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**GENERAL FISHERIES COMMISSION FOR  
THE MEDITERRANEAN  
COMMISSION GÉNÉRALE DES PÊCHES  
POUR LA MÉDITERRANÉE**



*Viale delle Terme di Caracalla, 00153 Rome, Italy. Tel: + 39 0657055730. www.gfcm.org*

**GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN**

**SCIENTIFIC ADVISORY COMMITTEE (SAC)**

**Thirteen Session**

**Marseille, France, 7-11 February 2011**

**Report of the Transversal workshop on red coral  
Alghero (Sardinia), Italy, 16-17 September 2010**

**OPENING, ARRANGEMENT OF THE MEETING AND ADOPTION OF THE AGENDA**

- 1) The SAC Transversal Workshop on Red Coral was held in Alghero (Sardinia), Italy, from 16 to 17 September, 2010. It was attended by 68 participants from Greece, Italy, Morocco and Spain as well representatives of FAO and the GFCM Secretariat (see list of participants in Appendix B).
- 2) Mr. Plino Conte, representative of the Italian Ministry of Agriculture, Food and Forestry Policies, Mr. R. Doneddu, representative of the regional Government of Sardinia (Italy) and Mr. M. Conoci, representative of Alghero city, welcomed the participants and thanked them for attending this meeting. They stressed the relevance of the GFCM as the appropriate regional body to present and discuss important issues related to the fisheries management in the Mediterranean and the Black Sea.
- 3) Mr. A. Srour, Deputy Executive Secretary of the GFCM, welcomed the participants and thanked the Italian authorities, in particular the regional Government of Sardinia, for their kindness in hosting and arranging the meeting. He introduced the GFCM and its functioning and recalled the frame of the meeting.
- 4) Mr. F. Alvarez, coordinator of the Sub Committee of Marine Environment and Ecosystems (SCMEE), chaired the meeting. He thanked the participants for attending the meeting and presented the mandate of SCMEE. Mrs. R. Cannas, M.C. Follesa, P. Pesci and Mr. A. Cau acted as rapporteurs.

5) The agenda was introduced and adopted by the WS (Appendix A).

## **INVENTORY OF THE STATE OF RED CORALS IN THE MEDITERRANEAN**

### **Information by national experts**

6) A total of 8 presentations were exposed by national experts on the management scheme, status of populations and exploitation level of red coral in Italy (Sardinia) and Morocco. The correlation between size/shape and environmental parameters (currents) and the utility of genetic analyses for management purposes were addressed. The abstracts as submitted by their respective authors are listed below.

### **Evolution of the main Sardinian red coral regulations from 1980 to 2010. (by Follesa M.C.)**

#### **Abstract:**

Red Coral (*Corallium rubrum*, 1758) in Sardinia is a historical important commercial resource with banks mainly distributed in the Northern and Western coasts of the island. Since 1979, harvesting has been regulated by the Regional Law n. 59 - 5 July 1979 "Coral Fishing Regulation" that introduced several restrictions to enable the sustainable exploitation of coral resources. In 1989, the Regional Law n. 23 of 30th May 1989 partly modified the Regional Law 5th July 1979 n. 59 and introduced new restrictions to ensure a more strict and effective protection of the coral resource and the marine ecosystem. For instance, the non selective gears (St. Andrew cross and ingegno) were banned and only manual harvesting with the pick is permitted and a limit size of harvesting is imposed. In this paper the progressive evolution with time of the main regional red coral management regulations (number of issued permission, time of harvesting, size limit, daily catch limit, and closed harvesting areas) is discussed. The management strategy adopted in Sardinia is one of the first in the Mediterranean Sea and could be considered as an example for the entire basin.

The Sardinian management measures, such as the legal minimum size, permanent refugia, licensing, maximum yield per day and banning of harvesting in shallow water could be considered adequate restrictions for the sustainability of the resource. Taking into account that the future stability of both the biological resource and the manufacturing industry should depend on continuous compliance with existing management measures as well as the regular monitoring to ensure that they are working, at the present state, we can state that the Sardinian harvesting limitations could be considered as a guide for other Mediterranean coral fisheries that are in urgent need of analogous management programs.

### **The status of red coral (*Corallium rubrum*) resource in the Northern and Western coasts of Sardinia.**

*(by Follesa M.C.)*

#### **Abstract:**

In the last 30 years Sardinian Administration have established some management actions to improve sustainable exploitation, conservation and protection of red coral in its waters. Taking into account that these regulations could have affected the state of the red coral banks, a picture of the spatial distribution of the deep red coral resource in the Northern and Western coasts of Sardinian are illustrated. Data of the last 4 years (2007-2010) on size structure, density, spatial distribution pattern were collected both by ROV video transects and colony sampling by professional divers. Three zones with different demography and density were identified. Some specific issues on the growth and reproductive biology of the deeper colonies in these zones are also presented. It will be also emphasized the utility of these data in the management of the resource.

**The state of red coral (*Corallium rubrum*) populations in the N.W. Sardinian fishing grounds. (by Chessa L.A.)**

**Abstract:**

Some aspects concerning distribution and ecology of the red coral (*Corallium rubrum*) in N.W. Sardinian coast and in particular on fishing grounds are discussed. In particular the distributions of the shallow as well as deep population are considered. The main population parameters are exposed with a particular emphasis for those colonies of a commercial value for which a calculation of the structural complexity has been made. The fishing techniques are also discussed in consideration with recent technological advances that could allow a safe fishing with a high level of environmental protection and good management.

**Coral morphology and current flows. A preliminary overview. (by Pesci P.)**

**Abstract:**

Preliminary analyses by the working group of the Department of Animal Biology and Ecology of University of Cagliari underlined a different morphology of the coral colonies in the different Sardinian coasts. In particular, in the Northern Coast taller and more branched colonies have been found than North-Western coast colonies of the same age. Southern colonies showed could be linked to the diverse hydrodynamic features in the areas.

A hydrodynamic model 3D of Sardinian Seas has been used to highlight if some hydrodynamic variables can be related to the growth pattern of the colonies in the different coasts. This model allowed to simulate a 2-years circulation in the areas. Average intensity and direction of currents between 80 and 120 m depths (the depth of the analyzed red coral samples) have been found and the circulation in the area has been simulated. The possible correlation between currents (intensity, direction and variability) and growth pattern of red coral colonies in the North, North-Western and South-Western coast of Sardinia have been evaluated.

The three studied areas showed different hydrodynamic features and an inverse relation between velocity of current and height of colonies has been found.

Obtained results, even if they are preliminary, confirm that red coral colonies have growth patterns different in the three areas in relation to the different velocity of currents. This differentiation confirms the proposal of a local management of red coral.

**Connectivity among red coral deep populations measured through genetic means. (by Cannas R.)**

**Abstract:**

Size and interconnectivity of genetic breeding units are important parameters to design management plans and identify conservation strategies. In fact, small and/or isolated populations are vulnerable to inbreeding depression, which might reduce their evolutionary potential that is their resistance and resilience following disturbance, such as harvesting or environmental perturbations.

In species with sessile adult stage, as for the red coral, dispersal is almost impossible to track directly because it relies on larval and/or gamete transport in the water column. An indirect way to measure connectivity is through genetics.

Up today, detailed genetic studies have been performed almost exclusively on shallow-water *C. rubrum* populations (15-50 m of depth). However, at present the populations deeper than 80m are those which are heavily commercially exploited.

At present the Department of animal biology and ecology of the University of Cagliari is performing the assessment of the genetic structure of populations from Sardinian commercially exploited banks (from -80 m to -120 m of depth) in order to gather information useful both for scientific and management purposes. The main findings of this research (still ongoing) are illustrated.

In summary, colonies from the Northern, Central Western, and South Western Sardinian coasts proved to be highly genetically differentiated. A strong genetic heterogeneity is measurable between samples over different spatial scales from hundreds to less than 1 km. In all samples, the inbreeding coefficient FIS is significantly  $> 0$ , indicating that breeding among close relatives seems to occur. Preliminary comparisons between deep and shallow-water populations from the same area seem to indicate the existence of a strong genetic differentiation among populations over depth.

Morphometric data for each of the genotyped populations are analyzed to investigate on possible links among populations' structure (size) and the main genetic indices. Considering the populations from within a given area where differences in size cannot be attributed to environmental factors, an inverse correlation was found between mean size and Fis (inbreeding coefficient). It is possible that the indirect effect of harvesting on populations is not only changing their size (the most exploited populations are usually the smallest in size) but also their connectivity/viability (the smallest populations have the highest Fis value).

In conclusion the genetic analyses confirmed that red corals are differentiated on local scale and hence a local management is needed. Furthermore, for a long term sustainable management of red coral fishing effort should be careful controlled.

### **Red coral sustainable management: key success factors and challenges for further improvement of regional regulation in Sardinia. (by Doneddu R., et al.)**

#### **Abstract:**

The Sardinian Regional Administration has enacted one of the first legislation on red coral harvesting in the Mediterranean Sea.

In order to ensure sustainable exploitation since 1979 the Regional Law 5th July 1979, n. 59 has introduced several management measures – in brackets the measures currently in place- including: limited annual harvesting licenses (max 30), restrictions on harvesting methods, harvest data collection (logbook), banks survey, fishermen training, yearly definition, through a regional decree, of harvesting season (1st May-15th October), allowed areas (all along Sardinian coastal waters apart from MPA's), no-take zones (2 on NE and E coast), daily quota per fisherman (2.5Kg) and license fee extent (1000 €/year).

In the last 30 years the regional regulation has been gradually implemented, banning since 1989 (Regional Law 30th May 1989 n. 23) from the use of non-selective and destructive dredges (such as the “barra italiana” and the St. Andrew's cross).

Furthermore, since the 1980's the Regional Administration has been funding scientific studies in order to collect biological data and obtain periodical assessment of the status of the resource along Sardinian coastal waters (the most recent surveys in 2007 and 2008).

On the basis of the scientific evidences collected, the annual regional decree introduced further restrictions, such as: minimum basal diameter (10 mm) and relative tolerance (20%), minimum depth (- 80 m), maximum number of fishermen per boat (2), maintenance of harvested red coral in a net soaked in sea water for at least 30 minutes in order to allow gametic products dispersion, immediate release of broken apical branches in the harvesting areas.

On the basis of the scientific evidences the regulation in place in Sardinia seems to be effective for the conservation of the resource as confirmed by recent scientific study (Cannas et al., 2010).

An overview of the red coral regulation and management actions in Sardinia in the last 30 years is provided , including the recent restocking program.

The analysis of the logbook data highlights that the number of total harvesting days and the number of issued licenses strongly decrease from 2006 to 2010 and the yearly average harvest for unit of effort (CPUE) shows the same trend whereas the average daily red coral harvest per fishermen seems to increase in the last years. The harvesting effort is mainly concentrated in the NW part of the island - Alghero and Bosa totally amount to more than the 70% of the harvest in 2010 (since July).

Moreover starting from a SWOT analysis an overview of key success factors and challenges for further improvement of regional regulation is provided.

In particular a well defined and tested legal framework, the adaptive management system based on scientific evidence and on a well settled multi-stakeholder cooperation (among operators, researchers and regional government) seem to be the main success factors.

Enhancing monitoring plans not only on more exploited populations (80-130 m) but also on deeper banks, starting an independent data assessment, rotating the allowed harvesting areas, employing broken distal branches for restocking, enforcing the measure against illegal exploitation with destructive gears, evaluating new selective robotic harvest systems, are some of the management enforcing measures under evaluation and the next commitment for the Regional Administration.

### **Fisheries of the red coral *Corallium rubrum* (Linnaeus, 1758) in Morocco. (by El Alloussi K.)**

#### **Abstract:**

This presentation contains data on several domains relating to the fishing of coral in Morocco, At the beginning we present briefly the most important historic information which are scattered in the department of marine fisheries and which indicates to us the level of exploitation of coral; The historic analysis shows an annual variation of captures by fishing boat during the last 30 years, expressing a progressive decrease of the captures which end by the closure of the fishing area.

The units fishing was of foreign vessels and the transfer of the fishing activity toward the area of Asilah in 1990 toward has allowed the application of new rules (marocanisation of the boat), which led the reduction in the number boat of 23 to 10 units.

Red coral is distributed in several areas of marine water in Morocco, but the official fisheries data show that existed in three areas from 40 to more than 120 m. The harvesting methods was scuba diving

Generally, the production of the red coral carried out each year shows the same tendency of evolution. The production reaches a maximum in the first year the opening of the zone of fishing and starts to fall progressively. During the last ten years the landing data shows a decline from maximum of 21,999 kg in 2002 to 1,595 kg in 2006. 70 Per cent of coral fished, between 1980 and 2009, is exported in Italy and 11 % in Switzerland

The rotation harvest schemes: currently, only two areas (Asilah and Al hoccima) are concerned the rotation will allow the reconstitution of the banks of coral affected. The area will be closed to fishing as the yield of fishing decrease. The harvesting period in each zone can vary depending on the density of coral populations. The regulation of red coral fishing has introduced several restrictions in order to improve sustainable exploitation (number of coral licences, Annual harvest amounts of each boat and closing area of fishing...), conservation of coral resources, and protection of marine ecosystems

The national Institute of halieutic Search (INRH) has to make prospecting before the opening of the fishing of coral, the last operation of prospecting is realized between July 2008 and June 2009 this operation gives detailed mapping and a regular monitoring scheme along with measures for the fishing and the protection of the red coral in the area Larache Cap Spatel.

The result of this operation of prospecting allowed the opening the area between Cap Sparte and Larche in these conditions:

- The depth of exploitation is situated between isobaths 40 to 80 metres;
- The period of opening of this fishery is one year with scientific follow-up and proceeds to a regular biological sampling;
- Authorization 10 licences and 3 divers by ship;
- Fixation TAC 600 kg by ship (6 tons by year for ten ships).

### **The exploitation of red coral in Morocco. (by Zoubai A.)**

#### **Abstract:**

The exploitation of the red coral in Morocco is endowed with a great economic importance beside fisheries resources. Coral resource is an old, rare, precious, much in demand and not easily renewable. At the national

level, the exploitation of red coral started at the 70's. This exploitation activity caused in a localized way a rarefaction of red coral colonies, particularly at zones at low depths.

The red coral by its commercial interest that it presents led to the extension of the activity of fishing towards the great depths. Taking into account the fragility of this resource and with the aim of preserving and ensuring the durability of this species, targeted research was undertaken. On the basis of scientific results obtained by l'Institut National de Recherche Halieutique (INRH), the Department of marine fisheries worked out in concertation with professionnels a regulation by promulgating decrees of fishings aiming at regulating the exploitation of the red coral and controlling the fishing effort.

## **GENERAL DISCUSSION ON NATIONAL EXPERTS PRESENTATIONS**

- 7) The workshop underlined that substantial information on red coral was exposed related to biological aspects and the assessment of Sardinian deep coral banks, and on the status and management of red coral in Sardinia (Italy) and Morocco. In particular, the relation between size/shape and environmental parameters (currents) and the utility of genetic analyses for management purposes were addressed.
- 8) It noted that management strategies of red coral are implemented in some GFCM sub-areas. In this respect, the Workshop appreciated in particular the case of the Sardinian region which could be considered as a good reference for other GFCM sub-regions. It was stressed that the main strength of the Sardinian management is its adaptive system flexible to modify in accordance with data gathered through periodical scientific monitoring.
- 9) Considering the fact that the presentations reconfirmed how red coral populations are biologically and genetically differentiated in different areas and at different depths, the meeting stressed the importance to locally define management units and conservation plans.
- 10) The participants noted that regional and local plans should be harmonized and supported by management strategies at pan-Mediterranean scale.
- 11) The workshop highlighted that at present the vast majority of monitoring and scientific studies have been performed at a local scale, but provisions for continued scientific researches and the realization of a common Mediterranean research program are crucial. The urgent need to carry out regional research activities was stressed.
- 12) The meeting recognized the value of a cooperative approach, the need to standardize methods and procedures and the importance for training and transfer of knowledge and technologies.
- 13) Mr Srouf informed the participants on the scheduled meetings during 2010 and encouraged them to attend. Special reference was made to the meeting of the GFCM Working Group on stock assessment of demersal species which will take place in Istanbul (Turkey) in October. He stressed the importance of this meeting as the appropriate frame to present works related to the assessment of the red corals.

## **TECHNICAL ISSUES RELATED TO THE MANAGEMENT AND CONSERVATION OF THE RED CORAL IN THE MEDITERRANEAN**

### **STATISTICS AND INFORMATION**

- 14) A total of 3 contributions were presented on the yield data that can be found in the FAO statistical databases for red coral, on the differences between past and present data and on the necessity to improve the quality of this type of information.
- 15) The abstracts as submitted by their authors are listed below.

#### **The harvest data on red coral (*Corallium rubrum*) available in the FAO global capture production database. (by *Garibaldi L.*)**

##### **Abstract:**

The FAO global capture production database includes harvest data for red coral (*Corallium rubrum*) for more than 30 years. Differently from the other catch statistics included in the database, which are usually submitted by national official sources, data on red coral are consistently provided since mid-1980s by a major red coral import-export and production of jewellery wholesaler. Although the data available in the FAO database present some shortcomings (i.e. possible conflict of interest for an industry data provider, data may refer in some cases to trade information rather than to actual annual harvest), the constant provision by the same source ensure consistent information for trend analysis. In the last four years the total harvest remained rather stable, recovering since the 1998 minimum. However, the average harvest in the 1978-80 period compared with 2006-08 showed a historical reduction by 55 percent. It should be noted that as most of the data in the FAO database cover quantities actually traded, they may also include IUU harvests that are not reported in official national data.

#### **Red coral fishing trends in Sardinia from 1978 up to now: analyses of published data. (by *Pesci P.*)**

##### **Abstract:**

Analyzed data derive from a publication of Liverino dating back to 1998. Here data of red coral amount harvested are reported for the period 1978-1997. Data are divided by country and each country is then subdivided in areas. Moreover data by different gears were reported, mainly boats using a towed gear and divers picking up red coral manually. Data on the quintals harvested by gear as well as the number of units (boats or divers) exerting it are given too. Clearly, these data are very detailed, showing for all the Mediterranean sea the evolution in both effort and harvested amount.

Red coral amounts landed in Sardinia from 1978 to 1997 show a substantial decrease since 1978. It is mainly due to the reduction in the harvested by towed gears (St. Andrew Cross and Ingegno). In fact the quantity obtained by diving has not strongly reduced. These landings data reflect the decrease in the fishing effort drove by the Sardinian regulations.

The closely connected trend of the reduction in the harvested amount following the decrease in the effort is common to other geographical areas such as Corsica, Tunisia and Alboran Isle.

These information underlines the importance of detailed data (e.g. by areas) together with the information on the effort made.

#### **Red coral yield data: can we (need to) improve them? (by *Cannas R.*)**

##### **Abstract:**

In different times three proposal have been submitted to CITES (Cop6-1987, Cop14-2007, Cop15-2010) for listing the red coral *Corallium rubrum* in Appendix II, calling for its management through a the strict

regulation of the trade. These proposals, all rejected, heavily depended on catch statistics to support inclusion under decline criterion. Recently, the FAO ad hoc expert advisory panel for the assessment of proposals to amend CITES Appendices reaffirmed that catch statistics in red coral do not necessarily mirror the status of the species since they can be influenced by many complex factors (e.g. economics such as price of coral, management practices such as size limits and area closures, etc.). Anyway, the availability of accurate catch data (along with independent fishery data) is not only a requirement limited to the CITES context, but all management/conservation programs need this information to design sound and effective plans.

At the moment, the only compilation of yield statistics for red coral by country is the FAO global capture production database, in which data for red coral are presently available from 1974 to 2008. The GFCM capture production database includes the same data (updated to 2006 for the moment) but also by GFCM statistical divisions, when this more detailed information is available.

A provisional analysis of these main sources and the cross-checking with published data permitted to highlight some problematic issues that can strongly compromise their utility (credibility).

Some examples will be presented related to incompleteness (e.g. areas where coral harvesting is actively performed but data are sparse), incongruence both with other official sources (data provided by ministerial bureau strikingly different from the FAO figures) and the national legislations (e.g. data on coral catches for areas for which the harvesting is legally interdicted since a decade).

Many of these discrepancies can be explained by the fact that the majority of the data included in the FAO database are not provided by national official correspondent, as for the other capture fishery data, but by a major wholesale company. In fact, it is highly plausible that data are confused also because yields figures are known to be regularly provided to FAO both by some (too few) production countries (data on harvesting) and by red coral wholesalers (that could provide along with fishing data also commercial data on sales probably mixing up annual actual data with data from stockpiles from previous years).

From this preliminary analysis, three main indications emerge. There is an urgent need :

- to have complete and correct data, and with respect to this a more prompt collaboration from countries in recording and providing national data to FAO is highly desirable;
- to identify discrepancies between different sources and possibly revise and improve backward data included in the FAO and GFCM databases;
- to have complete and trustable data on the effective annual yield that must be clearly distinct from the data on sales.

16) Data on red coral harvest by country are available from the FAO global capture database for more than 30 years (1978-2008). Differently from the other catch statistics included in the database, which are usually submitted by national official sources, data on red coral are consistently provided since mid-1980s by a major import-export and coral jewellery wholesaler. According to the information in the FAO database, trend of red coral harvest shows a long-term decline by 55% between 1978-80 and 2006-08 but recovered since the 1998 minimum and has been quite stable in recent years.

17) It was pointed out that in some cases figures in the FAO database are discrepant with national official data or legislation (e.g. data in years during which fishing of red coral was banned in a given country). However, given that harvest data provided to FAO are raised on the basis of quantities actually traded, they may also include quantities from IUU fishing that are not reported in official national data or possibly sometimes refer to quantities from stockpiles harvested in previous years.

18) The workshop noted the urgent need for more complete and comprehensive information to support management decisions and recommended that data on annual red coral harvest be regularly collected at the national level and submitted to FAO and to GFCM by Geographical Sub-Areas (GSAs). It would be desirable that also information on biological parameters (e.g. size) be collected from the coral landed.



- 19) Greece, the Autonomous Region of Sardinia (Italy) and Morocco, which had reported to have in place effective data collection systems, were requested to summarize their experiences that may be useful for other countries that would establish such a system.

### ***Greece***

According to the Presidential Decree n. 174/1994, when coral fishers discover a new stock have to declare it before proceeding with harvesting and subsequently they are requested to declare their overall landings to the local port authorities. There is no direct control on declarations. The Maritime Authority is responsible for enforcing the regulation.

### ***Italy (Autonomous Region of Sardinia)***

Pursuant to Art. 6 of the Regional Law n. 59/1979, allowed fishermen are requested to submit to the Regional Administration, within 30 days from the end of the harvesting season, a report showing the harvesting areas and the amount of red coral harvested.

Art. 4 of the annual Regional Decree (Dec. n. 31 of the 25<sup>th</sup> March 2010) specifies that allowed fishermen have to keep a daily logbook on their fishing activity with the following information: harvest area (geographic coordinates), depth, quantity and quality of red coral. The data collected through logbooks are stored and analyzed in order to yearly assess the harvesting effort and the yield in the harvesting areas.

The Italian Maritime Authority and the Environmental Protection Police of the Autonomous Region are responsible for the control of all fishing activities in Sardinia.

### ***Morocco***

The Decree n° 2-04-26 of 6 hijra on 1425 (January 17th, 2005) established regulations and modalities of red coral fishing. Fishers are requested to submit to the port representative of the Department of Marine Fisheries the following parameters: date of fishing, quantity landed and the processing company to which they sold the coral. Information gathered through fishers' declarations is later cross-checked with export data collected by the Custom authorities. Quantities exported regularly result higher than fishers' declarations but in recent years the gap between the two sources has been significantly reduced due to the improvement of the primary data.

- 20) The Workshop noted the good results obtained by these national and regional data collection systems on red coral harvest but recommended that, to avoid underreporting in fishers' declarations, random controls on board and at landing sites should be also in place and/or cross-checking with data from other sources (e.g. export data).

## **PRESENTATIONS BY NATIONAL EXPERTS**

- 21) A total of 10 presentations were made by national experts. The meeting was informed on the status of knowledge on red coral resource, on new demographic approaches to management and conservation, on the utility of genetic data to measure connectivity among populations, on new management measures, on the feasibility of the robotic harvesting and the necessity to test the sustainability of this technology.
- 22) The abstracts submitted by their authors are listed below

**A demographic approach to management and conservation of the precious Mediterranean red coral.**  
(by *Santangelo G.*)

**Abstract**

The precious Mediterranean red coral, whose exploitation lasts since two thousand years at least, is one of the most valuable marine resources. In recent years overharvesting occurred in several countries and the majority of shallow populations have been depleted. Demography could supply tools for a rational and sustainable exploitation of this resource; however there is the need of sound data on colony growth rate, population structure and reproduction which can allow modeling population trends over time. Demographic data collection and stock assessment are particularly needed for deep-dwelling populations which, having the highest economic value, are nowadays the main object of commercial exploitation. The Italian research team on red coral recently started a study on deep-dwelling populations of the North and Central Tyrrhenian Sea in which the species have been harvested until recent times. The scientific cruise has been carried out (with the support of the Italian Environment Ministry) by the research vessel *Astrea*. MULTIBEAM bathymetry, ROV video transects and colony sampling by professional divers have been carried out between 65 and 120 meters depth. Data on size (and age) structure, abundance, spatial distribution pattern, reproduction and genetic structure of four populations in Campania and Tuscany have been collected and are actually under analysis. The importance of demographic approach to conservation and management of Mediterranean red coral (*Corallium rubrum*) (Bramanti L. et al.).

**The importance of demographic approach to conservation and management of Mediterranean red coral (*Corallium rubrum*). (by Bramanti L.)****Abstract:**

Demographic models are fundamental to foster conservation and management of endangered or overexploited species matching harvesting to population growth rates. Such models are widely applied by conservation biologists. Mediterranean red coral (*Corallium rubrum*) is object of harvesting since ancient times and in the last years the need for conservation and management plans for this species emerged. Two different kinds of populations can be distinguished: 1) shallow-water populations (up to 50 meters depth), characterized by colonies with small size, few braches, high density and limited economic value. 2) Deep populations (below 50 m depth) characterized by large, sparse colonies with high economic value. Demographic data of the life table obtained for the coastal population under study were included in a non-linear, discrete, age-structured dynamic model, based on a Leslie-Lewis transition matrix. The model, taking into account the reproduction of the population, is more suitable for populations structured in several reproductive age classes (like red coral) with respect to classical fishery models. We applied such model to simulate the population trends under different scenarios. As deep dwelling populations actually show the dominance of sparse, large/old colonies, while shallow are mainly characterized by crowded, small/young colonies and high recruitment rate, we simulated the shift from the former to the latter structure. Our results suggest that a dramatic mortality increase of larger-older colonies (due to overfishing) could have determined the population structure we found. On the basis of our simulations it is possible to give some suggestion; as recently proposed in the course of different workshops on red coral management, the banning of harvesting on coastal populations could be an effective measure. Concerning deep populations a rational management would be possible only if planned on the basis of a sound demographic approach and sound demographic data.

**New insight into *Corallium rubrum* fishery management: An application oriented synthesis of recent data. (by Tsounis G.)****Abstract:**

Recent studies on the population status of *Corallium rubrum* brought international concern over the sustainability of coral fisheries. The available data state with confidence that shallow water stocks in air diving range have been overexploited, so that expert consultations recommend a Mediterranean-wide

protection of shallow water populations, and a management based on stock assessment and scientific monitoring.

The necessary revisions of current management measures include most importantly a larger minimum size limit, as the existing one is in most cases based on outdated practical considerations, rather than being based on recent scientific studies. However, geographic variability in environmental parameters influences coral growth rates and morphology to an extent that adequate size limits are likely to vary between 10 - 20 mm in base diameter. For this reason, number of branches and minimum height should be used as additional age limits. A sufficiently large part of the deep populations needs to be conserved through permanently protected areas (MPAs), as corals play a significant role in the ecosystem. Daily catch limits, as well as number of licenses must be carefully set, in order to avoid over harvesting from which the stocks likely take decades or centuries to recover. The key to set adequate harvesting guidelines are stock surveys prior to exposing an area to harvesting, and ongoing monitoring, yet most stocks have not been studied. Furthermore, control of illegal harvest and poaching is of urgent priority, as it is responsible for a large part of the observed overexploitation. Finally, it is recommendable that a cross-national management umbrella is established to support individual countries in the revision of their management.

**Population genetics, connectivity and management issues of precious red coral in the Mediterranean Sea. (by Costantini F.)**

**Abstract:**

Understanding spatial scales of genetic structuring is essential for the conservation and sustainable management of Mediterranean red coral populations. In this study we review the main results collected in the last decade on population genetics of the species. Several molecular markers (e.g. allozymes, microsatellites, ITS, COI) have been used to investigate patterns of genetic structuring at geographical scales ranging from meters to thousands of kilometers, as well as vertical gradients from 15 to 800 meter depth.

Phylogeographic patterns showed the occurrence of chaotic genetic structuring at Mediterranean scale in *C. rubrum* shallow water populations (15-50 meter depth). Genetic structuring has been found between shallow and deeper water populations (50-150 meter depth). At spatial scales of meters and tens of meters a surprisingly strong genetic divergence among neighboring populations has been found. These data suggest that habitat features together with biological processes favor the structuring of red coral in local "Evolutionarily Significant Units". Level of larval exchange and gene flow among red coral ESU is very limited, therefore, they should be considered equivalent to the "Management Unit", which require individual harvesting and conservation plan.

**A ROV for red coral (*Corallium rubrum*) fishing. (by Nutarelli P.)**

**Abstract:**

The underwater modern technologies allow the prospection of benthic resources at high depth. These technologies could also be useful for fishing purposes. Red coral fishing in Sardinia is allowed at depths over 80 m only to professional fisherman equipped with autonomous breathing apparatus.

In this work a R.O.V explicitly designed for fishing coral with very low impact for the biotopes, compared to the professional divers activities is presented. The R.O.V. is equipped with 4 single-phase asynchronous engines that allow any kind of movement. It has 4 cameras for a complete vision of the fishing grounds and for details. A mechanical arm allows more than 270° of excursion along the vertical plane. It allows the detach of the red coral ramification with high precision movements. These are obtained thanks to 2 idrojet pump that allow micro lateral movements of the arm. The R.O.V. weights 250 Kg and can operate up to 300 m by only a single pilot who can drive the R.O.V. with the aid of a simple console equipped on the surface unit of the system. The small size of the entire system, allows the operation by small and inexpensive boats. The modular construction allows repairs directly on the R.O.V. by the operator himself, on the field, with the of unqualified people. To reach the best performances, respecting the environment, the constructor of the R.O.V. supplies, together the system, a technical and operative training for the pilots.

**The need for binding management measures at regional level in the fishery of Red Coral (*Corallium rubrum*) in the Mediterranean. (by Pani M.)**

**Abstract:**

The paper summarizes the actions taken by GFCM in the 80's and the 90's for the management of the species in the Mediterranean and the more recent attempts to include the species and the entire family Corallidae into CITES.

These attempts to use trade controls under CITES as a supposed conservation tool, failed because the criteria for inclusion were not met, for implementation and enforcement issues and especially because the Parties felt that proper management under the relevant RFMO was far more important for the conservation of these species than trade controls.

The GFCM was specifically mentioned during various interventions at the CITES Conference in Doha (March 2010) as the most appropriate body to start new management actions on the Mediterranean species of precious corals.

The author suggests that the conservation of the Red Coral in the Mediterranean and the livelihoods of thousands of people that depends fully on this species, are now in the hands of fishery managers and the devising and implementation of common management measures in the region and related management plans are now imperative.

The following minimum management measures are suggested:

- Protection of the shallow water populations with the prohibition of harvesting red coral at less than 50mts of depth.
- The introduction of seasonal quotas based on population studies;
- A minimum diameter size of 10 mm with an allowance of 20%;
- A daily and seasonal reporting system for harvesters and a monitoring system devised with a participatory approach;
- Incentives for harvesters that participate and collaborate with scientific researches, through for example the possibility to form associations with direct recognition by local/national authorities;
- An yearly revision of the management measures in order to adapt them to local situations;
- An adequate enforcement system;
- Provisions for continued scientific researches to sustain management;
- A system of Marine protected areas with specific no take zones for red coral in a rotational fashion (es. 20 years closure and then if scientific research will allow harvest, specific yearly quotas strictly enforced).

A call is made on GFCM to start a process to adopt these measures, among others, in a timely manner, for the benefit of the species and the livelihoods of people depending on it.

**On the sustainable exploitation of the red coral resource. (by Cau A.)**

**Abstract:**

In Sardinia 30 years of regulations have permitted to preserve the red coral resource in a "good ecological condition". The management measures were able to effectively regulate the fishing effort. Recent population survey data indicate that in Sardinia the effort **MUST NOT BE INCREASED!** After the ban in 1989 of the non selective (destructive) fishing gears (e.g. St. Andrew Cross and Ingegno), the coral harvesting is allowed

only by diving. In recent times ROVs (Remote Operating Vehicles) have been permitted only for the scouting of potential beds, this “innovation” has led to increase the safety working conditions of divers along with the increase in the yield per dive. Basic ROVs can also be equipped with a robotic arm that permits remote-controlled harvesting.

During the presentation the high risk to legalise a new harvesting methodology (robotic harvesting) without comprehensive knowledge of the fishing effort and the sustainability of the gear is firmly pointed out, and the unavoidability of the precautionary approach before the legalization of new gears (e.g. robotic harvesting through ROV) is strongly affirmed.

In fact, despite the growing pressure for the legalization of the taking of corals by these machines, at present this use does not appear to be feasible for ecological as well as economic and social reasons.

The absolute lack of data on their fishing effort strictly imposes a precautionary approach and hence suggests to do not legalize this fishing technique at least until solid data (gathered through independent experimental scientific tests and not provided by traders or manufactured) unequivocally allow to quantify their performance (in terms of corals taken by unit of time).

This information would be essential to modify the actual (effective) management regulations. In point of fact, considering the peculiarities of this machines (not limited by the physical constraints of divers, and hence capable of diving deeper and longer than humans) the number of ROV licenses, its operational time/day, the season length, the depth limits etc. should be attentively defined before the gear is massively employed to avoid the risk that its unregulated (mis)use will lead to a sudden and unsustainable increase in the amount of coral harvested.

Last but not least, according to the experimental uses in the Pacific, ROV may damage precious corals if not carefully used because currents, nets and the topography of coral habitats make difficult to handle these tethered machines (WPCOUNCIL 2007); consequently long lasting damages to the ecosystems (the coralligenous communities) are also to be considered.

## **GENERAL OVERVIEW**

### **Summary of technical questionnaires (by *Follesa M.C. et al.*).**

23) The workshop was informed on the outcome from Technical questionnaire prepared by the GFCM Secretariat. The questionnaire was sent in advance to all the participants and spread by email to the relevant national experts in order to gather useful information on the fishery, management, conservation, restocking and scientific research on red coral in the different countries. A total of 8 questionnaires were filled and sent back to the GFCM Secretariat by experts from Greece, Italy (Sardinia), Spain (Balears and Cataluña) and Morocco. All the 8 questionnaires in their full extension are shown in Appendix C.

### **Review of existing management measures (by *Cannas R et al.*).**

24) In order to complete the information on the existing management measures enacted in the Mediterranean countries a summary of the main regulations based on the most updated bibliography, national laws and regulations was presented (see Appendix D). Apart from the information on the 4 countries provided by the over-mentioned questionnaires, information on other areas was given (e.g. Algeria, Albania, Croatia, France, Tunisia). The main management measures were presented and compared according to the following scheme: Fishing spatial restriction (Fishing areas, Interdicted areas - temporary closure, Interdicted areas - permanent closure, Depth limits); Fishing temporal restriction (Fishing season, Rotating harvesting system); selective harvesting (harvesting minimum size, Gear limits); Exploitation limits (quotas, licenses, reporting requirements). The participants were asked to check and suggest corrections on the bibliographic data on management measures according to their expertise and knowledge.

25) The workshop was informed on the main activities and initiatives for the conservation of red coral in the Mediterranean Sea realized under the responsibility of **RAC/SPA**.

**Framework for the conservation of red coral in the Mediterranean (RAC/SPA). (by Atef OUERGHI)**

**To be provided by the author**

- 26) Some participants questioned the representative of RAC SPA on the mechanism of establishment of SPAMIS in the high seas as well as on the possibilities for funding research activities. Some clarifications and explanations were provided
- 27) Mr Srour informed on the existing Memorandum of Understanding (MoU) between RAC/SPA and GFCM and on ongoing agreement to collaborate on specific topics among which the red coral..

**GENERAL DISCUSSION ON TECHNICAL ISSUES RELATED TO THE MANAGEMENT AND CONSERVATION**

- 28) The workshop recognized that the questionnaires permitted to update the information on legislation and management, to obtain data on production for specific areas that cannot usually be found in the FAO global production database and to be informed on implementation problems, sanctions, conservation and scientific research undertaken in the different countries (see Appendix C).
- 29) The participants recognized the utility to include data on the main existing management measures (national laws and regulations) as Appendixes (Appendix D) of the present report. It was stressed that they could represent a valid starting point (baseline) and stimulates countries to complete the information relative to their own pertinence.
- 30) The GFCM Secretariat informed the Workshop about a project funded by Italy and aimed at harmonizing the legislations in Mediterranean and Black Sea. It was stressed that information on regulations made available during this meeting will be considered by this project.
- 31) The workshop reaffirmed the urgent need to improve the knowledge on deep populations. It was stressed that little is known apart from data from very limited areas (e.g. Spain and Sardinia in a few published papers, data of surveys on deep populations of Sardinia and from the recent cruise in the Tyrrhenian Sea presented during the present workshop).
- 32) The workshop stressed that, at present, the use of the ROV for harvesting red coral poses many different problems. The meeting was informed about some experiences using the robotic harvesting for corals was allowed. In this case, the fishing effort was controlled by a management scheme that included the exclusive permission granted to 1 company to exploit the coasts all around a given island continuatively for 30 years. The participants pointed out that the same management measures cannot be applied in the Mediterranean where the harvesting is made at a small, local scale, rendering impossible to limit in such a strong way the number of licenses (machines) for social and economical reasons. The workshop expressed concern that ROV (not limited by physical constraints) could reach deeper depth and affect colonies that are today out of reach of divers. The absolute lack of independent data (scientific studies) on the amount of coral and hence the effort exerted by such a gear on the resource lead the participants to suggest the strict application of the precautionary approach. They agreed in saying that detailed studies are mandatory before proposing any legalization of this gear.

- 33) The workgroup recognized the importance of a participatory approach in the management of red coral with a stronger involvement of stakeholders. The meeting pointed out the significance to have not only short- but also medium- and long-term, common Mediterranean management plans.

## **GENERAL CONCLUSIONS AND RECOMMENDATIONS**

- 34) As general conclusions, the workshop agreed on the need to:

### **On Management and conservation measures**

- Set up a minimum size to foster population recovery. It is suggested to investigate on the possibility to consider other biological parameters such as branching pattern and colony height.
- Protect overharvested shallow-water populations.
- Study thoroughly the new technologies before allowing their use for harvesting, considering the potential risk of increasing the harvesting pressure on both the resource and the ecosystem.
- Ensure the biological and economical sustainability of the harvesting
- Consider the extension of the fishing to deeper water requires the need of establishing new deep water reserves.
- Improve data quality at the local level.
- Ensure adequate enforcement of the measures suggested and apply efficient controls

### **On scientific monitoring**

- Set up a cooperative approach at the Mediterranean level.
- Improve the knowledge on the status of red coral populations at the Mediterranean basis, both for shallow and deep populations.
- Carry out extensive studies on population biology and ecology of deep water populations
- Perform genetic studies to measure structuring and connectivity among populations.
- Consider the use of demographic models as useful tool for the management, in particular stressing that for the application at deep populations specific parameters are still lacking and must be acquired through extensive studies.
- Organize training programmes, both for scientists, officers and fishermen, to transfer new technologies and knowledge.
- Carry out regional medium term research programmes according to the proposal presented as Appendix E of this report. The need for funds to perform these programmes was stressed by this workshop.

### **On Collaboration and synergies with other institutions**

- Strengthen collaborations and synergies among different regional organizations and initiatives.
- Invite the FAO regional projects and potential donors to support as a priority the work plan as proposed by the workshop.

- 35) The workshop agreed on the following recommendations:

- To set up a minimum size of 10 mm of basal diameter with 20% tolerance. Stricter measures already in place should be maintained and adaptive approach should be considered in the case that valid scientific evidence demonstrates the need for a higher limit size.
- To prohibit the harvesting of the shallow water populations in the depth less than 50 mt. Stricter measures already in place should be maintained and adaptive approach should be considered.
- As a precautionary approach, to carry out regional pilot studies to assess the potential biological, ecological, economical and environmental impact regarding the use of new technologies to harvest red coral, namely, among others, ROV.

- To establish a daily and/or seasonal quota system based on number of licenses issued to control fishing effort. This quota system shall include a reporting system for harvesters with the standard GFCM Logbook adapted to coral harvesting and an appropriate monitoring system for landings.
- To set up a system of permanent or temporary (in a rotational fashion) no-take zones for red coral.
- To promote a participatory approach of all the stakeholders in the management processes.
- To collect annual data on red coral harvest at the national level and submit them in a timely manner to FAO and to GFCM by Geographical Sub-Areas (GSAs), according to GFCM Task 1 requirements. The applicability of the above statistical matrix to coral harvesting should be checked.
- To cross-check data from different sources (e.g. trade data).

#### **OTHER MATTERS**

- 36) The workshop unanimously thanked the hosting country (Italy) in particular the Autonomous Region of Sardinia for their hospitality and excellent organization.
- 37) The meeting also thanked the rapporteurs for the excellent work.

#### **ADOPTION OF THE REPORT/RECOMMENDATIONS**

- 38) The workshop formally adopted the Conclusions and Recommendations and agreed to adopt the entire Report by e-mail by the 10<sup>th</sup> of October 2010.



**Appendix A****Adopted Agenda**

- 1 Opening, arrangement of the meeting and adoption of the agenda**
- 2 Inventory of the state of red corals in the Mediterranean**
  - 2.1 Information by national experts**
  - 2.2 General discussion**
- 3. Technical issues related to the management and conservation of red coral in the Mediterranean**
  - 3.1 Statistics and information**
  - 3.2 Presentations by national experts**
  - 3.3 General overview**
  - 3.4 Framework for the conservation of red coral in the Mediterranean**
  - 3.5 General discussion**
- 4. General conclusions and Recommendations including on:**
- 5. Other matters**
- 6. Adoption of the Report**

## Appendix B

## List of participants

SCMEE coordinator  
Federico ALVAREZ  
Istituto Español de Oceanografía  
Centro Oceanográfico Baleares  
Muelle Poniente s/n  
07080 Palma, Spain  
Tel.: +34 971404945  
E-Mail: federico.alvarez@ba.ieo.es

Angelo CAU  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758022/+39070380285.  
E-Mail: cau@unica.it

Rita CANNAS  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758004  
E-Mail: rcannas@unica.it

Maria Cristina FOLLESA  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758014  
E-Mail: follesac@unica.it

Andrea ORTU  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758044  
E-Mail: andreaortu@unica.it

Claudia PEDONI  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758085  
E-Mail: pedoni@unica.it

Antonio PENDUGIU  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758065  
E-Mail: pendugiu@unica.it

Cristina PORCU  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758042.  
E-Mail: cporcu@unica.it

Paola PESCI  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758044.  
E-Mail: ppesci@unica.it

Flavio SACCO  
Dipartimento di Biologia Animale ed  
Ecologia  
University of Cagliari  
via T. Fiorelli, 1.  
Tel.: +390706758035.  
flaviosacco@unica.it

Georgios TSOUNIS  
Institut de ciencies del mar CMIMA  
Passeig Marítim de la Barceloneta, 37-49,  
08003 Barcelona, Spain  
Tel.: +34 932 309 555  
E-Mail: georgios@icm.csic.es

Giovanni SANTANGELO  
Dep. Biology (Zoology) University of  
Pisa  
Via Volta 6 I 56126 (Pisa)  
Tel.: +050 2211397  
E-Mail: gsantangelo@biologia.unipi.it

Marco PANI  
Vice-President for Europe  
IWMC-World Conservation Trust  
Piazza dei Mercanti 2  
00153 Rome Italy  
Tel. +39-347-3741260  
Fax. +39 06 97254793  
E: pani.marco@gmail.com

Lorenzo BRAMANTI  
Institut de Ciències del Mar/ Universitat de  
Pisa,  
Dipartimento di Biologia  
Passeig marítim de la Barceloneta 37-49,  
08003, Barcelona.  
Via Volta 6, I-56126, Pisa.  
E-Mail: bramanti@icm.csic.es

Tommaso MAZZA  
Assocoral  
Via Cappuccini, 64 -  
Torre Del Greco (NA)  
Tel.: +39 081-8821427  
E-mail: assocoral@libero.it

Mauro ASCIONE  
Assocoral  
Via Cappuccini, 64 -  
Torre Del Greco (NA)  
Tel.: +39 081-8821427  
E-mail: assocoral@libero.it

Khalid ELALLOUSSI  
Département de la pêche maritime  
BP: 476 Agdal Rabat, Maroc  
Tel: +212 537688235  
Fax.: +212 537 68 83 62  
E-Mail: elalloussi@mpm.gov.ma

Federica COSTANTINI  
University of Bologna – CIRSA  
Via Sant'Alberto, 163  
Tel.: +39 05440937301  
E-Mail: federica.costantini@unibo.it

Riccardo CATTANEO-VIETTI  
DIPTERIS – Università di Genova  
Corso Europa 26, Genova.  
Tel: +39103538102  
E-Mail: catta@unige.it

Pietro NUTARELLI  
Elettronica ENNE-Vado Ligure –  
via Bertola, 31 - 17047 Vado Ligure SV,  
Italy  
Tel: +39 019 880928  
E-Mail: elenne@tiscalinet.it

Lorenzo CHESSA  
Department of Plant Protection -Ecology-  
University of Sassari –  
via De Nicola, 9 Sassari (Italy)  
Tel: +39079229329  
E-Mail: chessa@uniss.it

Roberto DONEDDU  
Regione Autonoma della Sardegna  
via Pessagno 4 Cagliari, Italy  
Tel: +39070 6062516  
Fax: +39 0706062516  
E-Mail: rdoneddu@regione.sardegna.it

Maria Carla SORO  
Regione Autonoma della Sardegna  
via Pessagno 4 Cagliari, Italy  
Tel: +39070 6062988  
E-Mail: csoro@regione.sardegna.it

Marina CAMPOLMI  
Regione Autonoma della Sardegna  
via Pessagno 4 Cagliari, Italy  
Tel: +39070 6062767  
E-Mail: mcampolmi@regione.sardegna.it

Abdelaziz ZOUBAI  
INHR Casablanca  
2, rue de Tiznit  
E-Mail: zoubi@inrh.org.ma

Silvana MANCA  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
fax 39079389450  
E-Mail: smanca@agrisricerca.it

Simone SERRA  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
fax 39079389450  
E-Mail: sserra@agrisricerca.it

Giovanna CHESSA  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
fax 39079389450  
E-Mail: gchessa@agrisricerca.it

Fabrizio CHESSA  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
Fax +39079389450  
E-Mail: fchessa@agrisricerca.it

Nicola FOIS  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
fax 39079389450  
E-Mail: nfois@agrisricerca.it

Marco TRENTADUE  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
Fax +39079389450  
E-Mail: mtrentadue@agrisricerca.it

Rosanna FLORIS  
Agris Sardegna  
Bonassai SS291 km 18.6 07040 Olmedo  
(Sassari)  
Tel: +390792842372  
Fax +39079389450  
E-Mail: rfloris@agrisricerca.it

Ugo Giulio Vincenzo TANCHIS  
Agricoltura Department,  
Sardinian Regional Administration via  
pessagno, 4 Cagliari (Italy)  
E-Mail : ugov@tiscali.it

Fausto TROISI  
Coral Fishermen  
Piazza Civica, 32 Alghero (Italy)  
Tel : +39079930002  
E-Mail: fausto.troisi@tiscali.it

Iolanda VIALE  
Agenzia Regionale Laore Sardegna  
via Caprera, 8- 09123 Cagliari  
Fax: +3907060262408  
E-Mail: violanda@tiscali.it

Marina Rita MONAGHEDDU  
Agenzia Regionale Laore Sardegna  
via Caprera, 8- 09123 Cagliari  
Fax: +3907060262408  
E-Mail: marinamonagheddu@ersat.rupa.it

Kristian TELEKI  
SeaWeb  
32-26 Loman Street, London,  
SE1 0EH, UK  
Tel : +44 207 922 7706  
E-Mail : kteleki@seaweb.org

Luca BEDIN  
Ministero delle Politiche Agricole,  
Alimentari e Forestali  
Direzione Generale della Pesca Marittima  
e dell' Acquacoltura  
Viale dell' Arte 16, 00144 Roma  
Tel.:06 59084176  
E-Mail: l.bedin@politicheagricole.it

Antonio MACCARONI  
Direzione Generale della Pesca Marittima  
e dell' Acquacoltura  
Viale dell' Arte 16, 00144 Roma  
Tel.:06 59084176  
E-Mail: a.maccaroni@politicheagricole.it

Ezio BUSSOLETTI  
Università Parthenope  
Centro direzionale Isola C4  
80143 Napoli, Italy  
Tel: +39 081 5476514  
E-Mail: Ezio.bussoletti@asi.it

Vincenza MASTASCUSA  
Università Parthenope  
Dipartimento di scienze per l'ambiente  
Centro direzionale Isola C4  
80143 Napoli, Italy  
Fax: +39 081 5476527  
E-Mail: vincenzamastascusa@gmail.com

Roberto SANDULLI  
DISAM  
Università Parthenope  
Centro direzionale Isola C4  
80143 Napoli, Italy  
Tel: +39 081 5476527  
E-Mail:  
Roberto.sandulli@uniparthenope.it

Laura MURA  
AGRIS-Dipartimento per la Ricerca nelle  
Produzioni Animali  
Bonassai, 07040 Olmedo  
Tel:+390792842342  
E-Mail: lmura@agrisricerca.it

Antonio IANNIZZOTTO  
Ministry of Environment, Land and Sea  
Protection  
Nature Protection Directorate  
CITES Management Authority of Italy  
via, Capitan Bavastro – 00144 Rome  
Tel:+39 06 5722 8325  
E-  
Mail:iannizzotto.antonio@minambiente.it

Cristina PRIORI  
Università di Pisa  
Via A.Volta 6, Pisa, Italy  
Tel: +39 050 2211393  
E-Mail: cpriori24@yahoo.it

Maria SALOMIDI  
Institute of Oceanography Athens  
46.7km Athens Sounio Road,  
Anavissos 19013  
Tel: +30 2291076347  
E-Mail: msal@ath.hcmr.gr

Luisa VITALE  
Department of Plant Protection- Ecology  
– Sassari University (Italy).  
Viale Adua 4-07100 Sassari  
E-Mail: Luisavitale@tiscali.it

Atef OUERGHI  
UNEP/MAP-RAC/SPA  
E-Mail: atef.ouerghi@rac-spa.org

Luca GARIBALDI  
Food and Agriculture Organization (FAO)  
Fisheries and Aquaculture Department  
Viale delle Terme di Caracalla  
00153 Rome Italy  
Tel: + 39 06 57053867  
E-mail: [luca.garibaldi@fao.org](mailto:luca.garibaldi@fao.org)

Juan QUINTANA CASUS  
Elettronica Enne  
C/Palamos, 1118  
17200 Palagruel, GIRONA  
Tel: +34 972 304092  
E-Mail: juanqe@yahoo.es

Silva NUTARELLI  
Elettronica Enne  
via Bertola 31  
17047 Vado Ligure SV  
E-Mail: elenne@tiscalinet.it

Francesco MURA  
collaboratore  
Dipartimento Protezione delle Piante  
Università di Sassari  
E-Mail: ciscowave@tiscali.it

Mario CONOCI  
Vicesindaco  
Comune di Alghero  
Via Santa Anna  
Alghero  
Tel: +39 079 9978801  
E-Mail: m.conoci@comune.alghero.ss.it

Plinio CONTE  
Ministero delle Politiche agricole  
alimentari e forestali – D.G. della pesca  
via dell'Arte 16 00144 ROMA  
Fax: +3906 59084818  
Tel. +3906 59083442  
E-mail: p.conte@politicheagricole.gov.it

Mauro BERTELLETTI  
Ministero delle Politiche agricole  
alimentari e forestali – D.G. della pesca  
marittima e dell'acquacoltura  
via dell'Arte 16 00144 ROMA  
Tel. +3906 59084050  
Fax: +3906 59084176  
E-mail:  
[m.bertelletti@politicheagricole.gov.it](mailto:m.bertelletti@politicheagricole.gov.it)

Alessandro CAU  
Dipartimento di Biologia Animale ed  
Ecologia  
Via T Fiorelli 1  
E-Mail: kitedrodo@yahoo.it

Ciro LUNGO  
Corpo Forestale Stato  
via Carducci 5/E, Roma  
Tel: +39 0648905507  
E-Mail: c.lungo@corpoforestale.it

Emma Victoria BROOKS WILLIAMS  
Elettronica ENNE  
via Bertola,31  
17047 Vado Ligure(SV)  
E-Mail: elenne@tiscalinet.it

Rodolfo PARODI  
Elettronica ENNE  
via Bertola,31  
17047 Vado Ligure(SV)  
E-Mail: elenne@tiscalinet.it

Massimo SCARPATI  
Coral Fishermen  
Loc. Capo Falcone - Stintino  
Fax: +39 079/527113

Carlo Salvatore CARIA  
Coral Fishermen  
Via Nulauro Snc - Alghero  
Fax: +39 079/930002  
Massimo CILIBERTO  
Coral Fishermen  
Via XXI Aprile n. 3 - Stintino  
Fax: +39 178.2233996  
E-mail: maxcili@tiscali.it

Ernesto PAGLICI  
Coral Fishermen  
Via Ariosto n. 1 - Bosa  
Fax: +39 0785/372191  
E-mail: ernesto.paglisci@libero.it

Valentina ALTOMONTE  
Tel : +3934681107272

Mario VOLPE  
Elettronico  
Tel: +393289122010

Daniela STACCA  
Università  
v.le Italia 41  
E-Mail: danyes86@hotmail.com

Settimio CARDONE  
Coral Fishermen  
Res. Punta Moro 1022  
07041 Alghero (SS)  
E-Mail: nautisub@nautisub.com

Agostino CERCHI  
Coral Fishermen  
Via Tavlera 39  
Alghero  
Tel: 338636331

Yiannis Issarsi  
Institute of Marine Biological Resources  
HCMR  
Agios Kosmas, Greece  
E-Mail: issaris@ath.hcmr.gr

Marco BUSDRAGHAI  
Dusdraghi Progetti  
via aggius,14 Alghero  
Tel: +39079984111  
E-Mail: marcobusdraghi@gmail.com

Abdellah SROUR  
General Fisheries Commission for the  
Mediterranean  
Executive Secretary ad interim  
Fisheries and Aquaculture Department  
Viale delle Terme di Caracalla,1  
00153 Rome Italy  
Tel: + 39 06 57055730  
Fax: + 39 06 57056500  
E-mail: abdellah.sroure@fao.org

## Appendix C

**Synthesis of Technical Questionnaires**

In order to gather useful information on red coral the GFCM Secretariat prepared and spread a technical questionnaire among national experts (see below)

## Technical Questionnaire

1) Please describe Red Coral Fishery in your Country:

- Type of gear/technology used:
- Number of Licences
- Production
  - by day .....
  - by month .....
  - by year
- Geographical distribution:

2) Are there any regulations?

- At national level
- At local level
- Type of regulation (if by MPAs please indicate the coordinate)
- Date of entry in force of the regulation
- Commercial size limit
- Sanctions
- Problems of implementation

3) Are there any conservation or restocking Plans?

4) What is the scientific research undertaken?

A total of 8 questionnaires (**TeQ**) were filled and sent back to the Secretariat, allowing to gather relevant information from 4 countries: Greece (1 questionnaire); Italy – Sardinia (2 questionnaires); Morocco (2 questionnaires); Spain (3 questionnaires: 1 Balears, 2 Cataluña).

| Country          | Filled by  | questionnaire |
|------------------|--|---------------|
| Greece           | Salomidi Maria - Institute of Oceanography – Athens  | TeQ1_Gr       |
| Italy – Sardinia | Servizio Pesca - Regione Autonoma della Sardegna, Cagliari   | TeQ2_Sar      |
| Italy – Sardinia | Chessa Lorenzo - University of Sassari   | TeQ3_Sar      |
| Morocco          | Elalloussi Khalid - Département de la pêche maritime, Rabat  | TeQ4_Mor      |
| Morocco          | Zoubai Abdelaziz – INRH, Casablanca  | TeQ5_Mor      |
| Spain – Balears  | Aguilar Gonzales – Directorate for Fisheries, Balearic Regional Government                                     | TeQ6_SpaB     |
| Spain – Cataluña | Jordi Rodon Peris, Cap de la Secció d'Ordenacio Pesquera, Departament d'Agricultura, Alimentació i Acció Rural | TeQ7_SpaC     |
| Spain – Cataluña | Dr. Georgios Tsounis Institut de Ciències del Mar, CMIMA (CSIC), Barcelona                                     | TeQ8_SpaC     |

The answers provided by the experts in the questionnaires are listed in the following pages and are arranged in tables to make an easier comparison among the different management schemes:

## A1. Red coral fishery description

### A1.1. Type/technology

| questionnaire |   |
|---------------|---|
| TeQ1_Gr       | non-destructive collection by licensed commercial divers  |
| TeQ2_Sar      | professional scuba-dive fishermen with pick   |
| TeQ3_Sar      | Only licensed professional divers are allowed. They dive with gas mixture and use a pick to take the coral ramifications. |
| TeQ4_Mor      | The red coral is harvested only by SCUBA diving and by pick (sharp marteline )  |
| TeQ5_Mor      | By diving   |
| TeQ6_SpaB     | Just scuba diving with pickaxe  |
| TeQ7_SpaC     | All type of gears is forbidden for coral extraction. Is only Authorized a little hammer used with hand.                   |
| TeQ8_SpaC     | Scuba Diving  |



## A1.2. Number of licenses

| questionnaire |  |
|---------------|--|
| TeQ1_Gr       | (maximum) 10 boats annually  |
| TeQ2_Sar      | (maximum) 30 licence/year (in 2010:22 licences issued)                                   |
| TeQ3_Sar      | (maximum) 30 licence/year (in 2010:22 licences issued)                                   |
| TeQ4_Mor      | 10 for 10 boat fishing   |
| TeQ5_Mor      | 10   |
| TeQ6_SpaB     | 4 in Mallorca and 2 in Minorca   |
| TeQ7_SpaC     | 10 licenses issued by the local government and 10 licenses issued by Spanish government. |
| TeQ8_SpaC     | 16   |

## A1.3. Production

| questionnaire |  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
|---------------|--|---------------------------|------------------------------|--------------|-------------|-------------|--------|-------|----|----|------|----------|--------------------------------|---------------------------|------------------------------|-----|---------|--------------|---------------|--------------|--------------|
| TeQ1_Gr       | per year: ranging from 0-6952 kg (min production Cretan Sea 1998-2000, max production North Aegean Sea 1998-2000)  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ2_Sar      | 1.5 Kg/day/fisherman (2009), 1830 Kg/year (2009) (logbook data)  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ3_Sar      | 35.2 Kg/day/all licences, 2100 Kg by year/all licences, (estimation based on scientific survey)  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ4_Mor      | Variable according the boat, at a depth and the level of exploitation of the fishing area ): 3 different date of production (kg)<br><table border="1"> <thead> <tr> <th>Year/area</th> <th>1996 Asilah</th> <th>2002 Topo</th> <th>2002 Tofino</th> <th>2009 Asilah</th> </tr> </thead> <tbody> <tr> <td>By day</td> <td>1- 10</td> <td>26</td> <td>26</td> <td>1-20</td> </tr> <tr> <td>by month</td> <td>58 (November),<br/>280 (August)</td> <td>69 (march)<br/>3800(April)</td> <td>236 (June)<br/>1368 (October)</td> <td>400</td> </tr> <tr> <td>By year</td> <td><b>2 800</b></td> <td><b>16 455</b></td> <td><b>5 570</b></td> <td><b>2 136</b></td> </tr> </tbody> </table> | Year/area                 | 1996 Asilah                  | 2002 Topo    | 2002 Tofino | 2009 Asilah | By day | 1- 10 | 26 | 26 | 1-20 | by month | 58 (November),<br>280 (August) | 69 (march)<br>3800(April) | 236 (June)<br>1368 (October) | 400 | By year | <b>2 800</b> | <b>16 455</b> | <b>5 570</b> | <b>2 136</b> |
| Year/area     | 1996 Asilah  | 2002 Topo                 | 2002 Tofino                  | 2009 Asilah  |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| By day        | 1- 10  | 26                        | 26                           | 1-20         |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| by month      | 58 (November),<br>280 (August)   | 69 (march)<br>3800(April) | 236 (June)<br>1368 (October) | 400          |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| By year       | <b>2 800</b>   | <b>16 455</b>             | <b>5 570</b>                 | <b>2 136</b> |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ5_Mor      | by day 45 -50 kg/10 vessels; by month 0.5 ton/6 months, by year 3 tons   |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ6_SpaB     | 2007: 394 Kg; 2008: 534 Kg; 2009: 295 Kg (incomplete)  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ7_SpaC     | The extraction season is from May to November (six month). The extraction in Catalonia local waters was:<br>Year 2005: 1015 kg; Year 2006: 1230 kg; Year 2007: 1465 kg; Year 2008: 1004 kg; Year 2009: 565 kg (*)<br>We don't have any information about the extraction in Catalonia national waters.<br>(*) In 2009 some coral fishermen went to Morocco and they didn't work in Catalonia.   |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |
| TeQ8_SpaC     | by year ca. 6-8 metric tons  |                           |                              |              |             |             |        |       |    |    |      |          |                                |                           |                              |     |         |              |               |              |              |

#### A1.4. Geographical distribution

| questionnaire    |  |
|------------------|--|
| <b>TeQ1_Gr</b>   | information only available at very large scale. So far reported: North Aegean Sea, Ionian Sea, Cretan Sea  |
| <b>TeQ2_Sar</b>  | Harvesting is allowed (only >-80 m) all along Sardinian coastal waters apart from: Marine Protected Areas: Penisola del Sinis-Isola di Mal di Ventre, Capo Caccia-Isola Piana, Isola dell'Asinara, Tavolara - Punta Coda Cavallo, Capo Carbonara-Villasimius) Parks (Arcipelago della Maddalena e Porto Conte)<br>No-take zones: the area between Capo Testa (41°14'614 – 9° 08' 647) and Capo Coda Cavallo (40° 50' 634 - 9° 43' 701) ; the area between Capo Comino (40°31'700 - 9°49'700) and Capo Bellavista (39°55'800 – 9°42'800).<br>The Area for experimental study close to Capo Caccia (40°35'30- 8°06'05; 40°35'30- 8°07'45; 40°34'30-8°06'05; 40° 34'30- 8°07'45)  |
| <b>TeQ3_Sar</b>  | NW – SW – NE- East Central Sardinian coast: 80 – 140m depth  |
| <b>TeQ4_Mor</b>  | A review of available data concerning the spatial and vertical distribution of <i>C. rubrum</i> in the Moroccan seas water was conducted by retrieving information from publications in scientific journals, (e.g. Perspective d'exploitation du corail rouge sur la cote Méditerranéenne du Royaume du Maroc Note d'information n° 2 ISPM-1982) and moreover, the result of research activities of the Moroccan Centre for Marine Research (INRH) during the period of 2006 and 2007 in Mediterranean sea.<br>Red coral is distributed in several areas on the Moroccan Seas water<br>- In Atlantic: between Larch and Cap Spartel (Asilah)<br>- In the Detroit: Off the sea of Ben Younech (Benzo):<br>- In Mediterranean Sea: several areas: <ul style="list-style-type: none"> <li>• Banc du Xauen</li> <li>• Tops</li> <li>• Banc de Tofino</li> <li>• Sid Hssain ( Betoya)</li> <li>• Cap des trois Fourche</li> <li>• Au large de Cap de l'eau (Banc Guiard, Banc Campillo et île d'alboran)</li> </ul> The official fisheries data of the red coral in Morocco show that this resource existed only in three areas from 40 to more than 120 m. The shallow water populations (40 to 60 m) decrease, which seems to be closely related to the fishing effort:<br>In Atlantic : between Larch et Cap Spartel (Now opened to the fishing)<br>In Mediterranean Sea: Topo (closed to the fishing), Tofino (closed to the fishing for 10 year) |
| <b>TeQ5_Mor</b>  | Region of ALHOCEIMA  |
| <b>TeQ6_SpaB</b> | Two areas of inland waters are defined in Decret 40/2003. N of Mallorca and N of Menorca. Out of these areas, extraction is prohibited.  |
| <b>TeQ7_SpaC</b> | Only in Cap de Creus zone. North of Catalonia. Between Rosas and the French border   |
| <b>TeQ8_SpaC</b> | Ubiquitous in the Mediterranean, but the main commercial stocks of Spain are: Costa Brava, Alboran, Mallorca   |

## A2. Red coral fishery regulations

### A2.1. At national level

| questionnaire    |  |
|------------------|--|
| <b>TeQ1_Gr</b>   | A rotational harvest system is applied in five distinct (very large) geographical regions (each of them open for a maximum period of 5 yrs and then closed for 20 yrs)   |
| <b>TeQ2_Sar</b>  | NATIONAL LAW 963/1965, ART. 16 (D.P.R. 1639/1968, ARTT. 123 -124)  |
| <b>TeQ3_Sar</b>  | Italian Law n.963/1965, ART. 16 (D.P.R. 1639/1968,ARTT.123-124)  |
| <b>TeQ4_Mor</b>  | <p>Decree n° 2-04-26 of 6 hija on 1425 (in January 17th, 2005) fixing the conditions and the modalities of fishing of the coral.</p> <p>This decree determines the general conditions of fishing of coral considering the necessity of a rational exploitation of this resource by fixing the effort of fishing, the limitation of the number of boat, Annual harvest amounts of each boat and the periods of fishing by zone. Also, it stipulates that the access to the fishing is limited to the only ship-owners who can prove a possibility of total treatment in Morocco of the coral fished, or directly, in a unit of processing owners or developers, or because of a contract of delivery with a owner or of which they are developer of such a unit.</p> <p>The first text of application of this decree allowed the opening of the fishing of coral at the level of Al Hoceima in 2007 for 3 years, according to arrête (the order) of Minister for Agriculture, rural development and sea fishing n° 2655-06 of 21 choul on 1427 (in November 13th, 2006) regulating the fishing of red coral in the maritime said zone "Tofino" situated off Al hoceima .</p> <p>By the way, it is to indicate that with the aim of protecting the coral at the level of Topo into the National park of Al Hoceima (marine protection area) the department of marine fisheries closed his fishing for 10 years by the order n° 1954-05 of 06 Ramadan 1426 (in October 10th, 2005).</p> <p>In 2010, a new order is promulgated to organize the fishing of coral between Larche and Cap Spartel, it is about the order of Minister for Agriculture and Marine Fisheries n° 1566-10 of 29 jomada I on 1431 (in May 14th, 2010) regulating the fishing of red coral in between the Cap Sparte And Larche</p> |
| <b>TeQ5_Mor</b>  | yes  |
| <b>TeQ6_SpaB</b> | Real Decret 1415/2005  |
| <b>TeQ7_SpaC</b> | Real Decreto 1415/2005, de 25 de noviembre, por el que se regula la pesca del coral rojo y su primera venta (BOE núm. 293 de 8.12.2005); Orden APA/1592/2006, de 18 de mayo, por la que se regula el procedimiento de autorización para el ejercicio de la actividad de la pesca del coral rojo. (BOE núm. 125 de 26.05.2006)  |
| <b>TeQ8_SpaC</b> | Areas outside of specifically defined shore areas (not by fixed distance to shoreline, see below) are regulated nationally.  |

## A2.2. At local level

| questionnaire    |   |
|------------------|---|
| <b>TeQ1_Gr</b>   | None  |
| <b>TeQ2_Sar</b>  | Regional Law . 5th July 1979 n. 59 – Fishing allowed with: St. Andrew cross – “Ingegno” –“Divers with picozza”.<br>REGIONAL LAW n. 23 – 30th May 1989<br>REGIONAL COMMITTEE DECISION N. 3/33 DEL 26.1.2010<br>DECREE N. 0000861/DecA/31 del 25 marzo 2010<br>Starting from 1989 only divers allowed   |
| <b>TeQ3_Sar</b>  | Regional Law . 5th July 1979 n. 59 – Fishing allowed with: St. Andrew cross – “Ingegno” –“Divers with picozza”. Starting from 1989 only divers allowed  |
| <b>TeQ4_Mor</b>  | Do not exist  |
| <b>TeQ5_Mor</b>  | yes   |
| <b>TeQ6_SpaB</b> | Decret 40/2003. Balearic Government grants the permissions. Yearly, a season and number of licenses is defined.   |
| <b>TeQ7_SpaC</b> | Decret 389/2004, de 21 de setembre, per el qual se regula la pesca del coral rojo (Corallium rubrum) en les aigües interiors del litoral catalan. (DOGC núm. 4234 de 07.10.2004); Orden AAR/167/2010, de 19 de març, per la qual se estableixen mesures complementàries de regulació de l'extracció de coral rojo en les aigües interiors del litoral catalan |
| <b>TeQ8_SpaC</b> | So called “Interior waters”, designated area within transects connecting coastal capes, are subject of regulation through the local autonomous governments.   |

### A2.3. Type of regulation (if by MPAs please indicate the coordinate)

| questionnaire |  |
|---------------|--|
| TeQ1_Gr       | Only selective methods allowed (collection by divers)<br>Collection permanently restricted within the two Hellenic National Marine Parks of Zakynthos and Northern Sporades (see picture below)<br>–<br>Center coordinates for given polygons:<br>- 37° 41' 45.75''N 20° 54' 41.38''E (National Marine Park of Zakynthos)<br>- 37°15'43.98N 24°08'13.32''E (National Marine Park of Northern Sporades) |
| TeQ2_Sar      | Law and annual Regional Committee Decision, annual Decree  |
| TeQ3_Sar      | Law and annual Regional Committee Decision, annual Decree  |
| TeQ4_Mor      | See above  |
| TeQ5_Mor      | region of Topos  |
| TeQ6_SpaB     | Decret 40/2003 in all inland waters.   |
| TeQ7_SpaC     |  |
| TeQ8_SpaC     | Minimum size, Annual Quotas, Closed winter season, Gear. Fishing is allowed in the Cap de Creus national Reserve. Other MPA's such as the Medas Island MPA protect red coral, but only since the early 1990s, so the populations are rather young (given the 100 year life span of the species). Poachers are active evenin MPAs.<br>Medas Islands: 43°2'30''N, 13'30''E                               |

### A2.4. Date of entry in force of the regulation

| questionnaire |  |
|---------------|--|
| TeQ1_Gr       | 1994   |
| TeQ2_Sar      | 5th July 1979  |
| TeQ3_Sar      | 5th July 1979  |
| TeQ4_Mor      | 2005   |
| TeQ5_Mor      | In 1992 the Ministry of fisheries issued a text project of regulation taking into accounts the different views of all parties (Ministry, INRH and professionals) |
| TeQ6_SpaB     | 2003   |
| TeQ7_SpaC     | Year of first local regulation: 1983   |
| TeQ8_SpaC     | 07.07.1983 Document 291/1987   |

### A2.5. Commercial size limit

| questionnaire |  |
|---------------|--|
| TeQ1_Gr       | none   |
| TeQ2_Sar      | 10 mm basal diameter (20% tolerance)<br>Further restrictions: maximum red coral amount per day per fisherman 2.5 Kg, Limited harvesting time (1st May- 15th Oct), Number of No taking zone 2, Depth limit 80 m |
| TeQ3_Sar      | 10 mm basal diameter (20% tolerance)<br>Maximum red coral amount per day per fisherman 2.5 Kg  |
| TeQ4_Mor      | Do not exist (in project 7 mm basal diameter.)   |
| TeQ5_Mor      | Under study  |
| TeQ6_SpaB     | 7 mm of diameter at the base   |

|                  |   |
|------------------|---|
| <b>TeQ7_SpaC</b> | Minimum commercial size: 7 mm of diameter |
| <b>TeQ8_SpaC</b> | 7mm base diameter                         |

#### A2.6. Sanctions

| questionnaire    |  |
|------------------|--|
| <b>TeQ1_Gr</b>   | none   |
| <b>TeQ2_Sar</b>  | Harvesting without license or in banned area: sanctions from 2500 to 25000 Euros and seizure of boat, equipment and harvest; |
| <b>TeQ3_Sar</b>  | Boat confiscation; monetary penalties, confiscation of coral   |
| <b>TeQ4_Mor</b>  | Identical that existed for the sea fishing   |
| <b>TeQ5_Mor</b>  | lack of license, lack of security facilities, operation by night, lack of production declaration                             |
| <b>TeQ6_SpaB</b> | Not recently. Sanctions in Spanish waters imply to be excluded for two years.  |
| <b>TeQ7_SpaC</b> | Sanctions are usually for not authorized coral fishermen   |
| <b>TeQ8_SpaC</b> | Fines (which have proven inefficient in discouraging illegal harvest)  |

#### A2.7. Problems of implementation

| questionnaire    |  |
|------------------|--|
| <b>TeQ1_Gr</b>   | Poaching, lack of control to ensure legislation enforcement, lack of verification of declared landings, lack of population assessment studies.   |
| <b>TeQ2_Sar</b>  | Implementation of control system and harvesting data collection system and availability of financial resources   |
| <b>TeQ3_Sar</b>  | A better implementation of fishing activities could be reached, after research results, with the introduction of ROV fishing (no risk for operators; improve of sampling methods)  |
| <b>TeQ4_Mor</b>  | The ship-owners must to wait for the scientific data to be able to open an area to the fishing.<br>The ship-owners don't respect the condition to give their coral to national units of processing of coral;<br>The statistics supplied by the fishermen are not reliable. |
| <b>TeQ5_Mor</b>  | no, since there only a single port of entry of the vessels exploiting red coral  |
| <b>TeQ6_SpaB</b> | Lack of regular reports by catchers.   |
| <b>TeQ7_SpaC</b> | There are many problems with the control and inspection of coral fisheries, especially with illegal fishing.<br>For the year 2011 is provided to frame the coral fishing in an specific management plan.   |
| <b>TeQ8_SpaC</b> | Minimum size demonstrated to no be adequate; Fishing intensity higher than quota; Quota too high; Insufficient control on sea; Poaching; Fines not sufficient to discourage poachers   |

**A3. Red coral conservation / restocking**

| questionnaire    |   |
|------------------|---|
| <b>TeQ1_Gr</b>   | none  |
| <b>TeQ2_Sar</b>  | A restocking program has been funded, under the scientific responsibility of the Department of Animal Biology and Ecology of Cagliari University and with the commitment of professional scuba-dive fishermen.  |
| <b>TeQ3_Sar</b>  | Only proposed projects  |
| <b>TeQ4_Mor</b>  | The rotation harvest schemes: currently, only two areas (Asilah and Al hoceima) are concerned The rotation will allow the reconstitution of the banks of coral affected. The area will be closed to fishing as the yield of fishing decrease. The harvesting period in each zone can vary depending on the density of coral populations.<br>Limit harvesting in deep water: Authorize the fishing between 40-80 m |
| <b>TeQ5_Mor</b>  | Rotation system   |
| <b>TeQ6_SpaB</b> | Not specifically for <i>C. rubrum</i> . Two protected areas have been established (NE of Mallorca and NW of Menorca) where coral extraction is forbidden.   |
| <b>TeQ7_SpaC</b> | There is currently no management plan. But the set of regulations for Agriculture and environment act as a real management plan to ban fishing in certain areas and allowing regeneration of coral colonies.  |
| <b>TeQ8_SpaC</b> | No, but we are conducting pilot studies at this moment  |

#### A4. Red coral scientific research

| questionnaire    |  |
|------------------|--|
| <b>TeQ1_Gr</b>   | <p>Only scant species presence information. No data available on population structure and dynamics, no adequate spatial information (biotope mapping) for management purposes.</p> <p><b>List of existing literature</b></p> <ul style="list-style-type: none"> <li>• Chintiroglou, C., Dounas, C., Koukouras, A. 1989. The presence of <i>Corallium rubrum</i> (Linnaeus, 1758) in the eastern Mediterranean Sea. <i>Mitt. Zool. Mus. Berl.</i> 65 (1): 145-149.</li> <li>• Dounas, C., Eleftheriou, A., Koukouras, A. 1989. The presence of <i>Corallium rubrum</i> (Linnaeus, 1758) in Greek waters. A historical review. GFCM technical consultation on red coral of the Mediterranean, Torre Del Greco, 27-30 September 1988. FAO Fisheries Report No 413.</li> <li>• Salomidi, M., Smith, C., Katsanevakis, S., Panayotidis, P., Papathanassiou, V. 2009. Some observations on the structure and distribution of gorgonian assemblages in the eastern Mediterranean Sea. <i>Proceedings of the 1st Symposium on the Coralligenous and other Calcareous Bio-Concretions of the Mediterranean Sea</i>, Tabarka, 15-16 January 2009, 242-244.</li> <li>• Vafidis, D., Koukouras, A., Voultziadou-Koukoura, E. 1994. Octocoral fauna of the Aegean Sea with a check list of the Mediterranean species: New Information, Faunal Comparisons. <i>Annal. Inst. Océanogr. Paris</i> 70(2): 217-229.</li> </ul> |
| <b>TeQ2_Sar</b>  | <p>Two monitoring programs have been undertaken in 2007 and 2008.</p> <p>A research program on distribution, population structure and genetics of red coral funded in 2010.</p>  |
| <b>TeQ3_Sar</b>  | <p>Machine learning methods to support the diver's decision about which colonies can be harvested. The same approach is in phase of implementation for ROV fishing.</p>  |
| <b>TeQ4_Mor</b>  | <p>With the decree of 2005, the national Institute of halieutic Search (INRH) has to make prospecting before the opening of the fishing of coral, the last operation of prospecting is realized between July 2008 and June 2009 this operation gives detailed mapping and a regular monitoring scheme along with measures for the fishing and the protection of the red coral in the area Larache Cap Spatel.</p>  |
| <b>TeQ5_Mor</b>  | <p>Surveys in partnership with professionals</p>   |
| <b>TeQ6_SpaB</b> | <p>There isn't any specific research program on this species.</p>  |
| <b>TeQ7_SpaC</b> | <p>The local government has commissioned several scientific studies on the status of coral populations in the Catalan coast. Studies have been carried out by Professor Josep Maria Gili and Dr. Sergio Rossi.</p>   |
| <b>TeQ8_SpaC</b> | <p>No current projects are financed. Proposals to study deeper stocks have been unsuccessful.</p>  |



**Appendix D****Background document****Management measures – *Corallium rubrum***

Cannas R., Follesa M.C., Pesci P., Cau A. - Department of Animal Biology and Ecology, University of Cagliari - Via T. Fiorelli, 1 – Cagliari (Italy)

The task of managing red coral is not easy also because for such a valuable resource, a strong **conflict exists between sustainable management and short-term economical interest**. However, efforts should be taken in order to regulate and manage the species on the base of complete, correct and sound scientific data. In fact, **errors in ecosystem management could take especially long to rectify** and may have permanent consequences, considering the longevity and slow growth rate of this animal.

Red coral is a benthic species that represent an exclusive resource of each country (not partaken as it is for migrant species). For this reason, best results could be obtained with **local management measures** that consider peculiar and local specific status of the resource in order to take over a responsible and sustainable management of this precious resource.

The present document does not pretend to be an exhaustive compilation of all data (laws and regulations), but it should be regarded as a starting point. The aim of this work is to gather the available information and to stimulate the countries to complete and/or amend them. For all countries, mainly for those with incomplete and lacking data because of the difficulties in accessing to the national laws and regulations, the invitation is to provide (and regularly update) to the GFCM Secretariat and/or to the FAOlex database their national laws and regulations as soon as they are enacted.

**Laws and regulations**

Data on GFCM countries where red coral is known to occur, where coral fishery and specific laws and regulations concerning red coral harvesting have been enacted, are given in the following table 1 and table 2.

**Table 1 Data on *Corallium rubrum*: geographical distribution (occurrence), fishery (actual or past).**

|                                 | occurrence     | fishery                  | notes   |
|---------------------------------|----------------|--------------------------|---|
| <b>GFCM member countries</b>    |                |                          |   |
| Albania                         | Y              | regulated? <sup>1</sup>  | <sup>1</sup> See table 3                              |
| Algeria                         | Y              | interdicted <sup>2</sup> | <sup>2</sup> See table 3                              |
| Croatia                         | Y              | Yes                      |   |
| Cyprus                          | Y              | no data                  |   |
| Egypt                           | H <sup>3</sup> | no data                  | <sup>3</sup> Russell, 1846                            |
| France                          | Y              | Yes                      |   |
| Greece                          | Y              | Yes                      |   |
| Israel                          | ?              | no data                  |   |
| Italy                           | Y              | Yes                      |   |
| Lebanon                         | ?              | no data                  |   |
| Libya                           | ?              | no data                  |   |
| Malta                           | Y              | P                        |   |
| Monaco                          | Y              | interdicted <sup>4</sup> | <sup>4</sup> Anonymous, 2009, CITES CoP15 Proposal 21 |
| Montenegro                      | Y              | Yes                      |   |
| Morocco                         | Y              | Yes                      |   |
| Slovenia                        | ?              | no data                  |   |
| Spain                           | Y              | Yes                      |   |
| Syria                           | ?              | no data                  |   |
| Tunisia                         | Y              | Yes                      |   |
| Turkey                          | Y <sup>5</sup> | no data                  | <sup>5</sup> Anonymous, 2009, CITES CoP15 Proposal 21 |
| <b>no GFCM member countries</b> |                |                          |   |
| Cabo Verde                      | Y              | P                        |   |
| Gibraltar (UK)                  | Y              | P                        |   |
| Mauritania                      | Y              | no data                  |   |
| Portugal                        | Y              | P                        |   |
| Senegal                         | Y              | no data                  |   |

Y= data from GFCM, 1984;GFCM, 1989 and references therein; H = historical data only; ?=dubious/to be confirmed; P= in the past data from GFCM, 1984;GFCM, 1989

Table 2 National Laws and regulations concerning *Corallium rubrum*

|                              | fishery                          | Laws and regulations  |
|------------------------------|----------------------------------|---|
| <b>GFCM member countries</b> |                                  |   |
| <b>Albania</b>               | <b>Interdicted? regulated? *</b> | * Article 22 of Law No. 7908 of 1995 states that 'the taking of corals and sponges is prohibited at any time throughout Albanian waters, except for scientific research purposes' Is this statement not specifically referred to <i>C. rubrum</i> ? |
| <b>Algeria</b>               | <b>Interdicted**</b>             | Décret exécutif n° 95-323 1995 (past regulation)<br>**Décret exécutif N° 01-56 2001 (actual regulation)   |
| <b>Croatia</b>               | <b>Yes</b>                       | <i>Official Gazette</i> 155/05, 6/06, 46/06, 93/06, 66/07, 121/08, 146/08)  |
| <b>France</b>                | <b>Yes</b>                       | arrêté du 1er décembre 1960 (pêche sous-marine)<br>Decree No. 90-95 of 25.01.1990   |
| <b>France Corsica</b>        | <b>Yes</b>                       | Arrêté No. 67 / 2002/DRAM, JORF n°162 2006,<br>Arrêté N° 06-0358 2006, 06-0359 2006   |
| <b>France PACA***</b>        | <b>Yes</b>                       | Decree No. 90-95 of 25.01.1990  |
| <b>Greece</b>                | <b>Yes</b>                       | National Law 1740/1987, Presidential Decree 174/1994; Ministry Decision 240102/1995   |
| <b>Italy</b>                 | <b>Yes</b>                       | LN n. 963/1965, DPR, n. 1639/1968   |
| <b>Italy Sardinia</b>        | <b>Yes</b>                       | LR n. 59/1979, LR 23/1989, Decree N. 0000861/DecA/31/2010   |
| <b>Monaco</b>                | <b>interdicted<sup>o</sup></b>   | <sup>o</sup> Anonymous, 2009, Cites CoP15 Proposal 21   |
| <b>Montenegro</b>            | <b>Yes<sup>oo</sup></b>          | <sup>oo</sup> no data on regulations but yield data on FAO database   |
| <b>Morocco</b>               | <b>Yes</b>                       | décret n° 2-04-26 2005; arrêté n° 1954-05 2005, arrêté n° 2655-06 2006 (Mediterranean: Al Hoceima-Tofino), n° 1566-10 (Atlantic: Cap Sparte and Larche)   |
| <b>Spain</b>                 | <b>Yes</b>                       | BOE, 188, de 7 de agosto de 1965, Real Decreto 1212/84, Orden 3/1985,B.O.E. núm. 204 1997,B.O.E. núm. 233 1998,BOE NUM. 97, 1990, Real Decreto 1415/2005, Orden APA/1592/2006 (BOE núm. 125 de 26.05.2006)  |
| <b>Spain Baleares</b>        | <b>Yes</b>                       | Orden del Consejero de Agricultura y Pesca, de día 10 de mayo de 1985,Decreto 40/2003   |
| <b>Spain Cataluña</b>        | <b>Yes</b>                       | Decreto 389/2004, Orden MAH/293/2005;Law 4 / 1998; DOGC. 2611, 1998; Orden AAR/167/2010   |
| <b>Tunisia</b>               | <b>Yes</b>                       | arrêté du 26 février 1982   |

\*\*\*PACA Provence-Alpes and Cote d'Azur;

### Management measures

Up to now, a wide variety of approaches have been proposed or implemented to protect *C. rubrum* from the overexploitation. A brief summary is given in the following tables (Tabs 3-8).

**Table 3 Main typologies of management adopted so far in *Corallium rubrum***

|                              |                                       |                |
|------------------------------|---------------------------------------|----------------|
| Fishing spatial restriction  | Fishing areas                         | Very Common    |
|                              | Interdicted areas (temporary closure) | Very common    |
|                              | Interdicted areas (permanent closure) | Few cases      |
|                              | Depth limits                          | Very few cases |
| Fishing temporal restriction | Fishing season                        | Common         |
|                              | Rotating harvesting system            | A few cases    |
| Selective harvesting         | Gear limits                           | Very common    |
|                              | Minimum size                          | Very few cases |
| Exploitation limits          | Quotas                                | Very common    |
|                              | License                               | Very common    |

## Fishing spatial restrictions

A measure of management widely adopted is to allow the fishery only in **specific limited areas** (fishing areas) or to impose the **ban of fishing in certain areas** (interdicted areas) **temporarily** (fishing reserves) or **permanently** (e.g. marine protected areas)(Tab 4).

**Table 4 Fishing spatial restrictions for *Corallium rubrum***

|                            | <b>fishing areas</b>               | <b>fishing reserves</b> | <b>depth limits</b>           | <b>interdicted areas (e.g. MPAs)</b>                              |
|----------------------------|------------------------------------|-------------------------|-------------------------------|---|
| <b>Algeria*</b>            | yes                                |                         |                               | ?   |
| <b>Croatia</b>             | yes                                |                         |                               | ?   |
| <b>France (PACA)</b>       |                                    |                         |                               | Yes   |
| <b>France (Corsica)</b>    |                                    |                         | only >-50 m                   | Yes   |
| <b>Greece</b>              | 5 areas, not simultaneously opened |                         |                               | 2 national parks (Zakynthos and Northern Sporades)                |
| <b>Italy</b>               |                                    |                         |                               | MPAs and National Parks   |
| <b>Sardinia (Italy)</b>    |                                    | yes                     | only >-80m                    | 2 protected areas, 5 MPA, 2 parks                                 |
| <b>Morocco</b>             | yes                                |                         | only to -40 and -80 m         | MPA (Topo)  |
| <b>Spain (AE)</b>          | 5 national areas (with subareas)   |                         |                               | MPAs (Medas, Columbretes, Alboran)                                |
| <b>Spain Baleares (AI)</b> | 2 areas                            |                         |                               | 2 MPAs but not specific for red coral                             |
| <b>Spain Cataluña (AI)</b> | 1 (2) areas                        |                         |                               | MPA with restricted areas for red coral protection (Cap de Creus) |
| <b>Tunisia</b>             |                                    | yes                     | only >-50 m (off Cani Island) | ?   |

\*at present fishing is interdicted to collect corals, the regulations refer to the law of 1995; for Spain AE= aguas exteriores, AI= aguas interiores (see text);

As shown by table 4, almost all the countries limit the fishing effort by defining **fishing areas** (the only areas where fishing for red coral is allowed). In Spain the national laws define the limits for the exploitation of the banks found in external

waters (territorial waters called **aguas exteriores**) (Real Decreto 1415/2005, regulating fisheries and commercialization of the species and Orden APA/1592/2006, regulating the procedures for authorizations of this activity). For the internal waters (in principle, those that are behind the straight line between two ends, such as gulfs and bays, called **aguas interiores**) local authorities (autonomous regions or Comunidad autonomas) are responsible for the management and can enact their own laws. Only Sardinia and Tunisia regulate the harvesting by delimiting **fishing reserves** (listing all the areas where harvesting is forbidden).

As concerns the imposition of specific depth limits, at present only Sardinia, Corse, Morocco and Tunisia (in very limited areas) adopt this measure. Since 2008 the local government of Sardinia has decided to ban coral harvest in waters shallower than 80 m. Similarly, in Corse (Arrêté No. 67 / 2002/DRAM) fishermen agreed in harvesting only corals at >-50 m. According to the Arrêté n° 1566-10 in Morocco fishing for red coral in the Atlantic (in the area between Cap Sparte and Larche) is allowed only in the depth range between -40 m and – 80 m of depth. Concerning Tunisia fishing off “Cani” islands has been banned above 50 m of depth (decree of the 26 February 1982). In the past (from 1984 to 2005) Spain banned the harvesting live corals on bottoms between 100 and 120 m of depth (Decreto 1212/84 and Orden 3/1985). At depths above 100 m, coral fishing was allowed exclusively to divers while at depths exceeding 120 m the use of gears and underwater devices (submarine) was allowed, upon approval of the Ministry of Fishery.

Apart from temporary reserves (areas closed to fishing for predetermined periods as in implementing the rotation system so for management purposes) another form of management could be the establishment of **permanent reserves**, in which fishing is forbidden for good (for conservation purposes).

A special case of permanent reserve is the **MPA** that allow the recovery of populations in absence of fishing pressure. Nevertheless, most of the extant Mediterranean MPAs are multitasking multipurpose protected areas, that completely protect red coral (when present) only in core zones (usually the core zone, a small portion of the whole MPA).

### Fishing temporal restrictions

The control of fishing effort can be obtained by allowing fishery for a short period of time, through the implementation of **fishing season** and, in long-term strategies, **rotational harvests** (see Table 5) or by imposing a **quota** (maximum amount of coral that can be harvested in a given period).

**Table 5 Fishing temporal restrictions for *Corallium rubrum***

|                                | <b>rotational system yr<br/>(harvesting/closure)</b>           | <b>fishing season</b> | <b>quotas</b>  |
|--------------------------------|--|-----------------------|--|
| <b>Algeria*</b>                | 5/15 yr  | ?                     |  |
| <b>Croatia</b>                 |  | 1 Dec- 31 Mar         | 200 kg/yr /diver                                     |
| <b>Greece</b>                  | 5/20 yr  | 1 Apr-31 Dec          |  |
| <b>Sardinia (Italy)</b>        |  | 1 May - 15 Oct        | 2.5 kg/day/diver                                     |
| <b>Morocco</b>                 | Not fixed times,<br>depending on the status of<br>the resource | All year              | 500 kg /yr /boat<br>(Med)<br>600 kg /yr / boat (Atl) |
| <b>Spain (AE)</b>              | 5/25 yr **   | ?                     | 400 kg/yr ±10%<br>overall (AE+AI)                    |
| <b>Spain Baleares (AI)</b>     |  | 1May-31 Oct           | 400 kg/yr ±10%<br>overall (AE+AI)                    |
| <b>Spain Cataluña<br/>(AI)</b> |  | 1May-31 Oct           | 400 kg/yr ±10%<br>overall (AE+AI)                    |

\*at present fishing is interdicted to collect corals, the regulations refer to the law of 1995; \*\* BOE, 188, de 7 de agosto de 1965; for Spain AE= aguas exteriores, AI= aguas interiores

**Rotation system** (in use since the middle ages) focuses the fishing effort on one stock at a time. When the first one is exhausted, it is left to recover and harvesting is moved in another area. A rotation management scheme is employed today in Greece (5 areas are opened to fishing but not simultaneously; after a 5 years of exploitation of one area, another is opened while the first is closed for 20 years), in Morocco (variable years of exploitation and stop, depending on how fast the depletion of bank occurs and how fast the recover occurs) and in the past in Algeria (5 yr exploitation/15 yr closure) and Spain (5 yr exploitation/25 yr closure).

Limited **fishing seasons** are imposed in 4 countries: the longest being in Greece (9 months), followed by Croatia (8 months) and Spain (6 months), the shortest harvesting season is permitted in Sardinia (5.5 months in 2010).

As regards the **maximum amount of coral** that can be collected, 4 countries impose precise limits defined as kg/yr per license (200 kg in Croatia and 400±10% kg in Spain, summing up both the amount from the AE and the AI for a given license), kg /yr per boat (500 kg in Morocco- area of Al Hoceima, and since 2010 600 kg in Morocco - Atlantic waters), or kg/day/diver (2.5 kg in Sardinia).

## Selective harvesting

Table 6 Size and gear limits for *Corallium rubrum*

|                     | minimum size<br>(basal diameter)     | gear****   | cut                                  | after the<br>cut                             |
|---------------------|--------------------------------------|--|--------------------------------------|--|
| Algeria*            | >8 mm                                | only pick(since 1995)?                                       | 3 cm from base                       | 2h at sea                                    |
| Croatia             |                                      | Only pick since 1985? (YUG) <sup>o</sup><br>max 2 axes/diver |                                      |  |
| Italy Sardinia      | >10 mm ( $\pm 20\%$ )                | only pick (since 1989)                                       |                                      | 30 minutes at sea, broken apices left at sea |
| Morocco             | in project 7 mm basal diameter       | only pick (since 1980's?) <sup>oo</sup>                      |                                      |  |
| Spain (AE)          | >7 mm at point of fracture (>8 mm**) | only pick (since 1994)?                                      |                                      |  |
| Spain Baleares (AI) | >7 mm at point of fracture           | only pick (since 1994)?                                      |                                      |  |
| Spain Cataluña (AI) | >7 mm at point of fracture           | only pick (since 1994)?                                      |                                      |  |
| Tunisia             |                                      | only pick (since 1985)                                       | not to unroot (eradicate) the colony |  |

\*at present fishing is interdicted to collect corals, the regulations refer to the law of 1995;

\*\* BOE, 188, de 7 de agosto de 1965; for Spain AE= aguas exteriores, AI= aguas interiores;

\*\*\* all the EU countries banned the cross since 1994;

<sup>o</sup> former Yugoslavia (article 51 and 53 Regulation of 19 June 1985);

<sup>oo</sup> Dridi et al. 2010.

A **Minimum harvesting size** is at present imposed only in 2 countries, in particular the minimum basal diameter size, measured at the point of fracture (Spain) or at midpoint from the base and the first ramification (Sardinia). In Spain it is now fixed to 7 mm but in the past it was 8 mm (article 15, BOE, 188, 1965). In Sardinia the minimum size is set to 10 mm, but a 20% variance is allowed. In Algeria, when the fishery was opened, it was imposed to collect red coral with >8 mm of basal diameter (Décret exécutif n° 95-323 du 21 Octobre 1995).

In almost all the countries that have a red coral fishery, today the only **legal gear** is the manual harvesting performed by **SCUBA divers using a pickax**. The choice to ban of non-selective harvesting gears, the ingegno, or St. Andrew's cross, proved to be a very important and effective management measure in reducing the fishing effort and limiting the damage to the banks and associated fauna. Since the mid of 1980s the



Baleares (Orden del Consejero de Agricultura y Pesca, de día 10 de mayo de 1985) and Catalonia (Decreto 291/1983, de 30 de junio) prohibited dragging gears in their respective internal waters. From the 1st of April 1985 Tunisia banned the cross (decree of the 26 February 1982), in 1989 the ingegno was forbidden in Sardinia and in the same years in Morocco (Dridi, 2010). Later, in 1994, the ban was enforced by the European Union (EC Council Regulation No 1626/94) removing one of the most damaging coral fishery tool from European waters.

Some regulations specify how **the cut** has to be made (in Tunisia it is not allowed to 'uproot' the colony) In Sardinia and Algeria there is also the imposition, after the cut, to maintain red corals in sea water in order to allow the dispersion of gametic products. Furthermore in Sardinia, from 2010 the apices, accidentally broken, should be left in the harvest site immediately after the collection.

#### Licenses and reporting

Coral harvesting in Mediterranean waters is mainly controlled by licensing system permitting a controlled number of boats or divers to harvest coral (Tab 7). Usually a fixed (limited) number of permits/yr, sometimes linked to a specific area, is imposed. Furthermore, a few countries enact detailed regulations on different aspects (maximum number of divers per boat, license fee, vessel restrictions, time of day restrictions). In Sardinia fishermen can apply for the permit only if they can prove to have effectively collected coral in two distinct harvest seasons in the previous 5 years.

Table 7 Licenses numbers and other restrictions to divers

|                                | permits/licenses<br>(number divers/yr)                 | validity                 | restrictions                        | fee            | time of<br>day          |
|--------------------------------|--|--------------------------|-------------------------------------|----------------|-------------------------|
| <b>Algeria*</b>                |  | specific to<br>an area   |                                     |                |                         |
| <b>Croatia</b>                 | Number ?   | Annual/areas             |                                     |                |                         |
| <b>France (PACA)</b>           | Number ?   | annual                   |                                     |                |                         |
| <b>France (Corsica)</b>        | 10   | Annual?                  |                                     |                |                         |
| <b>Greece</b>                  | 10 boats   | 9 months                 | max 2 divers<br>/ boat              | 3000€          |                         |
| <b>Italy</b>                   | fishing license  |                          |                                     |                |                         |
| <b>Italy Sardinia</b>          | max 30   | annual                   | max 2 divers<br>/ boat              | 1000€/<br>year |                         |
| <b>Morocco</b>                 | 10 boats / area  | Annual                   | max 3 divers<br>/ boat (<50<br>tsl) |                | sunset<br>to<br>sunrise |
| <b>Spain (AE)</b>              | AE 47 : Ca=12, Ba-<br>Ma=10, Ba-Me=10,<br>Al=5, SAR=10 | annual 1<br>permit /area | 1 dive/day                          |                | sunset<br>to<br>sunrise |
| <b>Spain Baleares (AI)</b>     | AI: 6 (Mallorca)+2<br>(Menorca)                        | annual 1<br>permit /area | 1 dive/day                          |                |                         |
| <b>Spain Cataluña<br/>(AI)</b> | AI: 10 (from Roses<br>to France border)                | annual 1<br>permit /area | 1 dive/day<br>Dive in pairs         |                |                         |
| <b>Tunisia</b>                 | ?  |                          |                                     |                |                         |

\*at present fishing is interdicted to collect corals, the regulations refer to the law of 1995; Ca= Cataluña, Ba-Ma= Baleares-Mallorca, Ba-Ma=Baleares-Menorca, Al=Almería, SAR= South Atlantic Region

Table 8 Reporting requirements

|                            | new bed discovery                     | reporting | gross weight  | composition | depth and location | interval of reporting required        |
|----------------------------|---------------------------------------|-----------|---------------|-------------|--------------------|---------------------------------------|
| <b>Algeria*</b>            |                                       |           | at harbor     |             |                    |                                       |
| <b>Croatia</b>             |                                       |           | ?             |             |                    |                                       |
| <b>France (PACA)</b>       |                                       | yes       | yes           |             |                    | ?                                     |
| <b>France (Corsica)</b>    |                                       | yes       | yes           |             |                    | ?                                     |
| <b>Italy</b>               | exclusive exploitation for next 2 yrs | yes       |               |             |                    |                                       |
| <b>Italy Sardinia</b>      |                                       | yes       | yes           | yes         | yes                | daily harvesting data                 |
| <b>Morocco</b>             |                                       |           | ?             |             |                    |                                       |
| <b>Spain (AE)</b>          | yes                                   | yes       | at the harbor |             |                    | at the harbor (measured and weighted) |
| <b>Spain Balears (AI)</b>  | yes                                   | yes       | at the harbor |             |                    | as in Spain AE                        |
| <b>Spain Catalona (AI)</b> | yes                                   | yes       | at the harbor |             |                    | as in Spain AE                        |
| <b>Tunisia</b>             |                                       |           | at harbor     |             |                    |                                       |

\*at present fishing is interdicted to collect corals, the regulations refer to the law of 1995;

In many countries the discovery of a **new bed** must be reported to the national authorities. In Italy the reporting fishermen are allowed to exclusively exploit the bank for the following two years.

When a maximum quota is imposed, fishermen have **to report** the gross weight, sometimes at the harbor in presence of specific personnel or in the logbook (self-certification) (Tab .8). In Sardinia it is mandatory for fishermen to report (on a daily basis within 30 days from the end of harvesting season) data on coral amounts and composition of the harvest, position and depth of the exploited bank. In Spain they have also to provide data on amounts and sales (48 h after the sale a copy General Secretariat for Maritime Fisheries with a copy of the page of the logbook).

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## Appendix E

### Scientific research medium term working plan

Shallow populations (living between 10-50 meter depth), characterized by high dense, small sized colonies with a low commercial value have been well studied. They are overharvested and in need of protection. This creates the necessity to move towards a fishery in deeper waters, and calls for prior research on deep populations (deeper than 50 meters).

In particular, predictive demographic models are needed to manage the resource at local population level. To this aim the following priorities for scientific research in the Mediterranean are identified:

**Stock assessment:** large and small-scale bathymetric surveys and mapping of Mediterranean red coral populations through standardized methodologies.

**Oceanographic Data collection:** abiotic and biotic parameters recording (hydrodynamics, seston, sedimentation, temperature, etc).

#### **Population data:**

##### Demography:

- Population density.
- Colony growth rate assessment.
- Population size structure.
- Population reproductive structure and larval output.
- Recruitment and mortality assessment (including infection by boring sponges).
- Fishery dependent data.

##### Population genetics

- DNA microsatellite analysis of different populations
- Genetic variability and connectivity assessment

#### **Stock recovery and restoration.**

Development of restoration techniques.

#### **Development of alternative deep harvesting**

Evaluation on the impact of the application of Remote Operating Vehicle (ROV) and submersible harvesting.