst in onshore wind
- Perception of inequity; tuna farms seen to be making a lot of money but at same time oil from farms is affecting people
- Present location of farms generally accepted, but no farms in ports e.g. SPB
- Need to decide which areas could be used and how should they be allocated, existing farms need a level playing field
- In favour of zoning especially offshore
- No consultation yet regarding NE Zone
- Scope for aquaculture if responsible
- Different industries can live together e.g. Marsaxlokk – shipping, power station etc
- All industries need to work together on their relative strategies

Bunkering

- Areas mostly on the lee coast (so oil spills go offshore), in shelter, depth 50m due to mooring limits (chain length), good anchoring ground
- Thus same requirements as farms
- Well established in Malta, valuable industry
- No complaints from farms as yet regarding oil spills etc from bunkering
- Bunkering areas defined on charts but up to Government Policy what happens; no new areas likely
- Buffer zone of 500m between bunkering areas and farms

2.8 Malta Aquaculture Research Centre

- Present Government structure hard to manage due to staffing restrictions
- Lack of administrative staff means Director has no time to organise research etc
- Want to be able to run vocational courses for industry – but hard to do due to Government tendering process
- Present facilities limited and hard to manage due to location in Fort St Lucjan
- MARC needs to be a public private partnership (PPP) to be effective (e.g. Environmental Landscapes Consortium Ltd, a PPP with the Government)
- Organisation of aquaculture within MRRA is confused – covered by 2 different directorates, needs to be rationalised

2.9 Diving company in SE Malta

- Definite issue with smells and oil slick, very evident from the air

- Source most likely the 2 farms closest to shore, not the SE Zone
- One farm site is very close to the Blenheim Bomber dive site - particulate waste has an impact on visibility

2.10 Nature Trust

- Not against aquaculture *per se*
- Biggest concern is tuna stocks, CITES concerns – closing the cycle would be positive
- Impact on wild fisheries of feeding baitfish
- Complaints about smells/oil from tuna
- Concerned about impact of shallow water sites on posidonia e.g. SPB
- Mistra a "lost case" for posidonia due to very long recovery times
- OK with idea of tuna offshore and species grown from eggs closer to shore providing not in shallow bays
- Proposed NE Zone OK providing not close to shore
- Concern about lack of enforcement of Development Permit conditions in Malta generally
- "Enough laws to be a paradise" but no enforcement
- Police environmental enforcement unit is understaffed

2.11 Other views

- Industry has a history of equipment failures – needs COGP, standards
- Equipment needs to be rationalised to make better use of space
- The focus on tuna is high risk (dependence on quotas and the Japanese market)
- No <u>real</u> research being done on tuna breeding

Annex 11. Maps showing different marine uses and conservation designations in Malta

Map 1 – distribution of benthic infralittoral biotic assemblages of conservation importance

<u>Light green areas</u> = *Posidonia oceanica* (Neptune Grass) meadows, as mapped in Borg et al. (2009). MEPA conducted its own survey (GAS, 2003) of the extent of *P. oceanica* meadows in local waters but there are discrepancies between the *P. oceanica* meadow distribution as mapped out by Borg et al. (1999) and as mapped out by GAS (2003), particularly in areas where the seagrass is known from other surveys to occur on bedrock. For example, the map produced by GAS/MEPA (2003) does not indicate any *P. oceanica* meadows off Qala (Gozo), Spinola Headland (St Julians), and Fond l-Ghadir (Sliema), whereas extensive areas with the seagrass are known to occur at all three localities (BORG & SCHEMBRI, 2003). Such differences are probably attributable to differences in the surveying techniques used during the two surveys.

This seagrass species is not listed per se in the Habitats Directive but Posidonia beds are listed as a priority habitat under Annex I of the same Directive (National Habitat Types of Community Interest whose Conservation Requires the Designation of Special Areas of Conservation). This means that Malta is obliged to protect at least 85% of all *P. oceanica* beds within its territorial waters. In addition, *P. oceanica* is listed under Schedule III of LN 311 of 2006 of the Maltese Islands (i.e. Animal and Plant Species of National Interest whose Conservation requires the Designation of Special Areas of Conservation).

<u>Dark green areas</u> = *Cymodocea nodosa* (Lesser Neptune Grass) meadows. Since no ad hoc survey for such a seagrass species has been conducted in Maltese coastal waters to date, the mapped distribution of such meadows in local waters is not comprehensive but includes only the results from selected EIA studies. *C. nodosa* is protected to a lower level than *P. oceanica* in that it is listed within Schedule III of LN 311 of 2006 of the Maltese Islands.

<u>Red areas</u> = Maerl grounds, as discovered through the BIOMAERL project and the publications resulting from such a project, by Dimech et al. (2004), through infralittoral ecological surveys around Filfla and through other studies. The following different gradations of maerl-similar assemblages were plotted on the map:

- sand, pebbles and cobbles with encrusting coralline algae
- sand with rhodoliths
- cobbles and pebbles in association with rhodoliths
- maerl association with trawling tracks

Maerl sediments are characterized by accumulations of calcareous rhodophytes - mostly Corallinaceae but also Peyssonneliaceae - that form habitats with a high species diversity over broad geographical and depth ranges, with some of the species encountered in maerl beds (*Lithothamnion = Mesophyllum coralloides; Lithothamnion minervae; Phymatholithon = Lithothamnion calcareum*) listed in Schedule III of LN 311 of the Maltese Islands. The conservation value of these ecologically fragile systems in European waters is recognized under EU legislation (Council Directive 92/43/EEC, 1992) and international conventions (Convention for the protection of the Mediterranean Sea against pollution, 1976; Bern Convention, 1996; OSPAR convention, 1998). A special Action Plan for the protection of Mediterranean coralligenous and maerl assemblages has been recently adopted within the framework of the United Nations Environment Programme's Mediterranean Action Plan (UNEP-MAP).

<u>Purple areas</u> = Areas important for bird migration (Birdlife [Malta], personal communication).

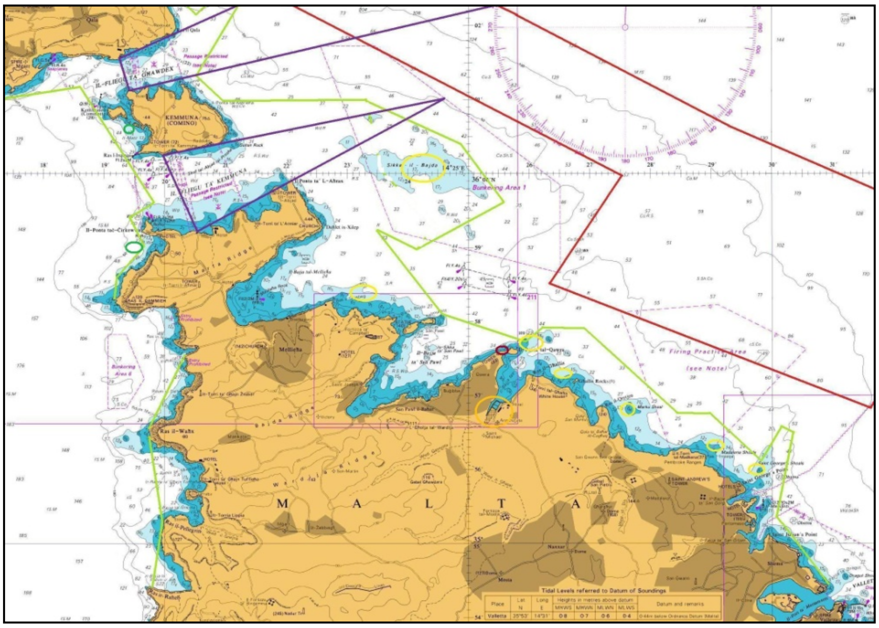
<u>Yellow areas</u> = extensive reef systems. Reefs are also listed within Annex I of the Habitats Directive (not as a priority habitat).

<u>Brown areas</u> = Vermetid reefs. On some shores, the shells of the vermetid gastropod *Dendropoma petraeum* are embedded in encrustations of the calcareous coralline red alga *Neogoniolithon notarsii* to form characteristic platforms known as 'trottoirs' or vermetid rims, mainly in the mediolittoral (a narrow zone which is roughly equivalent to the intertidal in the Mediterranean). *Dendropoma petraeum* is listed in Schedule II of LN 311 of

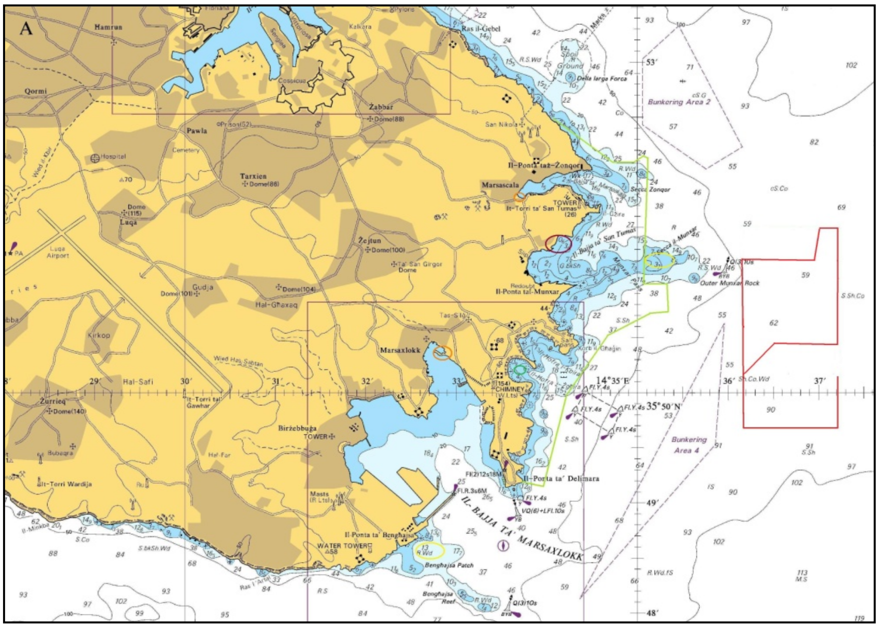
2006 of Malta (Animal and Plant Species of National Interest whose Conservation requires the Designation of Special Areas of Conservation). Here again, the spatial extent of such a bioceonosis has not been comprehensively mapped out in view of its sheer extent and since such a bioceonosis has not been rigorously mapped in the Maltese Islands.

Orange areas = Major saline marshlands sites in the Maltese Islands (Salini, il-Maghluq Marsascala, il-Ballut Marsaxlokk). All 3 sites are candidate Natura 2000 sites for the Maltese Islands, besides harbouring a suite of faunal and floral species of conservation inportance.

Map 1a – distribution of benthic infralittoral biotic assemblages of conservation importance

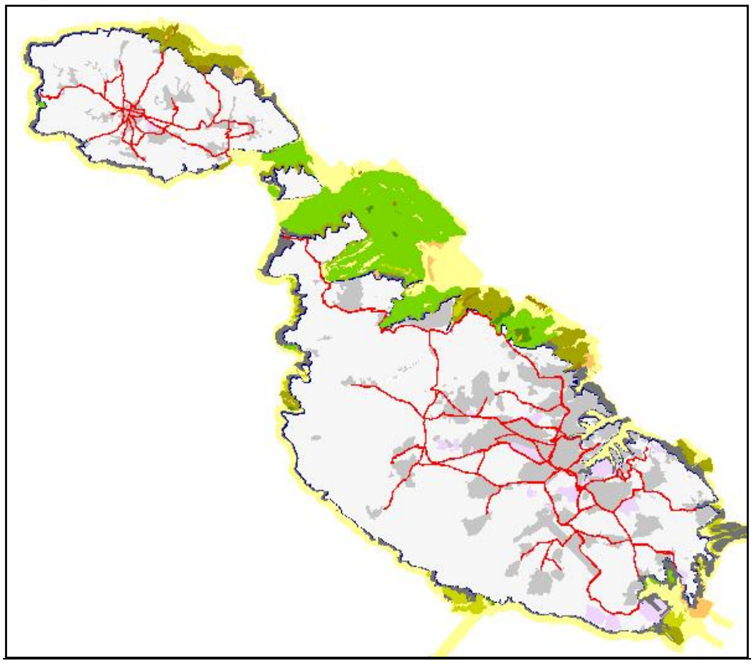


Map 1b – distribution of benthic infralittoral biotic assemblages of conservation importance



Map 1c. Posidonia distribution, from Borg et al 2009

Map 1d. Posidonia distribution, from GAS 2003

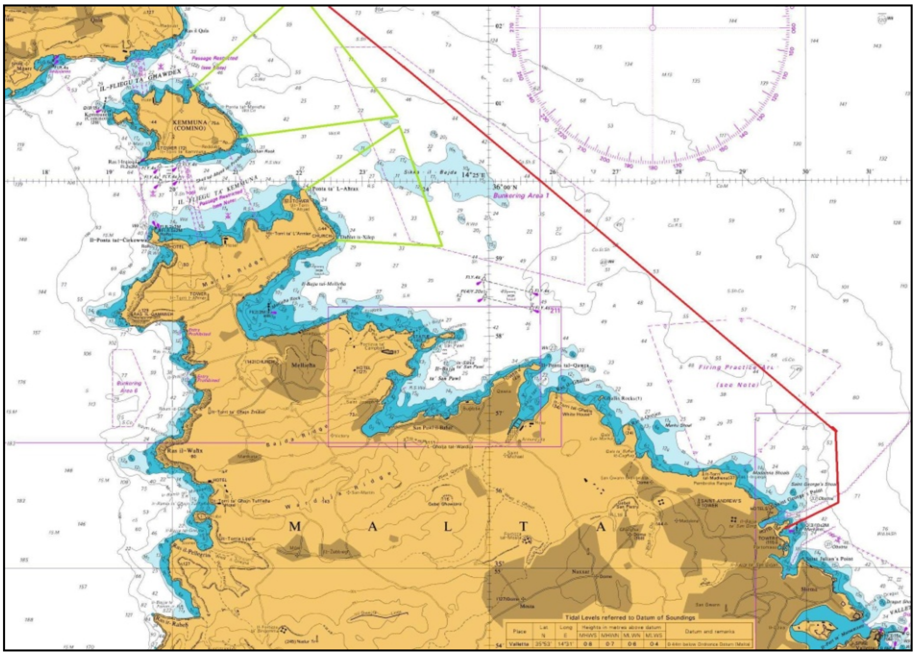


Map 2 – spatial extent of MPAs and IBAs of a coastal and/or marine timbre

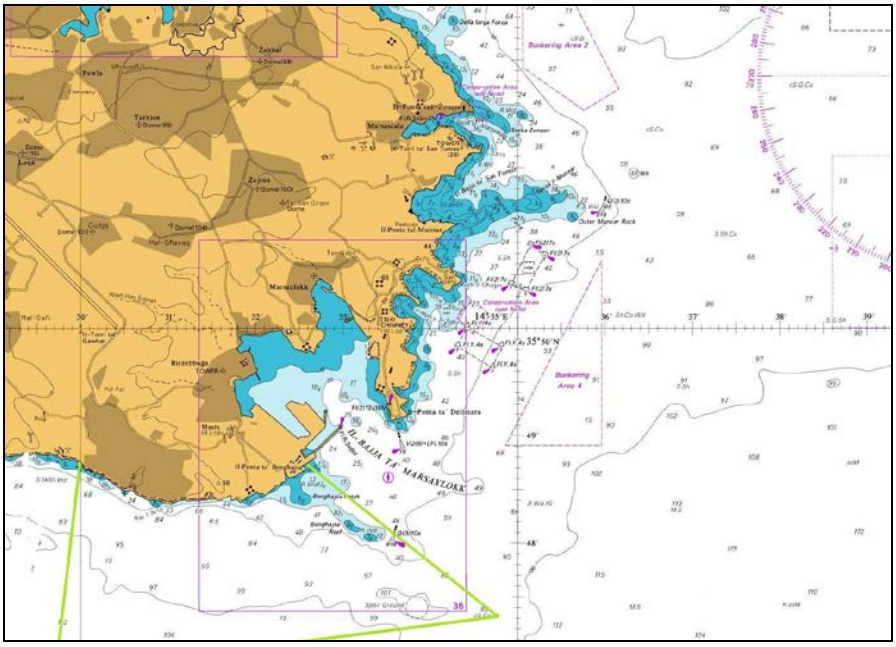
Red areas = 5 MPA's designated to date in Maltese coastal waters, by virtue of Government Notice 112 of 2007 and Government Notice 851 of 2010. Rdum Majjiesa, located off the west coast of the island of Malta, is the only MPA in local coastal waters to have a mamagement plan in place which is still awaiting parliamentary approval however and which thus has not been implemented to date. In addition, the same MPA is the only one to date to be recognised as a marine Special Area of Conservation (SAC), by virtue of Council Directive 92/43/EEC. The 5 MPAs have a combined area of 18,000 hectares which is equivalent to 5% of Malta's territorial waters, with MEPA currently conducting an exercise to identify MPAs within local waters which are further offshore than existing ones.

Green areas = The marine component of Important Bird Areas (IBAs) of the Maltese Islands, as identified by Borg & Sultana, 2004. Each IBA has additionally a terrestrial component which is constituted by a narrow coastal stretch contiguous to the same marine area. The marine component of each IBA represents a rafting zone for a variety of seabirds, including the Yelkouan shearwater, Cory Shearwater, Storm-Petrel and the Yellow-Legged Gull.

Map 2a – spatial extent of MPAs and IBAs of a coastal and/or marine timbre



Map 2b – spatial extent of MPAs and IBAs of a coastal and/or marine timbre



Map 3 – Bunkering Areas, Oil Rigs parking Area, Firing Practice Area and Spoil Grounds

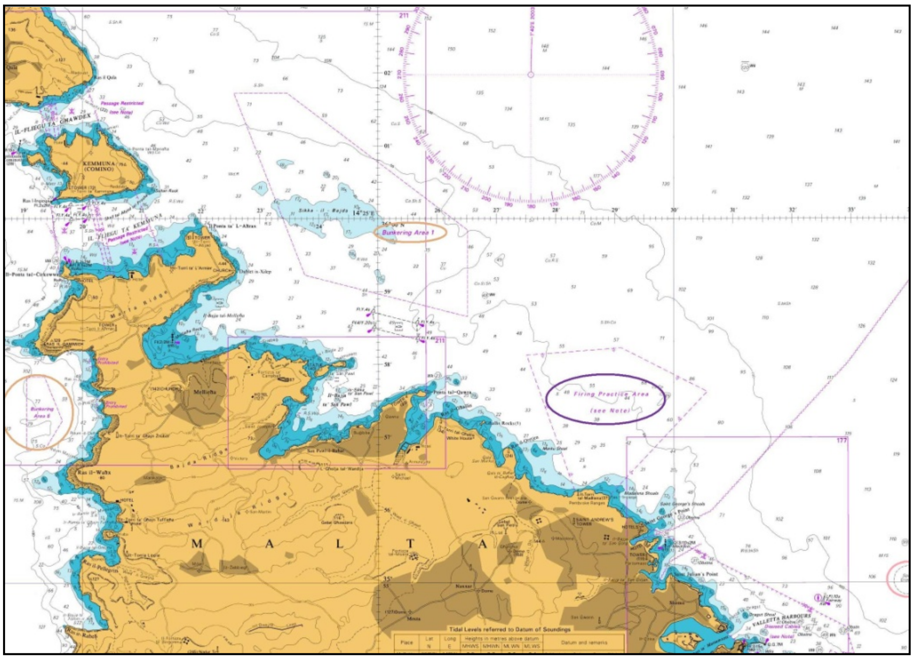
Brown areas: Bunkering and conveyance areas. Since **Bunkering and Conveyance Area 3** (Hurd's Bank - reserved for laden tankers) is located partly or fully outside the extent of the Admiralty Charts used for this mapping exercise, a supplementary map, provided by Transport Malta and indicating the position of such zones, is also being submitted with the two Admiralty Charts deployed. The combined marine area taken up by the six bunkering areas located in Maltese waters, for example, amounts to 58.27 km^2, or 1.58% of the total territorial waters.

Pink areas: Spoil grounds, where the monitored dumping at sea of inert construction debris and rubble is permitted. Despite the existence of 3 spoil grounds in Maltese coastal waters, just one spoil ground, located ca. 3 nautical miles to the NE of Valletta Harbour, is in use.

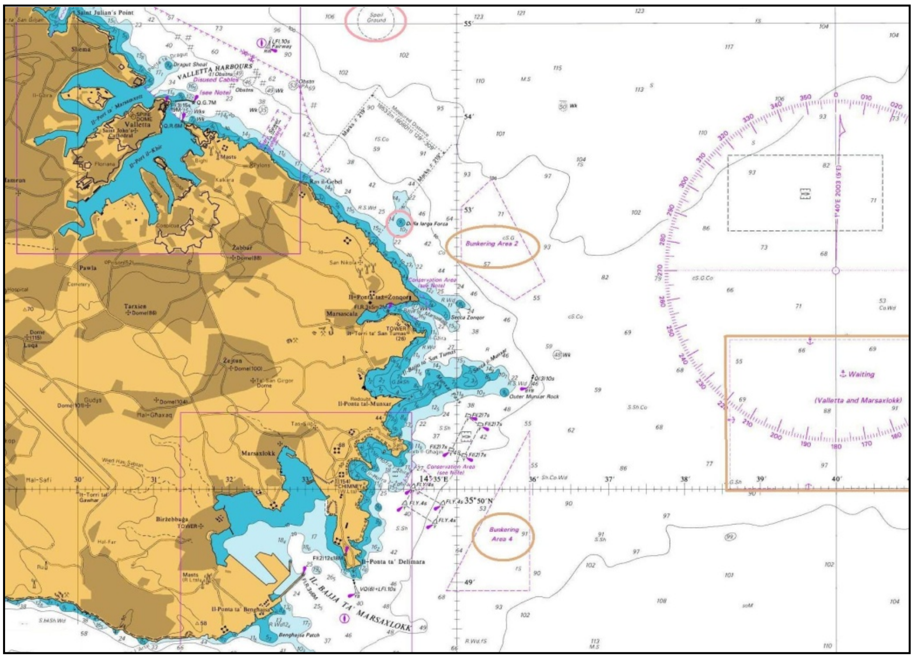
Purple area: Firing Practice Area (no entry to marine vessels).

Red area: Area assigned for oil rigs.

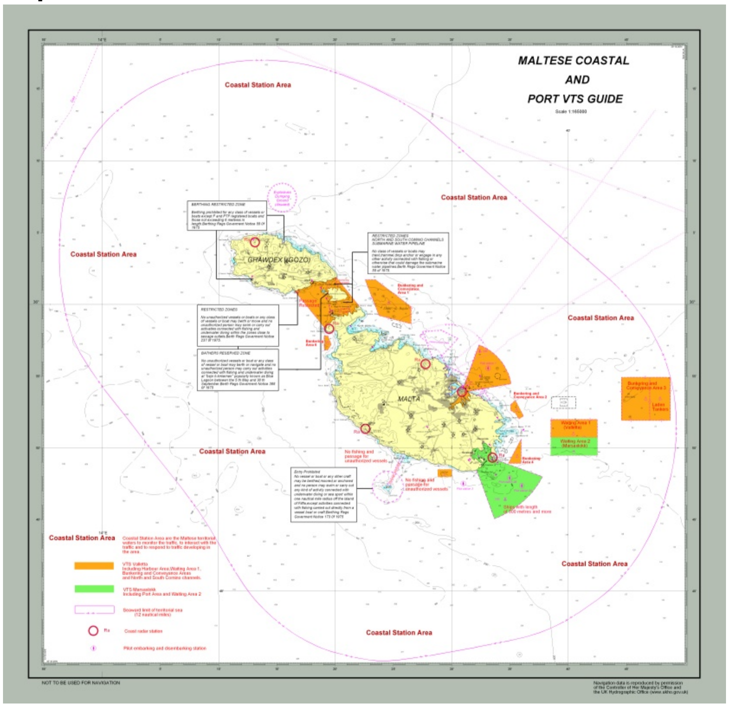
Map 3a – Bunkering Areas, Oil Rigs parking Area, Firing Practice Area and Spoil Grounds



Map 3b – Bunkering Areas, Oil Rigs parking Area, Firing Practice Area and Spoil Grounds



Map 3c. Maltese Coastal and Port Guide



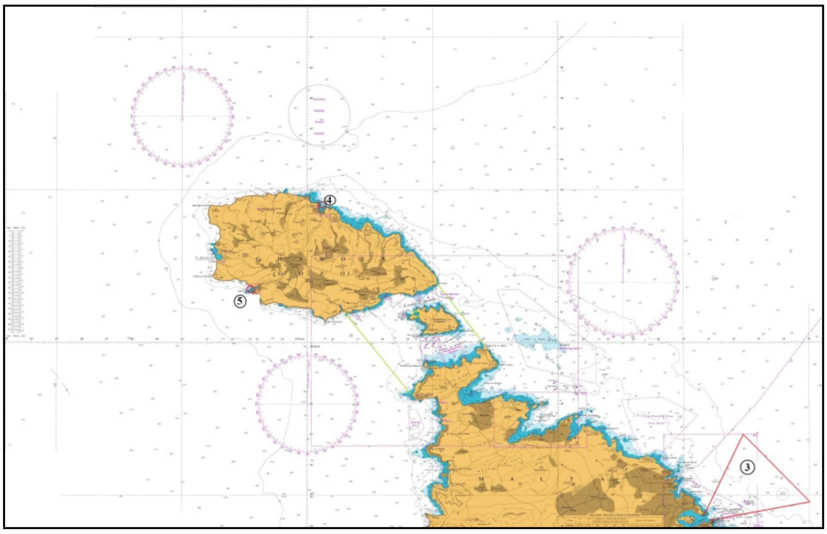
Map 4 – Marine areas with constraints for shipping

<u>Proviso:</u> ***This map excludes bunkering areas, spoil grounds, explosives disposal and firing areas, as these have been addressed in Map 3.***

<u>Red areas:</u>
1 – marine area reserved for ships having a length exceeding 800m.
2 – marine area reserved for the 'parking' of oil rigs.
3 – marine area falling under jurisdiction of Valletta Port Control.
4 and 5 – Berthing Restricted Zone. Berthing prohibited for any class of vessel or boat except those exceeding 6m in length, by virtue of Government Notice 55 of 1975.

<u>Green area</u> – Restricted Passage. Restricted zone (North and South Comino Channel) due to presence of submarine water pipeline. No class of vessel or boat may trawl, trammel net or drop anchor or engage in any other activity related to fishing or which could otherwise damage the submarine water pipeline, by virtue of Government Notice 55 of 1975.
<u>Yellow zone</u> – Bathers Reserved Zone. No authorised vessels or boat or any class of vessel or boat may berth or navigate and no unauthorised person may carry out activities connected with fishing and underwater diving at the Blue Lagoon between the 5th of May and the 30th of September, by virtue of Government Notice 388 of 1975.

Map 4a. Marine areas with constraints for shipping

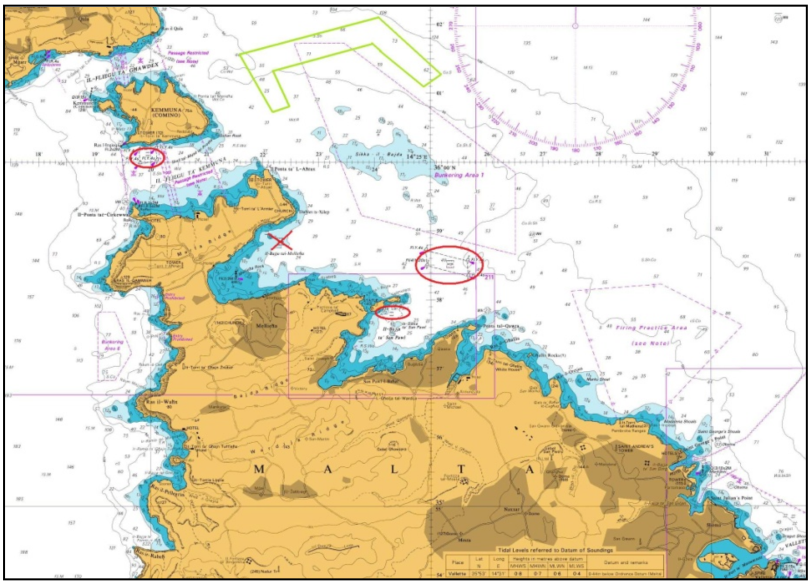


Map 4b. Marine areas with constraints for shipping

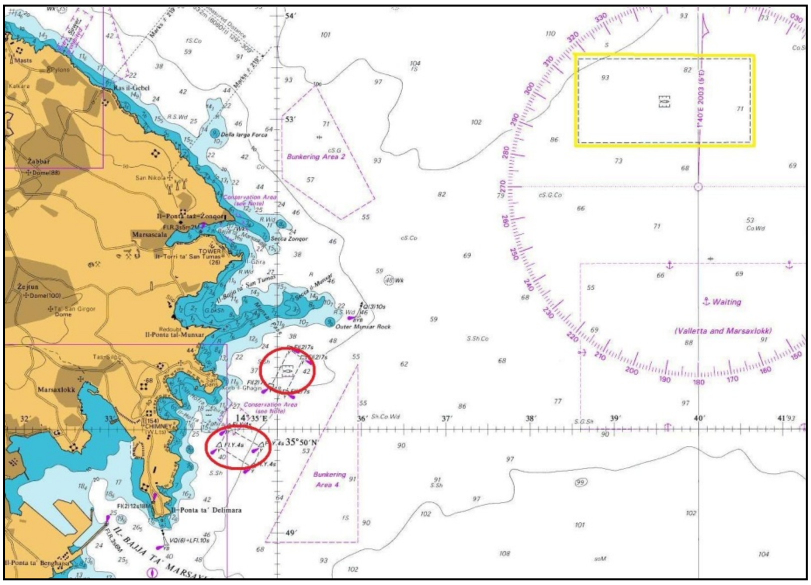
Map 5 – Location of existing fish-farms and 2 aquaculture zones

<u>Green area –</u> Marine area earmarked for the relocation of the Malta Mariculture Tuna Farm and possibly even of AJD operations to a North Aquaculture Zone. Currently, the EIA in connection with such a proposed new designation is underway.

Map 5a. Location of existing fish-farms and proposed NE aquaculture zone



Map 5b. Location of existing fish-farms and SE aquaculture zone

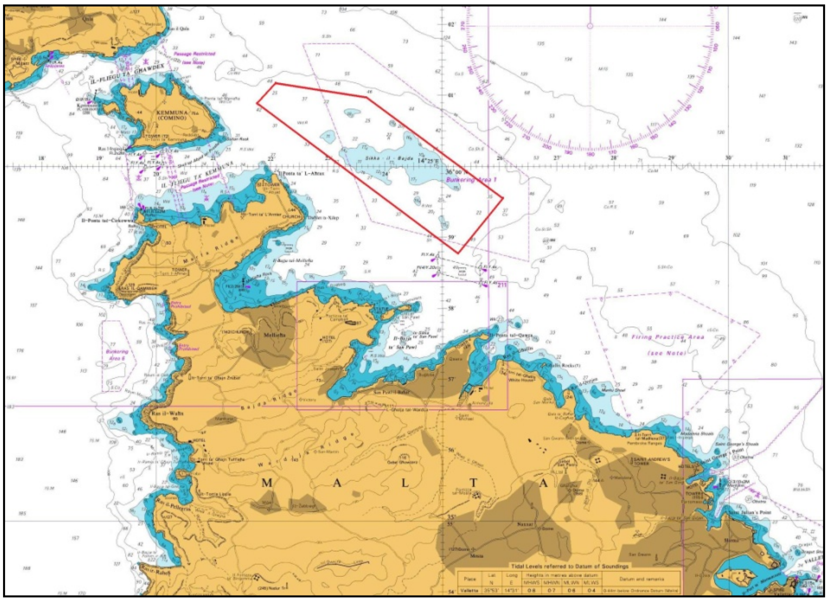


Map 6 – Proposed offshore wind farm

Red area = The marine area earmarked for the development of the offshore wind farm has been identified in the Project Description Statement (PDS) for the EIA commissioned in the summer of 2010 in connection with the same proposal. According to the PDS, such a marine area encompasses 11km^2 and ranges in depth from 10m to 35m and the developer will construct and operate the wind farm for a period of around 20-25 years after which the wind farm will be de-commissioned and the wind turbines and other related systems removed. According to latest correspondence with the MRRA, a maximum of either 19 or 25 wind turbines will be installed on site, with the first scenario accounting for a total of 7.5% and 5.5% of 2008 and 2020 (forecasted) total electricity demand of the Maltese Islands.

A network of undersea cables is required to interconnect the individual turbines and to transmit the bulk power to the onshore substation. The cables will have a diameter between 10 to 25 cm. They will consist of 3-core copper or aluminium conductors with suitable electrical insulation and steel armouring to prevent damage from external sources (e.g. anchoring). According to the EIA PDS, most probably the designation of the offshore wind farm would eventually translate into the area being declared a ‘no-fishing zone’ through the prohibition of anchoring in the area to avoid cable damage, although the deployment of mooring buoys might be contemplated.

Map 6. Proposed offshore wind farm



Map 7 – location of diving wrecks, artificial reefs and prime bathing spots

Yellow area – Artificial reef, deployed in October 2004, off Balluta Bay, and consisting of a series of concrete and Glogiberina Limestone blocks deployed as compensation for regressed *P. oceanica* beds as a result of the Portomosa hotel complex development at Spinola through the exploitation of the planning gain concept.

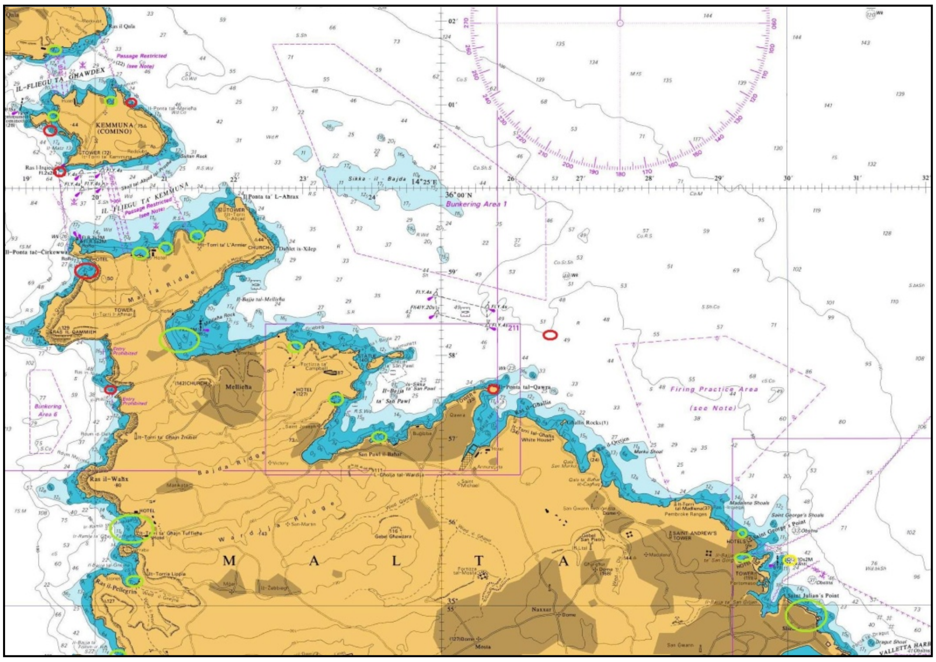
Green areas – Prime bathing spots, mainly (but not exclusively) sandy beaches.

Red areas – Major SCUBA diving sites, including (but not exclusively) wrecks. By virtue of Notice to Mariners 5 of 2008, conservation/no-stoppage zones were designated around the immediate environs of marine wrecks, coordinates for which were provided in the same Notice, as follows:

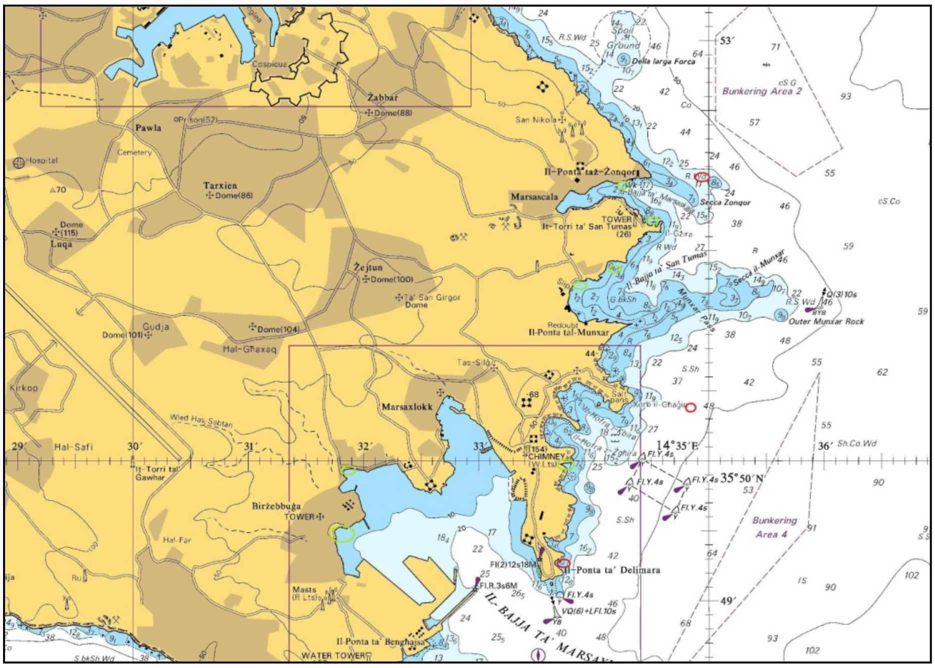
LOCATION	WRECK	POINT	LATITUDE (N)	LONGITUDE (E)
Wied iz-Zurrieq	Um el Faroud	A	35° 49.200'	14° 26.917'
		B	35° 49.150'	14° 27.200'
		C	35° 49.067'	14° 27.067'
		D	35° 49.083'	14° 26.833'
Off Xatt l-Ahmar	MV Xlendi	A	36° 01.067'	14° 16.967'
	Cominoland	B	36° 01.083'	14° 17.367'
	Karwela	C	36° 00.867'	14° 17.367'
		D	36° 00.867'	14° 16.983'
Marsacala	Tug St. Michael	A	35° 52.100'	14° 34.550'
	Tug 10	B	35° 51.900'	14° 34.650'
		C	35° 51.817'	14° 34.417'
		D	35° 52.017'	14° 34.300'
Off Qawra point	Imperial Eagle	A	35° 57.983'	14° 26.033'
		B	35° 57.833'	14° 26.233'
		C	35° 57.683'	14° 26.033'
		D	35° 57.833'	14° 25.850'
Off Cirkewwa	Rozi	A	35° 59.224'	14° 19.645'
	P29	B	35° 59.148'	14° 19.555'
		C	35° 59.299'	14° 19.365'
		D	35° 59.491'	14° 19.588'
		E	35° 59.387'	14° 19.716'
Off Xrobb l-Ghagin	Blenheim bomber	A	35° 50.267'	14° 34.467'
		B	35° 50.117'	14° 34.667'
		C	35° 49.950'	14° 34.467'
		D	35° 50.117'	14° 34.283'
Off Exiles point	Bristol Beaufighter	A	35° 55.617'	14° 30.183'
		B	35° 55.467'	14° 30.367'
		C	35° 55.300'	14° 30.183'
		D	35° 55.467'	14° 29.983'

Anchoring of divers' vessels at such sites is only permitted after pre-notification of the Valletta VTS. In addition, spear fishing and the use of fishing gear such as set bottom lines, trammel nets, gill nets and entangling nets, encircling nets, demersal pots and traps are prohibited in these areas. Only surface fishing is allowed including trolling lines (*rixa*) and angling for pelagic fish. The P31 wreck, scuttled in 2010 of the south-western coast of Comino, is missing from the list since its deployment post-dates such a Mariners Notice but is still interested by the same conditions.

Map 7a. Location of diving wrecks, artificial reefs and prime bathing spots



Map 7b. Location of diving wrecks, artificial reefs and prime bathing spots



Map 8 – Trawling zones and Dolphin Fish FAD's

Proviso: *Since most of the fishing activities falling within the scope of Map 8 take place in offshore areas (i.e. >3 nautical miles off the coast of the Maltese Islands), the maps as provided by the Fisheries Control Directorate (MRRA) are being submitted rather than adapted Admiralty Charts.*

Trawling in designated areas within the FMZ is allowed, although the total trawling capacity within the 25-n mile zone will not be allowed to increase from its present level. The size limitation of trawlers has been set at 24 m. This means that only trawlers smaller than 24 m will be allowed to trawl in specified areas within the FMZ; this measure is designed to conserve existing 'refugia' and fragile benthic ecosystems. As a further restriction, in areas where the depth of the sea floor is less than 200 m, such as Hurd Bank, as well as being smaller than 24 m, trawlers must also have an engine capacity that does not exceed 185 kW. There can be no further registration of trawlers, either local or foreign, for fishing in the FMZ.

(a) Deep sea trawling (during the day) in 600 m and below, where king prawns (*Aristeomorpha foliacea* and *Aristeus antennatus*) are targeted. When fishing for king prawns there is almost no by-catch, except for small marketable fish such as Forkbeard (*Phycis blennoides*), Hake (*Merluccius merluccius*) and Common Sole (*Solea vulgaris*). King prawns are found at depths of over 500 m throughout the year at all hours of the day, since sunlight does not penetrate to that depth. The trawling grounds are found in an area about 8 n miles to the northwest of Malta. Since the terrain is mud and free from obstacles, the duration of each trawl is at least 4 hours. Consequently, advantage is taken of the long daylight hours in the summer and at least three trawls a day can be undertaken.

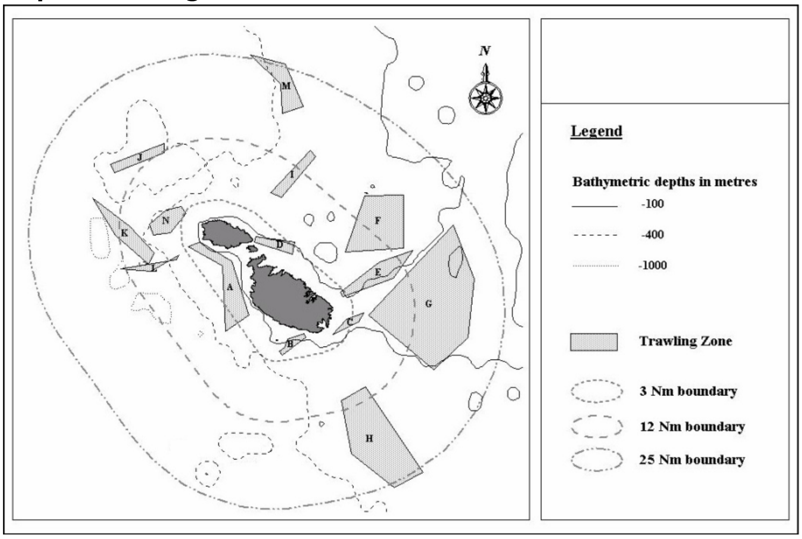
(b) Trawling in depths of between 150m and 200 m (during the day) where the terrain is mainly mud and clay yields shrimps (*Parapenaeus longirostris*), Hake (*Merluccius merluccius*), Red Mullet (*Mullus surmuletus* and *Mullus barbatus*), Common Octopus (*Octopus vulgaris*), Japanese Squid (*Todarodes sagittatus*), Cuttlefish (*Sepia officinalis*) and marketable by-catches of Dogfish, Spotted Dogfish, skates and rays (*Raja spp.*), Bogue (*Boops boops*) and Scad (*Trachurus mediterraneus*). These species are fished very close to land (3-4 n miles) and the activity is mainly carried out in winter, when the weather does not allow fishing in deeper waters.

(c) Trawling at night in depths of between 50m and 150 m on heterogeneous bottoms (such as Hurd Bank), yields Red Mullet (*Mullus barbatus*), Comber (*Serranus spp.*), Pandora (*Pagellus spp.*), squid, cuttlefish and Weaver (*Trachinus spp.*). This type of trawling is undertaken all along the northern side of the island but the main zone is on and around Hurd Bank where stocks are more abundant. Trawl time can never be longer than one hour, since the rough terrain would put too much strain on the trawl nets and damage them. This allows for several trawls to be carried out during the night.

Dolphin Fish FADs

The Fisheries Control Division within MRRA operate a system for the distribution of lines of FADs (Fish Aggregating Devices) around the Maltese Islands and the allocation of one line of FADs per fisherman. This system is based upon the establishment of a specific geographical distribution of the lines by the same Division. Each line has a number within a district, which belongs to a main port from the area. The total number of lines is 130 and they are distributed into 11 districts. Each registered fisherman with a licence for dolphin fish applies for a line and a lottery takes place. This is an objective method to allocate the lines to the fishermen every year. The fishing season extends from mid August until end of December. Nevertheless, in some years fishing activity has been recorded in January as well. The zones for FADs lie well offshore and are thus not shown on the map.

Map 8. Trawling zones



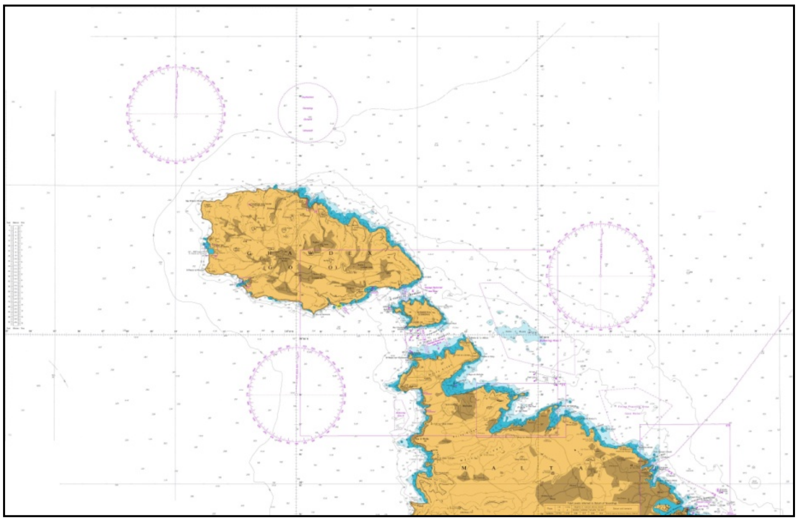
Map 9 – Sicily interconnector cable landing point, desalination plants, land reclamation

<u>Green area</u> = envisaged cable landing site for the Sicily Interconnector, at Bahar ic-Caghaq.

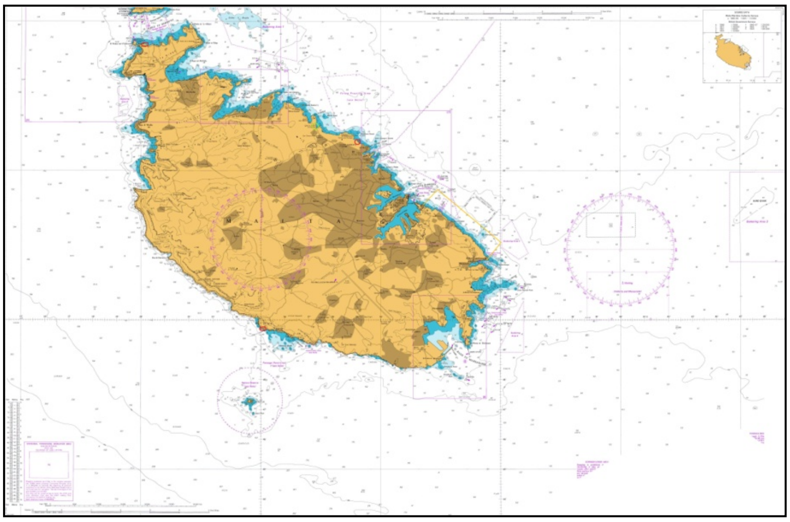
<u>Red Areas</u> = desalination (RO) plants (3 – Pembroke, Ghar Lapsi, Cirkewwa).

<u>Orange</u> = site earmarked as most congenial for land reclamation purposes, after initially 6 sites were assessed (CarlBro, 2005) for their land reclamation potential. This site was subsequently further surveyed, along with the coastal site off Maghtab landfill (Scott-Wilson, 2008). No formal decision has been taken by MEPA in this direction.

Map 9a. Sicily interconnector cable landing point, desalination plants, land reclamation



Map 9b. Sicily interconnector cable landing point, desalination plants, land reclamation



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Annex 12. Calculation of areas occupied by cages

Nursery system production and biomass estimates

Species	seabream	a'jack portion	a'jack lge
Ongrowing prod. (t)	1,000	1,000	1,000
harvest size (kg)	0.40	0.60	4.00
survival %	90%	95%	90%
Fry nos	2,777,778	1,754,386	277,778
No. of batches	4	2	1
Fry/batch	694,444	877,193	277,778
Transfer size (kg)	0.05	0.05	0.10
Max batch wt (kg)	34,722	43,860	27,778
Overlap %	50%	25%	0%
Max. biomass (kg)	52,083	54,825	27,778
Production p.a. (t)	139	88	28

Species	Tuna	Seabream (portion)		Amberjack (portion)		Amberjack (large)		Amberjack 50/50	
Production phase	Ongrow	Ongrow	Nursery	Ongrow	Nursery	Ongrow	Nursery	Ongrow	Nursery
Production p.a. (t)	1,000	1,000		1,000		1,000		1,000	
Production cycle (months)	6	14	2	6	1.5	30	2		
Ratio production: max. biomass	1	1.8		1.25		0.65			
Maximum biomass (t)	1,000	556	52	800	55	1,538	28		
Max. stocking density (kg/m3)	2.5	15	12	15	10	15	10		
Avg. harvest size (kg)	200	0.40	0.05	0.60	0.05	4.00	0.10		
Cage requirements and sea surface area needed									
Cage type:plastic circle									
Diameter (m)	50	20	12	20	12	30	12		
Side depth (m)	20	8	5	8	5	15	5		
Cone depth (m)	18	5	0	5	0	10	0		
Total depth (m)	38	13	5	13	5	25	5		
Cage volume (m3)	51,013	3,035	565	3,035	565	12,950	565		
Maximum stock/cage (t)	128	46	7	46	6	194	6		
Number of cages (rounded up)	8	13	8	18	10	8	5		
Total cage volume (m3)	408,106	39,453	4,522	54,627	5,652	103,601	2,826		
Mooring type	grid	grid	grid	grid	grid	grid	grid		
Grid width (m)	100	40	24	40	24	60	24		
Grid length (m)	800	520	192	720	240	480	120		
Grid area (m2)	80,000	20,800	4,608	28,800	5,760	28,800	2,880		
Grid area (ha)	8.0	2.1	0.5	2.9	0.6	2.9	0.3	2.9	0.4
Moorings and seabed area needed									
Water depth (m)	70	40	10	40	10	40	10		
Leg length:depth ratio	5	5	5	5	5	5	5		
Leg length (m)	350	200	50	200	50	200	50		
Overall width (m)	800	440	124	440	124	460	124		
Overall length (m)	1500	920	292	1120	340	880	220		
Overall seabed area (m2)	1,200,000	404,800	36,208	492,800	42,160	404,800	27,280		
Seabed area (ha)	120.0	40.5	3.6	49.3	4.2	40.5	2.7	44.9	3.5

SUMMARY TABLE

Sea areas occupied by different species and systems

Species	Tuna	Seabream (portion)		Amberjack (portion)		Amberjack (large)		Mix of CCS [1]	
Production phase	Ongrow	Ongrow	Nursery	Ongrow	Nursery	Ongrow	Nursery	Ongrow	Nursery
Production p.a. (t)	1000	1000	139	1000	88	1000	28	1000.0	98.3
Production cycle (months)	6	14	2	6	1.5	30	2	16.0	1.9
Avg. harvest size (kg)	200	0.40	0.05	0.60	0.05	4.00	0.10	1.4	0.06
Water depth assumed (m)	70	40	10	40	10	40	10	40.0	10.0
Sea surface occupied (ha)[2]	8.0	2.1	0.5	2.9	0.6	2.9	0.3	2.5	0.4
Seabed area occupied (ha)[3]	120	40	3.6	49	4.2	40	2.7	42.7	3.5

Notes

1 Mix of CCS composed of 50% portion seabream, 25% portion amberjack, 25% large amberjack

2 Sea surface represents area occupied by surface mooring grid for plastic cages, assuming grid is 2x cage diameter

3 Seabed area assumes mooring leg length is 5x water depth

Annex 13. Reference model for closed cycle species

Reference model for closed cycle species

P&L (per kg)	Base case [1]	Future [2]
SALES	4.04	5.77
VARIABLE COSTS		
Fry	0.52	0.48
Food	1.90	2.03
Labour	0.55	0.58
Packing & marketing	0.45	0.45
Other variable costs	0.05	0.08
	3.47	3.61
GROSS PROFIT	0.57	2.16
FIXED COSTS	0.36	0.39
TOTAL PRODUCTION COST	3.84	4.00
PROFIT	0.20	1.77

Notes

1 Base case 95% seabream, 5% bass & meagre

2 Future case 50% seabream 25% portion amberjack 25% large amberjack

Annex 14. Reference model for hatchery

Reference model 2 for hatchery production (CCS)				
Species	50% seabream, 50% amberjack			
Production p.a. (million)	20			
Selling cost/fry (€)	0.3			
Capex (€m)	8,483,261			
Staff FTEs (inc. management)	92			
	€		% of costs	% of revenue
Sales	6,000,000			100.0%
Feeds& nutrients	741,076		20.6%	12.4%
Labour	981,818		27.3%	16.4%
Total direct costs		1,722,895	47.9%	28.7%
Salaries	376,364		10.5%	6.3%
Admin costs	100,800		2.8%	1.7%
Prof fees	55,636		1.5%	0.9%
Power	351,635		9.8%	5.9%
Vehicle costs	20,160		0.6%	0.3%
Site rental	35,345		1.0%	0.6%
Repairs and renewals	62,915		1.7%	1.0%
Stock insurance	73,636		2.0%	1.2%
Depreciation	730,576		20.3%	12.2%
Misc	65,455		1.8%	1.1%
Total fixed costs		1,872,522	52.1%	
Total costs		3,595,416	100.0%	
Profit before finance and tax		2,404,584		40.1%