

**International Master's Program:  
Integrated Coastal Zone Management (ICZM)  
Master-Thesis**

**Management of Marine Bio-Resources  
-A Comparative Study of Three European Coastal  
Areas-**



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**Dedicated to Dr. Martin Sprung  
who died in a car accident near Faro, Portugal,  
on 18<sup>th</sup> July 2003**

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## Abbreviations

ASEMA	<i>Asociación de Empresas de Acuicultura Marina de Andalucía</i> ; Association of Enterprises for Marine Aquaculture in Andalusia
BRT	<i>Brutto Register Tons</i>
CCMAR	<i>Centro de Ciências do Mar</i> (Centre of Science for the Sea)
CCRAIlg	<i>Comissão de Coordenação da Região do Algarve</i> ; Commission for Regional Management
CFP	<i>Common Fisheries Policy</i>
CWSS	<i>Common Wadden Sea Secretariat</i>
DGPA	<i>Direcção Gerale das Pescas e Aquicultura</i> ; General Directorate of Fisheries and Aquaculture
DGAP	<i>Direcção Gerale a Administração de Portos</i> ; Port Administration
DPMT	<i>Dominio Público Marítimo Terrestre</i> ; Marine Terrestrial Public Domain
DRAOT	<i>Direcção Regional do Ambiente e Ordenamento do Território</i> ; Regional Directorate of Environment and Land Planning
EEZ	<i>Exclusive Economic Zone</i>
IBA	<i>Important Bird Area</i>
ICN	<i>Instituto da Conservação da Natureza</i> ; Institute of Nature Conservation
ICZM	<i>Integrated Coastal Zone Management</i>
IPIMAR	<i>Instituto Português de Investigação das Pescas e do Mar</i> ; Portuguese Fisheries research institute
IUCN	<i>International Union for Conservation of Nature and Natural Resources</i>
MAB	<i>Man and Biosphere</i>
NNatG	<i>Niedersächsisches Naturschutzgesetz</i> (Lower Saxonian Nature Conservation Law)
NPL	<i>National Park Law</i> , in this report related to the National Park Law of the Wadden Sea of Lower Saxony, amended in 2001
PDS	<i>Plan de Desarrollo Sostenible</i> ; Plan for Sustainable Development
PNBC	<i>Parque Natural Bahía de Cádiz</i> ; Natural Park of the Bay of Cádiz
PNRF	<i>Parque Natural Ria Formosa</i> ; Ria Formosa Natural Park

PO	<i>Producer Organisation</i>
POAP	<i>Plano de Ordenamento de Áreas Protegidas; Plan for Protected Areas</i>
POOC	<i>Plano de Ordenamento da Orla Costeira; Coastal Zone Master Plan</i>
PORN	<i>Plan de Ordenación de Recursos Naturales; Organizing Plan for Natural Resources</i>
PRUG	<i>Plan Rector de Uso y Gestión; Ruling Plan for Use and Management</i>
PSSA	<i>Particularly Sensitive Sea Area</i>
SPA	<i>Special Protection Area</i>
WSF	<i>Wadden Sea Forum</i>
WSP	<i>Wadden Sea Plan</i>

# Management of Marine Bio-Resources

## -A Comparative Study of Three European Coastal Areas-

### 1 Introduction

#### 1.1 The Coastal Zone and ICZM

Given the fact that with around 89000 km Europe's coastline is relatively long compared to its land area and that around half of the Union's population lives within 50 km of the sea the great economical, environmental, socio-cultural and recreational importance of Europe's coastal zone<sup>1</sup> can not be overlooked (EC, 2001). There exists a great variety of different types of coastal zones with a broad range of human activities such as industry, tourism, aquaculture and, fishery<sup>2</sup>. All of these activities compete for vital space. The rising demand for coastal resources and increasing number and intensity of human uses has been led to the degradation of many coastal systems (EC, 2001).

Since the late 1980's the awareness of the problems of the coastal zone has grown internationally due to the numerous problems that can be encountered nowadays such as water contamination, coastal erosion, habitat destruction or resource depletion. With the implementation of a European strategy for Integrated Coastal Zone Management (ICZM) the European Communities have set a mark for promoting an integrated and participative approach for an environmentally and economically sustainable, as well as a socially acceptable form of management for European coastal zones (COM, 2000). Through the Demonstration program on ICZM the European Commission revealed the most common problems of European coastal zones to be:

- unplanned development of sectoral activities, particularly tourism
- decline of traditional, environmentally compatible sectors like coastal fisheries

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<sup>1</sup> The coastal zone is defined as a strip of land and sea of varying width depending on the nature of the environment and the management needs that is usually not corresponding to existing administrative or planning units (<http://europa.eu.int/comm/environment/iczm/situation.htm>, accessed in July 2003).

<sup>2</sup> If not stated otherwise, in this report, the term "fishery" refers to all types of fishing, including gathering and harvesting activities

- coastal erosion, also as a result from sea level rise
- lack of appropriate communications and transport networks

Among others, resulting consequences are unemployment, social degradation and instability, as well as damage of natural habitats and human settlements<sup>3</sup>. However, the overall dilemma can be seen in the fact that the development of any kind of activities is not kept within the limits of the local environmental carrying capacity (COM, 2000).

## 1.2 Wetlands – Importance and Threats

Wetlands<sup>4</sup> are one of the most productive ecosystems in the world (Mitsch & Gosselink, 1993) but at the same time among the most fragile and threatened natural habitats of the coastal zone (EC, 2001). Population increases and changes in economic activities have been reasons for the destruction of many of these coastal areas and the resulting habitat loss has been damaging coastal economies (EC, 2001). Particularly with the adoption of the Ramsar Convention on Wetlands in 1971, coastal wetlands (including lagoons, estuaries, salt marshes, inshore rocky reefs and sandy slopes) due to their importance as nurseries, feeding and spawning grounds for a large variety of fish and shellfish species as well as for many birds and some mammals<sup>5</sup> have gained international importance in terms of nature conservation. Many commercially important products are harvested and collected from wetlands and a significant proportion of the catch of fish and shellfish species is originating from these areas<sup>6</sup>.

## 1.3 Marine Bio-Resources and the Fishery Sector

The gradual depletion of fishery stocks in coastal areas is an important issue affecting Europe's coastal zones<sup>7</sup>. The above mentioned habitat destruction and resulting damage to coastal spawning grounds is to a certain extent responsible for this development (COM, 2000), but, also over-fishing and the unsustainable management of natural marine bio-resources has led to dramatic reductions in natural

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<sup>3</sup> <http://icm.noaa.gov/>, accessed in August 2003

<sup>4</sup> For definition, see Annex I

<sup>5</sup> [http://www.ramsar.org/key\\_guide\\_list\\_e.htm](http://www.ramsar.org/key_guide_list_e.htm); <http://h2osparc.wq.ncsu.edu/info/wetlands/index.html>, accessed in July 2003

<sup>6</sup> <http://europa.eu.int/comm/environment/iczm/situation.htm>, accessed in July 2003

<sup>7</sup> <http://europa.eu.int/comm/environment/iczm/home.htm>, accessed in July 2003

stocks (EC, 2001). The recently published paper on the worldwide depletion of predatory fish communities reveals that the sustainability of fisheries is being severely compromised on a global scale (Myers & Worm, 2003). Concerning European coastal waters, the Common Fisheries Policy (CFP) of the European Union has not only failed one of its aims which was to conserve fish stocks<sup>8</sup> but has also increased unemployment in many coastal areas by reducing the number of boats of the fishing fleet (EC, 2001). However, under the recently adopted CFP long-term objectives have been set for attaining safe levels of stocks and it is aimed to promote further both ecological and socio-economic priorities<sup>8</sup>.

In the case of aquaculture<sup>9</sup>, a sector that has been expanding and intensified during the past three decades and which has been growing more rapidly than all other food producing sectors (average growth rate of 9.2 % per year since 1979) (FAO, 2002), the Commission recognized the necessity to develop a strategy for the sustainable development of this sector (COM, 2002). On the one hand, aquaculture practiced in coastal and brackish waters can have positive impacts on the coastal zone since it demands good water qualities and a clean environment, values that are also necessary for other coastal activities such as tourism (EC, 2001). But on the other hand and apart from many problems related to pollution as well as to the maintenance of competitiveness on the market, conflicts between aquaculture and other coastal uses such as tourism, port uses and environmental conservation exist (Alvarez, 2001; Uriarte, 2001). However, due to the necessity of food supply for a steadily increasing population as well as owing to the increasing loss of coastal habitats, the sector of fisheries and aquaculture including the collection and harvesting of marine organisms –in this connection referred to as the exploitation of marine bio-resources– is one major topic concerning sustainable coastal management in Europe.

Marine bio-resources<sup>10</sup> are exploited many coastal areas, particularly in very productive systems such as coastal lagoons or intertidal areas. Very often the use of these organisms has been a way of life for centuries and still plays an important

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<sup>8</sup> [http://europa.eu.int/comm/fisheries/reform/index\\_en.htm](http://europa.eu.int/comm/fisheries/reform/index_en.htm), accessed in July 2003

<sup>9</sup> In this case referred to the rearing or culturing of organism using techniques designed to increase the production of the organisms in question beyond the natural capacity of the ecosystem; the organisms remain the property of a natural or legal person throughout the rearing or culture stage, up to and including harvesting. (Council Regulation 2792/99 of 17 December 1999 laying down the detailed rules and arrangements regarding Community structural assistance in the fisheries sector, OJ L 337 of 30/12/1999) ([http://europa.eu.int/comm/fisheries/doc\\_et\\_publ/factsheets/legal\\_texts/docscom/en/com\\_02\\_511\\_en.pdf](http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/com_02_511_en.pdf)), accessed in July 2003

<sup>10</sup> In this report the term “marine bio-resources” is restricted to living organisms

socio-economic role in many coastal regions (COM, 2002). However, as it is stated above, many problems are superimposing therewith related activities, making it difficult to find an adequate form of management of the respective region and therewith related exploitation activities.

#### 1.4 Objectives of the Study

In order to develop promising future management strategies for an environmentally and economically sustainable use of natural marine bio-resources, it is necessary to exemplify the current situation of reference areas. Therefore, this study aims to determine the present problems and to gain insight into current management solutions related to the exploitation of marine bio-resources in three different European coastal areas that have been chosen as reference sites: the Natural Park Bay of Cádiz (Spain), the Natural Park Ria Formosa (Portugal) and the Wadden Sea National Park of Lower Saxony (Germany). Whereas the Spanish and the Portuguese sites are situated in warm-temperate southern European countries, the Wadden Sea area has been chosen as a representative for a coastal area located in the cold-temperate zone. The three sites have in common in that they are prominent areas in terms of their productivity where the use of marine bio-resources is a relevant matter of fact and where user conflicts are a major subject of discussion. Moreover, the Bay of Cádiz, the Ria Formosa as well as the Wadden Sea of Lower Saxony are protected by national nature conservation regulations and most of the respective areas are wetlands of international importance, designated as Ramsar sites<sup>11</sup>.

Since there is a strong need for an exchange of experience and know-how concerning issues that are of a European dimension such as the conservation of important coastal habitats and the sustainable use of their natural resources<sup>12</sup>, it is relevant to know if there exist more similarities or rather differences in problems related to the use of marine bio-resources and occurring in different coastal areas. In consequence, it is required to examine how different coastal regions cope with such problems on local and regional scales and if the respective current management strategies are promising in the long term and could be –in a certain way– transferred to other European regions. This is particularly important since there is an increasing

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<sup>11</sup> <http://www.ramsar.org>, accessed in July 2003

<sup>12</sup> <http://europa.eu.int/comm/environment/iczm/situation.htm>, accessed in July 2003

awareness that fishery resources must be developed and used in ways that are environmentally and economically sustainable (FAO, 2002).

To summarize, the objectives of the present project are to:

- determine the main species groups used and depict the manner of exploitation
- characterize the specific problems related to this activity
- outline current management strategies and evaluate the respective mission statement related to the exploitation of marine bio-resources
- discuss the obtained outcomes against the background of the European vision on an integrated resource management.

## 2 Approach to the Topic

Besides the consultation of published data, scientific research reports and internet sources, in this project, it was aimed to use local knowledge as a source of information. This approach is based on the assumption that the management of a certain area or ecosystem can profit from the application of informal knowledge held by the local population and stakeholders since these groups know best about the real challenges their particular region has to face. For that purpose different people were consulted which are involved in or concerned with the use of marine bio-resources in the respective area, such as regulators (e.g. representatives from the Natural or National Park Authorities), producers (e.g. fishermen or people involved in the aquaculture/harvesting business), researchers, and other local authorities<sup>13</sup>. This approach is in line with the European ICZM strategy of fostering the involvement of the stakeholders and taking political decisions as close to the citizens as possible. The challenge was to relate the knowledge of stakeholders to any further background information in such a way that a condensed picture of the actual situation could be given.

Due to the fact that three different coastal habitats have been comprised in the report on hand, it is obvious that this study does not cover a wide range of stakeholders or a large number of subjects related to the exploitation of marine bio-resources. Thus, information on single aspects of the respective region can sometimes be incomplete. But, based on the information obtained about the three sites, the aim of the project was to gain a superordinate view on the current situation,

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<sup>13</sup> The records of the talks with the different people are given in Annex III

management strategies, and future perspectives related to the exploitation of marine bio-resources in the European coastal areas Bay of Cádiz, Ria Formosa, and Lower Saxonian Wadden Sea.

### 3 Presentation of Study Sites

In this chapter, location, main environmental characteristics and the protection status of the three different coastal areas Bay of Cádiz, Ria Formosa, and Lower Saxonian Wadden Sea are presented.

#### 3.1 Bay of Cádiz, Spain

The total coastline of Spain amounts to around 7880 km –including the Balearic and the Canary Islands –and is bordering the North Atlantic and the Mediterranean Sea between Portugal and France<sup>14</sup>. Andalusia, the largest Spanish autonomous region, is situated in the South of the Iberian Peninsula<sup>15</sup>. The Bay of Cádiz is located at the SW end of the Iberian Peninsula in the province of Cádiz which is one of the eight provinces of the region of Andalusia (Fig. 1).



**Fig. 1** Location of the Bay of Cádiz in the SW of Spain. The red line determines the limit of the Natural Park of the Bay of Cádiz. Source: Consejería de Medio Ambiente (2003a)

<sup>14</sup> <http://www.fao.org/fi/fcp/es/ESP/profile.htm>, accessed in August 2003

<sup>15</sup> <http://www.idealspain.com/Pages/Places/Andalucia.htm>, accessed in August 2003

### Site Description

The Bay of Cádiz extends over an area of approximately 100 km<sup>2</sup> and is constituted by an embayment-like external sector which is open to the Atlantic ocean and an internal lagoon-like sector (Luna del Barco et al., 2002). The first sub-environment reaches depths up to 20 m at its seaward edge whereas the second one is a shallow protected marine environment with an average water depth of two meters (see Fig. 1). Large areas of salt marshes fringe this area. Both sectors are connected by the Puntales strait which is mainly responsible for the renewal of the water of the internal bay (Jódar et al., 2002b).

The Bay of Cádiz is a mesotidal environment with semidiurnal co-oscillating tides and a mean tidal range of 2.4 m and a maximum spring tidal range of 3.7 m (Jódar et al., 2002a). Mean water temperature oscillates between 11.1 °C (December) and around 24 °C (August). However, variations are much larger in more stagnant areas such as the “esteros”<sup>16</sup> (Arias, 1996). The area has been built up by sediments derived from the river Guadalete along with lesser contributions from other rivers (Sales et al., 1983). Particularly, the internal sector is fringed by tidal flats, salt marshes, tidal creeks, and Salinas<sup>17</sup> where extensive and (semi-)intensive marine aquaculture is performed to a large extend (DelValls et al., 1998) (Fig. 2).



**Fig. 2 Impressions of the Natural Park Bay of Cádiz.** Left: Channel, wall to delimit the area of a former Salina, and adjacent interior bay at low tide; Right: (semi-) intensive basin used for the cultivation of *Sparus aurata* within the area of the Salina “San Margarita” (Original photos)

Apart from a variety of ecosystems which also includes beaches, small cliffs, old dune systems, and coastal pine forests, the Bay of Cádiz comprises the five

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<sup>16</sup> For definition, see Annex I

<sup>17</sup> For definition, see Annex I

municipalities San Fernando, Chiclana de la Frontera, Puerto Real, Puerto de Santa María, and Cádiz which create a polynuclear urban agglomeration. Population amounts to more than 400,000 inhabitants<sup>18</sup>, a number which is at least doubled during summer time (Arcila, pers. comm.). In general, the city of Cádiz has quite a large importance as a centre of leisure as well as of cultural and official activities (Luna del Barco et al., 2002).

### Importance and Protection Status

The Bay of Cadiz is described as an outstanding example of Atlantic tidal marshes on the Iberian Peninsula and is characterized by a high biological productivity that is giving rise to favorable environmental conditions for the existence of a variety of different species (Arias, 1996). In particular, it is an important site for migrating and wintering water birds and gives refuge to the breeding populations of five different shorebird species. The area is also fundamental for spawning, nursery and foraging of commercially important fish species<sup>19</sup>. In 1989, the Bay of Cádiz was included in the inventory of the protected natural spaces in Andalusia and has been designed as a natural park<sup>20</sup> with a total area of 10,000 ha. Therewith, it is one of the around 30 protected natural spaces in the providence of Cádiz. The most special characteristic of the park can be attributed to the fragmentation of the area: most of the surface of the park area is occupied by salt ponds and tidal channels whereas permanently inundated zones of the bay as well as the five previously mentioned urban nuclei are not included (Arias & Drake, 1999). Around 5500 ha are Salinas and 3000-3500 ha correspond to the intertidal area (Barragan-Muñoz, pers. comm.).

In terms of international designations, the Natural Park Bahía de Cádiz (PNBC) has been classified as a Special Protection Area (SPA) for birds in accordance with the Birds Directive (79/409/EEC)<sup>21</sup> (Luna del Barco et al., 2002) and is consequently part of the NATURA 2000 network in the framework of the EC Habitat Directive. Furthermore, it has officially been declared a Ramsar site in January 2003 (Bravo, pers. comm.) and is therefore classified as a wetland of international importance.

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<sup>18</sup> <http://www.juntadeandalucia.es/cultura/iaph/infopha/05textose/boletin35/b3501.html>, accessed in August 2003

<sup>19</sup> [http://www.ramsar.org/profiles\\_spain.htm](http://www.ramsar.org/profiles_spain.htm), accessed in August 2003

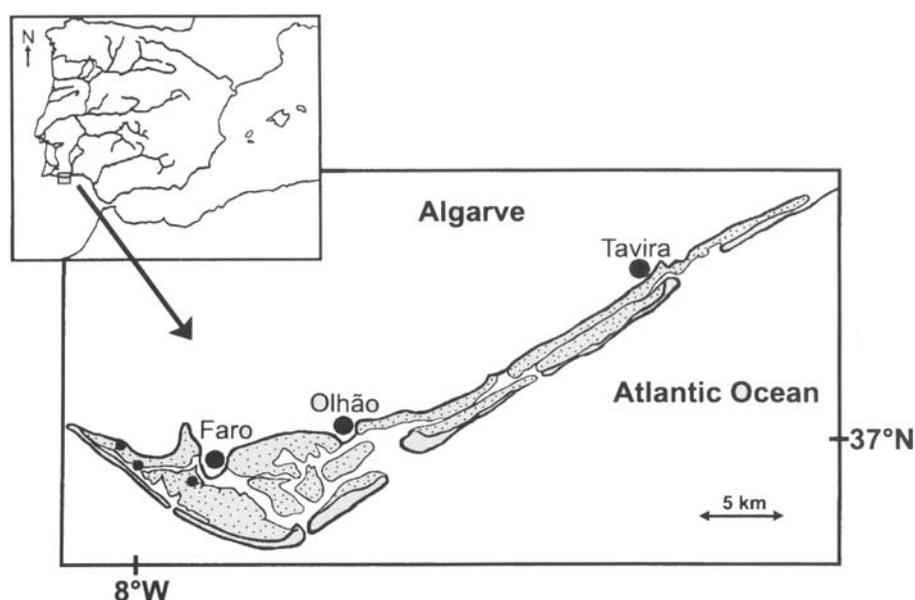
<sup>20</sup> <http://www.juntadeandalucia.es/cultura/iaph/infopha/05textose/boletin35/b3501.html#4>, accessed in July 2003

<sup>21</sup> Council Directive of 2<sup>nd</sup> April 1979 on the Conservation of wild birds (79/409/EEC)

In the past, most of the saltmarshes have been transformed into Salinas for the purpose of salt extraction (as from now termed “Salina-saltmarshes”) but this activity has mostly been abandoned with the salt crisis during the 20<sup>th</sup> century. As a consequence, salt ponds have been reverted to more natural habitats or been transformed into basins for more intensive forms of aquaculture. Nevertheless, the salt extraction activity has left remains of large cultural interest such as the ancient houses or special walls which, apart from the different natural values, constitute an important part of the landscape. Today, aquaculture is the principal activity that is developing in the Natural Park Bahía de Cádiz (Consejería de Medio Ambiente, 2003a). Most of the aquaculture performed in this system is fish poly-culture in semi-enclosed areas (extensive aquaculture). However, the implementation of monocultures in ponds, particularly of the sea bream (*Sparus aurata*), has been increased (Drake & Arias, 1997).

### 3.2 Ria Formosa, Portugal

The Algarve coastline in the south of Portugal extends around 160 km from Cabo São Vicente in the west to the Guadiana River on the border with Spain to the east (Pita et al., 2002). The Ria Formosa is located in the province of the Algarve (Malaquias & Morenito, 2000) (Fig. 3).



**Fig. 3** Location of the Ria Formosa on the Algarve coastline south of Portugal.  
Source: Asmus et al. (2000)

### Site Description

The Ria Formosa is an approximately 55 km long shallow mesotidal lagoon with a maximum width of 6 km in front of the town Faro and a medium depth of 3-4 meters (Malaquias & Morenito, 2000; Sprung & Machado, 2000). Connection with the Atlantic Ocean is given by six deep inlets, Ancão, Faro-Olhão, Armona, Fuzeta, Tavira, and Cacela, which correspond to the borders of the five barrier islands that are protecting the lagoon against direct action of the sea (Asmus et al., 2000). Tidal range varies between 2.8 and 0.6 (1.3) meters at mean spring tide and mean neap tide, respectively (Sprung et al., 2001; Sprung & Machado, 2000). There is a rather intensive exchange of 50-75 % (until 90 %) of the water mass in each tidal cycle (Águas, 1986; Newton & Icely, 2002). Residence time of the water is extremely short, between half a day and two days (Neves et al., 1996). Except during heavy rainfall, particularly during winter time, and apart from small rivers and some seasonal streams, there is no significant freshwater input into the lagoon and salinity ranges from 35.5 to 36.9 PSU all year round (Falcão et al., 1985). Water temperature has been measured from a 12 °C in winter to 28 °C in summer (Sprung, 1994).

The Ria Formosa can be considered as a true barrier island system consisting of mainland, barrier islands, back barrier lagoons, inlet deltas, barrier platforms and shoreface (Pilkey et al., 1989) with extensive mud flats, sand banks, dune systems, saltmarshes, and substantial *Zostera* beds<sup>22</sup>. Depending on the actual boundaries that have been used as reference points (Fonseca, pers. comm.), published and unpublished data on the total Ria Formosa area vary considerably (Sprung et al., 2001), ranging from the often cited 16,300 ha (Monteiro, 1989) to 17,664 ha (Geographic Information<sup>23</sup>) or even 18,400 ha (Lecoq, 1996). However, the wetland area (including saltmarshes) is estimated at 10,500 ha ( $\approx 105 \text{ km}^2$ ) of which around 3600 ha are permanently inundated (Cachola, pers. comm.).

### Importance and Protection Status

The Ria Formosa lagoon is the largest coastal lagoon system of the southern coast of Portugal (Gamito, 1989) and of great importance for tourism, aquaculture, fisheries and wildlife. It is a very productive site in general terms (Sprung, 1994). Within the lagoon, the culturing of bivalves on ground plots is a traditional activity,

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<sup>22</sup> <http://www.investnatura.com/alg.htm>, accessed in August 2003

<sup>23</sup> ICN (Instituto de Conservação da Natureza, <http://www.icn.pt>), accessed in July 2003

accounting for an 80-95 % of the total bivalve mollusk production of Portugal (Procesl et al., 1999; Pita et al., 2002). Clam production (*Ruditapes decussatus*) in the Ria Formosa has reached 10,000 tons in the past and long been a source of sustenance for the local population as well as an important source of income (Bernardino, 2000) (Fig. 4).



**Fig. 4 Impressions from the Natural Park Ria Formosa.** Left: Lagoon area at low tide with barrier island in the back; Right: harvesting of clams (*Ruditapes decussatus*) from a bottom-culturing plot (“viveiro”) (Original photos)

Moreover, the gathering and harvesting of invertebrates as well as many types of fishery are important economic activities (Erzini, pers. comm.). The Ria Formosa area is not only important in terms of the capturing and fishing of large quantities of different organisms but also as a nursery for a variety of commercially important species (Pita et al., 2002). Furthermore, it contains important habitats and vegetative communities for birds and other fauna as well as many several endemic plant species. The number of resident and migrant water birds can exceed 20,000 individuals which sometimes represent more than 1 % of the relevant populations of the species (Ramsar Sites Database<sup>24</sup>).

The Ria was established as a natural park under Portuguese law by a Decree-Law in December 1987<sup>25</sup>, following the former 1987 Natural Reserve ordinance<sup>26</sup>. Around 90 % of the whole area are covered by a natural park (= Ria Formosa Natural Park, PNRF). The Ria is considered of European importance for biodiversity and has been classified as site of special interest for nature conservation (site 13 of the preliminary list for the NATURA 2000 network) under the protection of Habitats and

<sup>24</sup> <http://www.ramsar.org>, accessed in July 2003

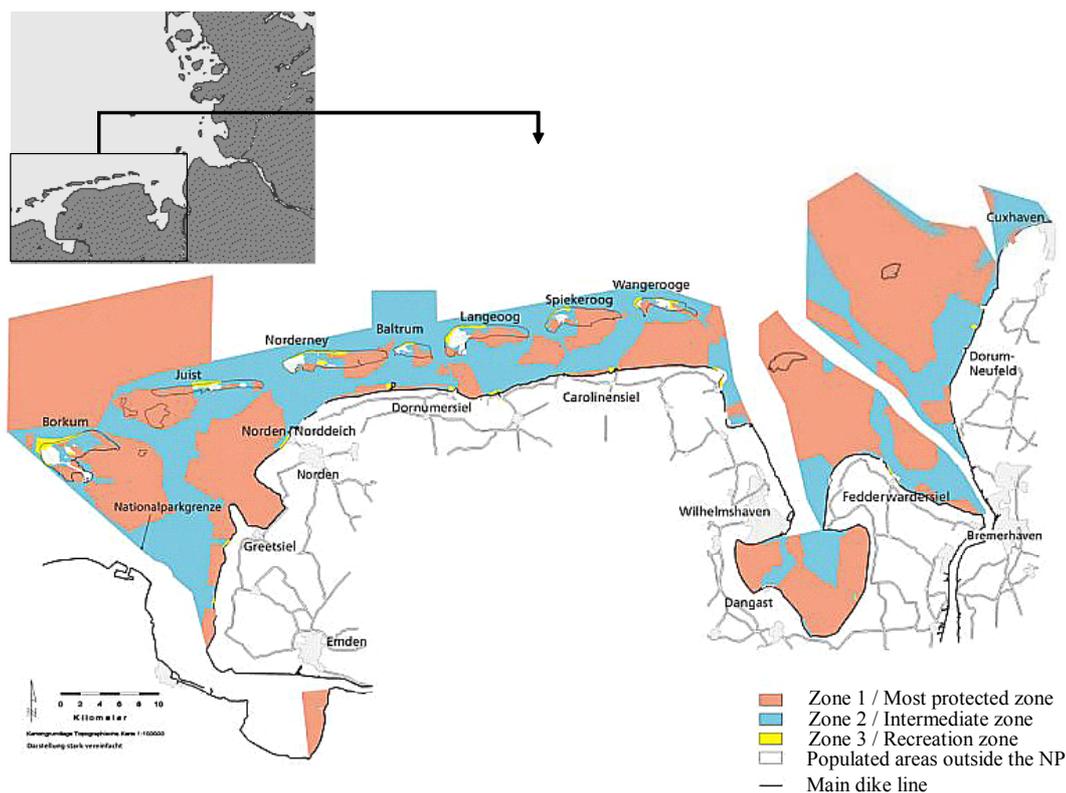
<sup>25</sup> Decreto-Lei n.º 373/87 de 09-12-87 ([http://www.diramb.gov.pt/data/basedoc/TXT\\_LN\\_1176\\_1\\_0001.htm#b0009](http://www.diramb.gov.pt/data/basedoc/TXT_LN_1176_1_0001.htm#b0009)), accessed in July 2003

<sup>26</sup> ICN, <http://www.icn.pt>

Birds Directives (Community Directive 79/409/EEC)<sup>27</sup>. It is an important bird area (IBA) and has been designated Ramsar site for the protection of wetlands (Pita et al., 2002).

### 3.3 Wadden Sea Area of Lower Saxony, Germany

The German coastal region borders the North Sea to the northwest and the Baltic Sea to the northeast of the country. The total length of the German coastline is around 3700 km of which approximately 1590 km can be attributed to the North Sea Coast. Most of the coastline is shallow, i.e. marshland coast, beach ridge or dune coast (Sterr, 2000). This shallow coastal area is termed Wadden Sea and extends up to 30 km off the mainland shore (Seaman & Ruth, 1997). The Wadden Sea in front of the German coastal state of Lower Saxony is one part of the shallow North Sea coastal area (Fig. 5).



**Fig. 5 Location and limits of the Wadden Sea National Park of Lower Saxony.**

Source: Internet<sup>28</sup>

<sup>27</sup> <http://www.pml.ac.uk/biomare/docs/Second%20questionnaire%20Sprung.doc>

<sup>28</sup> <http://www.mu.niedersachsen.de/Nationalparke/vorstellung1.htm>;

<http://www.bsh/Meereskunde/Gezeiten/805.htm>, accessed in August 2003

### Site Description

With an average width of 10 km, the Wadden Sea of the North Sea extends along a 500 km stretch from Den Helder (The Netherlands) across the coast of Germany to Esbjerg (Denmark)<sup>29</sup>. It is the largest coastal wetland in Europe (WWF, 2002) covering an area of about 10,000 km<sup>2</sup> of which around 4500 km<sup>2</sup> are intertidal. The coast is characterized by 5000 km<sup>2</sup> of channels and tidal flats protected by several sandy barrier islands situated in front of the coast. Freshwater enters the system via the estuaries of the three rivers Elbe, Weser, and Ems. There are two daily tides with a mean tidal range between 1.7 m (open coast) and 3.5 m (in the inlets) (Seaman & Ruth, 1997). Extreme environmental fluctuations are a typical feature of the Wadden Sea: the average salinity of around 30 PSU may fluctuate from 20 to 34 PSU due to evaporation and precipitation effects, and water temperature can be around the freezing point in winter but can rise to more than 20 °C in summer. On the surface of tidal flats temperature can reach 30 °C and more. Storms occur frequently, particularly during winter time, and there is a fairly high turbidity of the water (Seaman & Ruth, 1997).

The major habitats and land cover types of the Wadden Sea belonging to the German state of Lower Saxony are intertidal sand-, muddy sand- and mudflats with benthic microalgae (mainly diatoms), blue mussel beds and tidal channels as well as sand dunes on the barrier islands and salt marshes<sup>30</sup> (Fig. 6).



**Fig. 6 Impressions from the Wadden Sea National Park of Lower Saxony.** Left: Mussel bank on the back side of the island Spiekeroog; Right: Mudflats in front of the town Wilhelmshaven (Photos: Uwe Walter)

<sup>29</sup> <http://www.umweltdaten.de/download/ecosystemapproach.pdf>, accessed in July 2003

<sup>30</sup> <http://www2.unesco.org/mab/br/brdir/directory/biores.asp?mode=all&code=GER+10>, accessed in July 2003

Most of the Wadden Sea of Lower Saxony is designed as a national park (see below) with a total area of 277,700 ha after an amendment in 2001 (Fig. 5). Of this, around 267,000 ha contribute to the wetland area with the sublittoral (e.g. channels) and the intertidal area (Wadden flats) taking up approximately 44 % and 49 %, respectively (data according to Czeck, pers. comm.).

### Importance and Protection Status

The Wadden Sea is of extreme importance because –apart from being the largest coherent European wetland area with the largest unbroken stretch of mudflats worldwide– it is considered to be one of the still existent relatively unspoiled nature reserves<sup>31</sup>.

In general, the Wadden Sea is characterized by a high biological productivity and high natural dynamics. The area has a large influence upon the North Sea fisheries as a whole because nursery grounds for a large variety of commercial species caught in the North Sea are located in the Wadden Sea<sup>32</sup>. Out of more than 100 different finfish species that have been counted in the Wadden Sea only eight live permanently in this area (NPA & UBA, 1998). Bivalves account for more than two-thirds of the Wadden Sea biomass with the blue mussel *Mytilus edulis* and the cockle *Cerastoderma edulis* being among the most abundant species (Seaman & Ruth, 1997). The area is of outstanding importance for breeding, wintering and staging water birds<sup>33</sup>. Furthermore, many important economic activities such as tourism, harbors, and shipping industry, military, offshore industry (such as gas), sand and shell extraction as well as local fisheries are concentrated in the landward and seaward area of the shoreline (Sterr, 2000). As a consequence, it can be assumed that the quality of water, sediment, and marine habitats of the Wadden Sea is largely influenced by these activities.

Around 20 years ago, the three countries of Denmark, The Netherlands, and Germany have started a process which by means of the trilateral Wadden Sea cooperation has resulted in the protection and conservation of the entire Wadden Sea<sup>34</sup>. Since 1986, tidal flats, beaches, and salt marshes along the Lower Saxonian coast as well as most of the Frisian Islands have been protected by a National Park

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<sup>31</sup> [http://www.waddenseamaps.net/area\\_coverage/welcome.html](http://www.waddenseamaps.net/area_coverage/welcome.html), accessed in July 2003

<sup>32</sup> [http://www.waddenseamaps.net/area\\_coverage/welcome.html](http://www.waddenseamaps.net/area_coverage/welcome.html), accessed in July 2003

<sup>33</sup> <http://www.ramsar.org>, accessed in July 2003

<sup>34</sup> <http://cwss.www.de/tgc/Wsp/0-Preface.html>, accessed in July 2003

Law (NPG)<sup>35</sup>. Moreover, the Lower Saxony part of the Conservation Area<sup>36</sup> has been designated as Special Protection Area (SPA) according to the EC Bird Directive and will consequently be included in the ecological network NATURA 2000 in the framework of the EC Habitat Directive. Apart from these two mentioned legally binding EC Directives, the German Wadden Sea national parks are Ramsar sites<sup>37</sup> and the whole Conservation Area has also been designated as Man and Biosphere Reserve (MAB), a protected area of representative terrestrial and coastal environments<sup>38</sup>. In October 2002, the marine part of the Wadden Sea Conservation Area which includes the Wadden Sea national parks in Germany has been designated as a Particularly Sensitive Sea Area (PSSA) by the International Maritime Organization (IMO). Although this designation does not imply any further restrictions for shipping or the use of the harbors, the area is marked on the sea charts and ships are requested to be particularly careful (WWF, 2002). Finally, the Lower Saxonian part of the Wadden Sea, together with the Dutch, Danish, and Schleswig-Holstein Wadden Sea areas, is discussed to be inscribed as a World Heritage Site. It meets all of the UNESCO criteria as a “Natural Property”, representing one of the World’s greatest wetland ecosystem<sup>39</sup>.

### 3.4 Summary

For an overview of the three sites, geographical, and main environmental characteristics are summarized in Table 1.

**Table 1 Summary of selected data of the three sites Bay of Cádiz, Ria Formosa, and Wadden Sea National Park of Lower Saxony**

	Natural Park Bay of Cádiz (PNBC)	Natural Park Ria Formosa (PNRF)	Wadden Sea National Park of Lower Saxony (WSNP)
<b>Total area [ha]</b>	10,000	16,300 – 18,400	277,700
<b>Wetland area [ha]</b>	~ 9000	~ 10,500	~ 267,200 (269,100*)
<b>Tidal range [m]</b>	2.4	0.6 (1.3) – 1.8	1.7-3.5
<b>National Protection Status</b>	Natural Park	Natural Park	National Park
<b>International Designations</b>	-Ramsar site; SPA; -Included in list for NATURA 2000 network	-Ramsar site; IBA; -Included in list for NATURA 2000 network	-Ramsar site ; SPA; MAB; PSSA; -Included in list for NATURA 2000 network

<sup>35</sup> <http://www.mu.niedersachsen.de/Nationalparke/waddensea.htm>, accessed in July 2003

<sup>36</sup> For definition, see Annex I

<sup>37</sup> <http://www.ramsar.org>, accessed in July 2003

<sup>38</sup> <http://cwss.www.de/tgc/Wsp/0-Preface.html>, accessed in July 2003

<sup>39</sup> [http://www.bezirksregierung-weser-ems.de/master/0.,C1436091\\_N1698\\_L20\\_D0\\_I807,00.html](http://www.bezirksregierung-weser-ems.de/master/0.,C1436091_N1698_L20_D0_I807,00.html), accessed in September 2003

			-Subject to trilateral agreements
<b>Outstanding characteristics</b>	-Very fragmented area -High biological productivity -Nursery, spawning, breeding area	-High biological productivity -Nursery, spawning, breeding area	-Part of the largest contiguous European wetland area -High biological productivity -Nursery, spawning, breeding area
<b>Important activities</b>	-Extensive and (semi-) intensive aquaculture in traditional or transformed Salinas	-Traditional activity: bivalve culturing -Tourism	-Tourism, local fisheries etc.

\* Temporarily wetland that is including summer polders

It has to be pointed towards the fact that even though in geographic terms the total Lower Saxonian Wadden Sea area is slightly larger than the area of the respective national park, in the report on hand there is giving reference to the area designed as national park. The same applies to the Ria Formosa of which around 90 % are protected as a natural park and also to the Natural Park of the Bay of Cádiz. Consequently, in the following the denominations Ria Formosa, Bay of Cadiz and Lower Saxonian Wadden Sea refer to the areas designed as natural parks or as national park, respectively.

In major difference to the Bay of Cádiz and the Ria Formosa, the Lower Saxonian Wadden Sea has a higher national protection category. Of outstanding feature is the large dimension of the Lower Saxonian Wadden Sea and the therewith related large size of the wetland area compared to the two southern European areas. All three areas are important in terms of their biologic productivity and in their role as nursery, resting, and breeding places for many different species. Activities related to the exploitation of marine bio-resources are a very characteristic feature in both southern areas but comparatively less present in the Wadden Sea.

#### 4 Exploitation of Marine Bio-Resources

This chapter represents the current situation concerning the exploitation of marine bio-resources of each coastal region. The main species or species groups are specified, the main forms of exploitation are briefly explained along with some production numbers and a short description of the socio-economic situation as well as of the main problems that are related to this sector.

#### 4.1 Bay of Cádiz, Spain

In the Bay of Cádiz, extensive and (semi-)intensive forms of marine aquaculture, principally of finfish species, as well as the gathering (“marisqueo”) and fishing of organism or the culturing of bivalves in enclosed areas (“Parques de cultivo de moluscos”) are performed (Table 2).

**Table 2 Principal species exploited in the Bay of Cádiz.** The list is based on different sources of written information as well as information gathered from the talks with different people listed in Annex III

<i>English term</i>	<i>Scientific Name</i>	<i>Manner of exploitation</i>
<b>Finfish</b>		
Thicklipped grey mullet	<i>Chelon labrosus</i>	Extensive traditional aquaculture
Mullet	<i>Liza ssp.</i>	Extensive traditional aquaculture, Fishing
Grey mullet	<i>Mugil cephalus</i>	Extensive traditional aquaculture
Gilthead sea bream	<i>Sparus aurata</i>	Extensive traditional, improved and intensive aquaculture
Sea bass	<i>Dicentrarchus labrax</i>	Extensive traditional and intensive aquaculture
Spotted sea bass	<i>Dicentrarchus punctatus</i>	Extensive traditional aquaculture
European Eel	<i>Anguila anguila</i>	Extensive traditional aquaculture
Sole	<i>Solea senegalensis</i>	Extensive traditional and improved aquaculture
<b>Shellfish</b>		
Peppery furrow shell	<i>Scrobicularia plana</i>	Marisqueo
Manila clam	<i>Ruditapes phlippinarum</i>	Cultivation in mollusk parks
Clam	<i>R. decussatus</i>	Marisqueo
Golden carpet shell	<i>Tapes aureus</i>	Marisqueo
Portuguese oyster	<i>Crassostrea angulata</i>	Cultivation in mollusk parks
Cockle	<i>Cerastoderma edule</i>	Marisqueo
Razor shell	<i>Solen marginatus</i>	Marisqueo
Snails	<i>Murex brandaris</i> <i>Monodonta turbinata</i>	Marisqueo
<b>Cuttlefish</b>		
Common cuttlefish	<i>Sepia officinalis</i>	Fishing/Marisqueo
<b>Crustaceans</b>		
Burrowing shrimp	<i>Upogebia deltaura</i>	Marisqueo
Grass or Atlantic ditch shrimp	<i>Palaemonetes varians</i>	Marisqueo
Common prawn	<i>Palaemon serratus</i>	Marisqueo
Fiddler crab	<i>Uca tangeri</i>	Marisqueo
European shore crab	<i>Carcinus maenas</i>	Fishing/Marisqueo
Prawns	<i>Penaeus kerathurus</i> <i>Penaeus japonicus</i>	Fishing/Marisqueo
Common spider crab	<i>Maja squinado</i>	Fishing/Marisqueo
<b>Other Invertebrates</b>		
Worms	<i>Marphysa sanguinea</i> <i>Diopatra napolitana</i> <i>Nereis diversicolor</i> <i>Arenicola marina</i>	Fishing/Marisqueo

Information compiled by personal communications or by published data

Even though the list of organisms exploited is fairly large, according to Lopez (pers. comm.), there are more species that could potentially been exploited. For

example, the brine shrimp *Artemia salina* which occurs in great quantities in the salt pans and which is of great interest for food in the aquaculture business could be exploited commercially by means of an adequate management (Román & Rodríguez, 1986; Arias, pers. comm.). Concerning algae, there are species of interest (e.g. *Enteromorpha intestinalis*, *Ulva lactuca*) but apparently occurring quantities are too small for a commercial exploitation. A pilot project is taking place with an ascidia species (*Ecteinascidia turbinata*) that is thought to contain substances against cancer. However, the local spirit for launching new enterprises in terms of the exploitation of new bio-resources is considered to be very low which can be seen in the fact that the research concerning *E. turbinata* is performed by an external Galician enterprise (Lopez, pers. comm.).

### Finfish Aquaculture

In the Bay of Cádiz, marine aquaculture of different finfish species is the major form in terms of the exploitation of marine bio-resources (see Table 2). Today, most of the finfish aquaculture in the area is performed in old Salinas that were originally used for the extraction of salt (Arias & Drake, 1994). Marine aquaculture in the Bay of Cádiz is closely related to the restructuring of the salt sector after the salt crisis in the 1940s and has particularly gained importance since the beginning of the 1980s, the time when most of the transformation from original salt ponds towards aquaculture units took place (Arias, 1996).

As stated by Arias and Drake (1999) at least three types of marine aquaculture can be distinguished in relation to, among others, the degree of transformation of the salt pond, the origin of fry and the type of food (Box 1).

#### **Box 1**

##### **Aquaculture regimes in the Parque Natural Bahía de Cádiz<sup>40</sup>**

- a. **Traditional extensive:** Performed in traditional salt ponds, particularly in the “esteros” and without any kind of fertilization or contribution of feed; Young fish enter the Salina through the channels in a natural way; Outcome: Poly-culture of finfish species (see Table 2) with a high proportion of commercially less valuable species (*Liza* spp.); Production: around 5kg/ha/year (*Sparus aurata*), 140 kg/ha/year (Mulletts)
- b. **Improved extensive:** Similar to the traditional method; Fry of selected commercially important species (usually *S. aurata*) that is originating from hatcheries is added in order to enhance the production of the species of interest; Production: 75-600 kg/ha/year

<sup>40</sup> For a thorough description of the structure and function of traditional and transformed salt ponds, see Arias (1996) and Arias & Drake (1999).

c. **Intensive and semi-intensive\***: Performed in completely or partly transformed Salinas by means of the deepening of the channels and dredging of the ponds; Contribution of oxygen, fry and artificial fodder; Usually monoculture of *S. aurata*. In the case of the semi-intensive form the general degree of transformation of the Salina is less and natural feed is complemented with artificial fodder; Production: 10000-25000 kg/ha/year.

\*According to Barragán-Muñoz (pers. comm.) the distinction between the intensive and semi-intensive form, is not definite.

Source: Arias, 1996; Barragán-Muñoz, 1996; Arias & Drake, 1999; Consejería de Medio Ambiente, 2003a

At present the extensive form of aquaculture, traditional or improved, is the principal system performed in the Bay of Cádiz, occupying around 60 % (2013 ha) of the authorized surface (Consejería de Medio Ambiente, 2003a). In contrast, the intensive or semi-intensive form is only occupying 24 % (799 ha). 19 authorized areas (580 ha) are not producing or have been abandoned (Table 3).

**Table 3 Production systems of marine cultures in the Bay of Cádiz (2002)**

Aquaculture regimes	N° of authorized exploitations		Exploitations [%]		Surface [ha]		Surface [%]	
		Σ		Σ				Σ
Traditional extensive	28	Σ 56	30	Σ 60	1299	Σ	38	Σ 59
Improved extensive	28		30		714		2013	
Intensive	12	Σ 19	13	Σ	635	Σ	19	Σ 24
Semi-intensive	5		5		164		799	
Without exploitation	13	Σ 19	14	Σ	428	Σ	13	Σ 17
Abandoned	6		7		152		580	
<b>Total</b>	<b>92</b>		<b>100</b>		<b>3392</b>		<b>100</b>	

Source: Consejería de Agricultura y Pesca (2001) in Consejería de Medio Ambiente (2003a)

The size of salt ponds used for the culturing varies between 15 and 50 ha (García de Lomas de Mier, pers. comm.). Out of the altogether 92 authorized exploitations, 90 are situated within the Bay of Cádiz. Considering the surface area of around 3390 ha altogether, it can be stated that out of the existing 5500 ha Salinas around 62 % are authorized for the culturing of marine organisms. Marine aquaculture is either a family-based business or performed by industrialized enterprises of which “Cupimar” is the most important one in the Bay of Cádiz. Around 1900 ha (~50 %) of the authorized area is governed by “Cupimar” of which approximately 300 ha are used for the (semi-)intensive form of culturing. In contrast, only 18 % of the authorized area is operated by family-businesses. Here, the traditional extensive form of aquaculture, usually performed as a half-time activity, is prevailing and it is characterized by little investments and a general low output (Barragán-Muñoz, 2003)

### Bivalve Culturing

Apart from the mentioned cultivation of finfish species in the transformed salt ponds and channels, there exist a few bivalve culturing areas (“Parques de cultivo de moluscos”) within the intertidal area, principally located in the municipalities of Cádiz, Chiclana, and San Fernando. The clam *Ruditapes philippinarum* as well as the oyster *Crassostrea angulata* is the principal mollusk species being cultured whereas cultivation of the less resistant clam *R. decussatus* only takes place occasionally (Consejería de Medio Ambiente, 2003a). Bivalve seeds are supplied by hatcheries and, at a certain size, put on ground plots (“viveros”) that are supported by phytoplankton-enriched water from the surrounding channels. Afterwards, earth ponds of 40 cm depth serve as the final device for the cultivation until market size (Arias, 1996).

Although in 2002 the setting up of two new areas was requested, since 1995 no new cultivation parks have been established. At present, there exist altogether 11 authorized installations with a total area of 33.3 ha. However, only six of those are actively used, representing 17 % of the authorized area (Consejería de Medio Ambiente, 2003a). The cultivation of bivalves in the Bay of Cádiz is mainly performed by a cooperative that is consisting of seven enterprises and which is occupying 64 % of the authorized area (Barragán-Muñoz, 2003).

### Gathering of Organisms (“Marisqueo”) and Fishing Activities

The “marisqueo” in the intertidal zone is principally undertaken by the traditional method of turning over the mud by hand. Sometimes, hand tools such as hoes, rakes or shovels as well as small boats in order to access certain mud flats are in use (Consejería de Medio Ambiente, 2003a). Captured organisms are of commercial interest (see Table 2) either in terms of bait for sport fishing (worms, shrimps, crabs) or as an ingredient for the typical plates of Cádiz (Arias, 1996). Moreover, gathering of organisms is also carried out for the own consumption (pers. observation). There are no official data about the “marisqueo” which truly reflect the dimension of this activity. From the licenses that have been given by the provincial office of the Regional Ministry of Agriculture and Fishery (“Delegación Provincial de Agricultura y Pesca”) for the whole province of Cádiz, a number of 66 licenses has been deduced for the Bay of Cádiz. However, the gathering-activity has generally increased and it is estimated that around 200 people are regularly carrying out this

activity (Barragán-Muñoz, 2003). Quantification of the gathered objects is difficult since only a minor part of the captured organisms is commercialized on the local markets (Consejería de Medio Ambiente, 2003a).

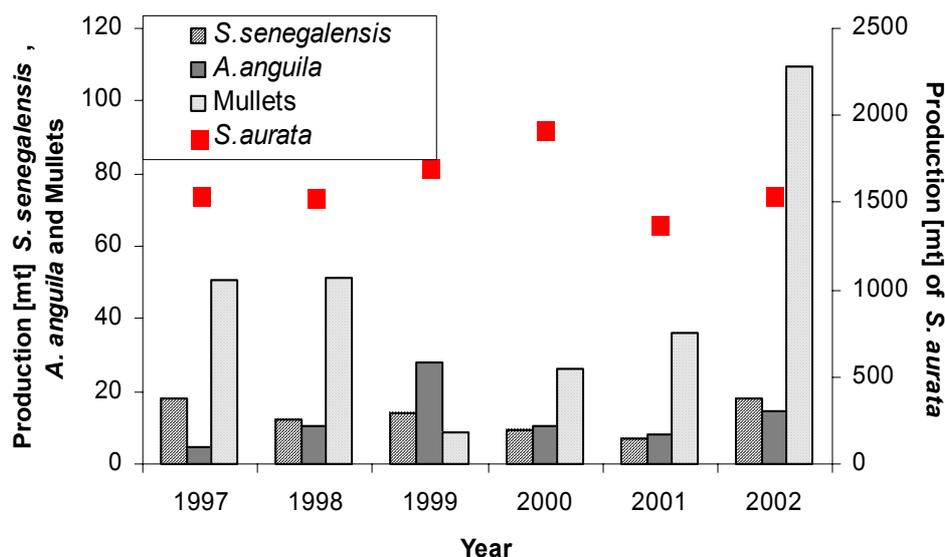
Concerning the fishing activity within the Bay of Cádiz, it appears that there is a profound lack of knowledge about this sector with the most complete study having been performed by Villar (1999). However, for the Bay of Cádiz, particularly for the inner bay, fishing can generally be described as artisan and residual (Barragán-Muñoz, 2003). It is mainly performed by small boats ( $\leq 5$  BRT) but also from the water's edge such as the "Carranza-bridge". Principal organisms are finfish species such as *Liza* sp. but also the cuttlefish *Sepia officinalis* and crustacean species such as *Maja squinado*, *Carcinus maenas* or *Penaeus* sp. (Villar, 1999). Fishing in the inner bay is allowed in determined areas and with an adequate permit (Ruiz, pers. comm.), however, most of the actual fishing activity is performed at the edge of the legal norms, e.g. by using illegal fishing devices such as trawling gear (Barragán-Muñoz, 2003).

#### 4.1.1 Facts on Production

Aquaculture production obtained in the providence of Cádiz traditionally contributes to more than 50 % to the total aquaculture production of Andalusia with most of the production originating from enterprises in the surroundings of the Bay of Cádiz<sup>41</sup>. Therefore, local aquaculture-production numbers can be considered as very important, at least on a regional scale. From many attempts with different species to more intensive forms of culturing, only a few species which best endure the restrictions of the environment (e.g. high salinity, great amount of individuals per area) have proven to be successful. At present, the production of commercial fish in the Bay of Cádiz is mainly based on seabream (*Sparus aurata*), sole (*Solea senegalensis*) but also on species of lesser economic value such as the European eel (*Anguilla anguilla*) and mullets (Fig. 7) (Barragán-Muñoz, 2003). In contrast, the intensive cultivation of the European Spiny lobster *Penaeus japonicus* has not been proven successful (Arias, pers. comm.).

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<sup>41</sup> <http://www.mispecies.com/noticias/2003/ago/030825-andalucia.asp>, accessed in August 2003



**Fig. 7** Average production [in metric tons] of the main finfish species in the Bay of Cádiz during the last six years. Data obtained from the Delegación Provincial de Cádiz de la Consejería de Agricultura y Pesca de la Junta de Andalucía (2003) in Barragán-Muñoz (2003).

The production of *Sparus aurata* is outstanding and reached a maximum of almost 2000 tons in the year 2000 whereas the group of mullets, in the second place in the year 2002, reached a production number of only around 110 tons (see Fig. 7). Aquaculture production of *S. aurata* in the Bay of Cádiz contributed to 37.6 % of the total Andalusia production in 2002.

Production of the clam species *Ruditapes philippinarum* and the oyster *Crassostrea angulata* in the bivalve cultivation parks varies according to the environmental conditions (Arias, 1996). For the year 2002, the mean production of *R. philippinarum* and *C. angulata* has been estimated to around 17.5 mt and 14.7 mt, respectively (Barragán-Muñoz, 2003).

Apart from the production of commercial fish, nurseries are used for the production of fry, principally of the seabream, seabass (*Dicentrarchus labrax*), sole, prawn (*Penaeus japonicus*) and oyster (*Crassostrea angulata*) (data not shown). Similar to the production of consumable-sized fish, the production of *S. aurata*-fry is standing out (44,000,000 units in 2002).

#### 4.1.2 Socio-Economics

At present, marine aquaculture is the principal economic activity that is developing in the Bay of Cádiz (Barragán-Muñoz, 2003). However, in the surrounding region

most of the places of employment are generated by the manufacturing industry and the service sector (Consejería de Medio Ambiente, 2003a). Beach-tourism and therewith related sources of income are of great importance (Lopez, pers. comm.).

Concerning the exploitation of marine organisms in the Bay of Cádiz, *Solea senegalensis* is the most important species in terms of the economic profit. The market price amounts to 18-20 €/kg. Production of this species has not been optimized so far and the demand on the market is high (Molinero, pers. comm.). For *Sparus aurata* which is the most important species in terms of quantity, market prices have been declining during the last years which is mainly attributed to the high competition with products that are entering the market from the cheaper Greek or Turkish production units. Here, the market price is situated at 6-8 €/kg at present (pers. observation). In the main, only the primary product is sold on the local and national market and thus no additional value is added to the raw products.

In the aquaculture sector it is estimated that approximately 310 people are directly employed in the culturing activity. 120 people thereof are working at the biggest aquaculture enterprise, “Cupimar” (Garcia de Lomas Mier, pers. comm.), the only one in the respective area that is dedicated to the integral cultivation (production of larvae and fry, fattening up and commercialization). People employed in this business work in specialized sectors such as maintenance, production, commercialization and technique. The rest of the enterprises and family-businesses is fairly small, each with a staff of around two to three people that is generally unspecialized. Here, people usually rely on a secondary source of income. The captured fish originating from the extensive aquaculture is directly transferred to the local market without any kind of elaboration (Arias, pers. comm.).

Most of the people who are performing the fishing and the “marisqueo” of organisms in the intertidal zones of the Bay of Cádiz are pertaining to a sector of population with little economic opportunities and a low level of professional education. The “marisqueo” is usually carried out individually (Consejería de Medio Ambiente, 2003a), but at least for mollusks an organized capturing and commercialization in the form of cooperatives exist (Perez, pers. comm.). However, similar to the fishing activity, the gathering and harvesting of organisms has augmented drastically which can partly be attributed to the crisis in the offshore fishery but also to a re-conversion of the naval industry. Before, around 15-20,000 jobs were created by this branch of industry but today only a few people are

employed in that business (Abarca, pers. comm.). Hence, the rising unemployment during the last decades but also a steady population growth of the surrounding municipalities, particularly during summer time (Consejería de Medio Ambiente, 2003a), are leading to the above mentioned activities.

In the past, the gathering of organisms has been one of the principal sources of income and has left a strong mark in the character and culture of its people<sup>42</sup>. Today, apart from being performed as a secondary income for the families, very often the “marisqueo” but also the fishing has a somehow recreational character for whole families, especially at the weekends and during holiday time. Hence, the estimated number of around 200 people performing the gathering of organisms per day can easily augment to 500 (Barragán-Muñoz, 2003). The dimension of the “marisqueo”-activity in the Bay of Cádiz can be exemplified by a calculation according to the data given by Villar (1999) (see Box 2).

**Box 2 Approximation on the dimension of the “marisqueo” dedicated to polychaete worms<sup>43</sup> in the Bay of Cádiz.**

**Assumption:**

1 person (“mariscador”) captures seven pots per day during mean spring tide (each pot contains 70-100 worms; price per pot = 6 €)

⇒ ~ 42 €/day/per person

**Calculation:**

200 persons/day × 7 pots = 1400 pots/spring tide  
(assuming 20 spring tides/year),

→ 1050 pots × 20 = 28,000 pots/year\*

⇒ 28,000 pots × 6 € = **168,000 €/year**

\* As stated by Villar (1999) this calculated number only refers to the captures that have been obtained by those people who are operating with little boats and unload their catches in the emplacements that have been observed in the cited study. Hence, the given figure only represents a certain percentage of the actual economic benefit obtained by the gathering of organisms.

⇒ A more realistic figure of the yearly economic benefit is given with the figure of around **600,000 €/year**

Data according to Villar (1999) for the period 1995-1996

It is concluded that the activity of the gathering and harvesting, very often performed at the margin of the legal norm, can be considered as an activity which on the one hand is giving immediate income to a certain amount of people, on the other hand is sustaining numerous installations dedicated to the selling and commercialization of live bait including the export to other areas (Villar, 1999).

<sup>42</sup> <http://www.juntadeandalucia.es/cultura/iaph/infopha/05textose/boletin35/b3502.html>, accessed in August 2003

<sup>43</sup> Principal species: *Diapatra napolitana*, *Marphysia sanguinea*, *Arenicola marina*, *Nereis diversicolor*; very much appreciated as bait for the fishermen that are fishing in the channels

Given the fact that the aquaculture activity generates around three indirect working places for each direct one (Garcia de Loma, pers. comm.) and assuming an actual economically active population of 139,139 people (Barragán-Muñoz, 2003), around 0.66 % of the active population are directly and indirectly employed in the aquaculture sector in the Bay of Cádiz. Augmenting 200 people performing the gathering of organisms daily to the people occupied in the aquaculture business, altogether around 1130 people (0.81 % of active population) are directly and indirectly dependent on the exploitation of marine organisms in the Bay of Cádiz.

#### 4.1.3 Principal Problems

The outstanding problems and effects that have been referred to by the interlocutors and located in the cited literature in relation to the exploitation of marine bio-resources in the Bay of Cádiz –particularly in relation to the principal activity of aquaculture– are summarized in Box 3 .

##### Box 3

###### **General Pollution and Water Quality**

The Bay of Cádiz receives urban sewage from a human population of around 400,000 habitants. Even though sewage treatment plants are now operating, there are still small but scattered sources of non-purified water and organic material entering the zone which has a general negative effect on the marine environment. Also a lot of solid waste is disposed within the area of the Bay of Cádiz which reflects a certain *lack of environmental awareness* of the local population. Moreover, there are secondary sources of pollution such as nautical activities or industries related to the manufacturing of car and aircraft components (Drake et al., 1999). The (semi-)intensive form of aquaculture, also releases large amounts organic material such as artificial food or feces into the surrounding channels and until now only a few depuration systems for the water originating from the culturing activities exist. As a consequence, the quality of the water which is supplying the aquaculture regimes (fish farming but also bivalve cultures) is sometimes very poor. The resulting proliferation of algae and low oxygen concentrations in the water body can lead to the collapse of the species in culture. Only the traditional extensive as well as the improved extensive form of aquaculture is considered to be environmentally friendly (Arias, 1996).

###### **Ley 22/88 de Costas (Shore Law 1988)**

The repercussion/interpretation of the Shore Law 1988 in that the areas adjacent to the shore, including those that are subject to tidal changes and comprising most of the salt pond areas, belong to the maritime-terrestrial Public Domain of the state apparently puts a break to the development of the aquaculture activity itself and prevents the maintenance of the environment that is used for the respective activity (Arias & Drake, 1999). People performing aquaculture do not have interest in investing in their installations which are situated on property that is not belonging to them but to the public. As a result, former aquaculture installations are getting abandoned with deterioration of the particular habitat going on.

###### **High Production Costs/ Low Market Prices**

Apart from the above described repercussion of the Shore Law, there is a high risk

attributed to the sector of aquaculture which explains the retention of the banks to grant loans for further investments. Particularly for the principal species cultured in the Bay of Cádiz, *Sparus aurata*, market prices have been declining markedly during the last years. This is particularly attributed to the high costs that are associated with the cultivation in the Salinas compared to the production in open sea cages such as for example performed in Greece or Morocco. Especially the extensive form of production is not profitable any more even though it is considered to be the only form of cultivation compatible with the surrounding environment. "Cupimar" is the only enterprise that has been started to invest in open sea cages in order to reach a higher production and to have lower production costs (Barragán-Muñoz, 2003).

#### **Robbery and Lack of Control**

Large losses in the aquaculture production can be attributed to the robbery performed by single people or even by organized groups that are taking away large amount of fish, particularly out of the (semi-)intensive culturing units where fish is stocked in great densities. A recent announcement has revealed that around 600,000 € are annually lost by this kind of activity<sup>44</sup>. Robbery is of major concern especially to owners with restricted economic possibilities for paying surveillance for the sometimes extensive areas but also for the main enterprise "Cupimar" which has to invest a lot in surveillance which in turn augments production costs. This activity has not been controlled so far, neither the act itself nor the selling of the captured products on the streets (Arias & Drake, 1999).

#### **Furtive Fishing and Over-Exploitation of Stocks**

A lot of species are collected without any kind of permit and furtive fishing is taking place to a large extent, leading to over-exploitation of the stocks. Due to a general increase of the activity and the use of inadequate tools as previously mentioned, populations of some bivalve species such as *Scrobicularia plana*, *Cerastoderma edule* or *Solen marginatus* are thought to be endangered (Barragán-Muñoz, 2003). It has also been observed that the amount of organisms captured by the "marisqueo" has declined around 30 % during a five-year period (Villar, 1999).

The impact of illegal fishing in the channels, e.g. by means of trammel nets, is possibly one of the responsible factors for the rising difficulties in getting enough supply of young fish for the extensive aquaculture regimes which is entering the Salinas in a natural way. This in turn is resulting in a low production and a small yield (Arias & Drake, 1999).

#### **Predation by Ichthyophague Birds**

The high abundance of fish-predatory birds, particularly of the cormorant, causes large economic losses since not only large amounts of fish are captured out of the extensive or (semi-) intensive culturing tanks but also damage is caused to the fish if it is not caught properly and released back into ponds. The massive proliferation of ichthyophague birds is attributed to the high densities of fish in a given area. Because the natural park legislation does not allow the shooting or scaring away of the birds, investment into nets covering the ponds is necessary (Barragán-Muñoz, 2003).

#### **Transformation of the Habitat**

Out of the nature conservation point of view, transformations of some areas used for the culturing purpose lead to an alteration of the water level and changes in the species composition (e.g. ichthyophague bird species in favor of limicoles). Due to a higher profitability, the channels and ponds are deepened and broadened every time so that hydrodynamic conditions change and the original structure of the salt ponds gets lost.

#### **Urbanization and general human pressure**

Areas belonging to or being located at the edge of the to the Bay of Cádiz area are still

<sup>44</sup> <http://www.mispecies.com/noticias/2003/ago/030825-ladrones.asp>, accessed in August 2003

taken away due to construction purposes (e.g. amplification of the railway-lines, construction of bridges) or due to the local refilling of salt ponds with solid material (e.g. for amplification of university campus). This situation is not expected to change in future times since urbanization around the park is still increasing. Apart from the fact that more contamination originating from traffic and planned industry will affect the living resources, the described measures lead to a further fragmentation of the park with resulting hydrodynamic changes (e.g. circulation patterns of water masses in the interior part of the bay). Thus, life cycles of organisms which have been adapted to the original circumstances are now being affected by these changes, including the organisms that are exploited or used commercially.

## 4.2 Ria Formosa, Portugal

Similar to the situation in the Bay of Cádiz, within the Ria a variety of species is exploited or used in different manners: bivalve culture, finfish aquaculture, fishing by gear, gathering of invertebrates (“Mariscage”). The following table gives a list of the *principal* species used and their manner of exploitation. However, it is important to stress that this list is not exhaustive since particularly the “mariscage” is extended to many more species (Dinis et al., unpubl. interim reports, AQCESS project).

**Table 4 Principal species exploited in the Ria Formosa.** The list is based on different sources of written information as well as information gathered from the talks with different people listed in Annex III

<i>English term</i>	<i>Scientific Name</i>	<i>Manner of exploitation</i>
<b>Finfish</b>		
Gilthead sea bream	<i>Sparus aurata</i>	All forms of aquaculture; fishing
Sea bass	<i>Dicentrarchus labrax</i>	All forms of aquaculture; fishing
Sea breams	<i>Diplodus ssp.</i>	Extensive aquaculture; fishing
Soles	<i>Solea senegalensis</i> <i>Solea vulgaris</i>	Extensive aquaculture; experiments in other aquaculture regimes; fishing
Eel	<i>Anguila anguila</i>	Extensive aquaculture; fishing
<b>Shellfish</b>		
Clam	<i>Ruditapes decussatus</i>	Cultivation plots (“Viveiros”); Mariscage
Oysters	<i>Crassostrea ssp.</i> <i>Ostra edulis</i>	Viveiros
Cockle	<i>Cerastoderma edule</i>	Viveiros; Mariscage
Mussels	<i>Mytilus ssp.</i>	Viveiros; Mariscage
Golden carpet shell	<i>Tapes aureus</i>	(Viveiros); Mariscage
	<i>Venerupis ssp.</i>	Viveiros; Mariscage
Thick trough shell	<i>Spisula solida</i>	Mariscage
Peppery furrow shell	<i>Scrobicularia plana</i>	Mariscage
Razor shells	<i>Ensis ssp.</i> <i>Solen marginatus</i>	Mariscage Mariscage (only close to the inlets of the lagoon)
Snail	<i>Murex sp.</i>	Mariscage (as bait)
<b>Cuttlefish</b>		
Common cuttlefish	<i>Sepia officinalis</i>	Fishing/Mariscage; experiments in aquaculture
Common octopus	<i>Octopus vulgaris</i>	Fishing/Mariscage
<b>Crustaceans</b>		
Shrimp	<i>Upogebia sp.</i>	Mariscage (as bait)
Fiddler crab	<i>Uca tangeri</i>	Mariscage (only major claws)

<b>Other Invertebrates</b>		
Worms	<i>Marphysia sanguinea</i> <i>Diopatra sp.</i>	Mariscage (as bait)

Information compiled by personal communications or by published data

According to the statements of different people, most of the organisms naturally occurring in the Ria are already somehow exploited. However, experiments and research are performed for the improvement of production and for making better use of certain species. For example, flat-fish species such as *Solea senegalensis* are very much appreciated and have high market prices. As stated by Dias (pers. comm.), there are also other species such as prawns and *Sepia officinalis* that could be made better use of in terms of cultivation.

It is interesting to point out that two microalgae species naturally occurring in the sea, *Nanocloropsis oculata* and *Phayodactylum tricomutum* are grown in pure cultures and are thus commercially exploited by the local enterprise NECTON in the way that the favorable circumstances of the high solar radiation are used for the algae production on specially constructed panels. Obtained biomass is converted into fish food or alginates for the cosmetic industry. The same company has also re-established a traditional way of producing high-quality salt (“Flor de Sal”).

#### Bivalve Culture (“Viveiros”)

The most significant activity in terms of the exploitation of organisms in the Ria is the culturing of clams (*Ruditapes decussatus*) in bivalve bottom culture, so-called “viveiros”. These plots are run by single people usually organized in cooperatives which use manual methods for this kind of culturing activity (Sprung, pers. comm.). Usually, wooden sticks mark the borders of a licensed cultivation plot which is situated in the intertidal zone. The beds for the bivalves have to be prepared, renovated and cleaned frequently during the year and sand or gravel are added in order to improve the development of the bivalves. For the purpose of restocking, the leaseholder usually “plants” the bivalves by means of adding juveniles (seeds) that have been collected on natural banks to the culture plots. Afterwards, the bivalves are grown and harvested in the leases by each owner<sup>45</sup> (Manjua, pers. comm.).

Data that have been collected for the new Land Management Plan for the Ria Formosa (“Plan de Ordenamento da Parque Natural Ria Formosa, POPNRF”) give a

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<sup>45</sup> [http://europa.eu.int/comm/fisheries/doc\\_et\\_publ/liste\\_publi/studies/women/annex5\\_Portugal.pdf](http://europa.eu.int/comm/fisheries/doc_et_publ/liste_publi/studies/women/annex5_Portugal.pdf), accessed in July 2003

figure of 456 ha (=1319 licensed “viveiros”) that are actually being used for the extensive form of bivalve culturing with the main species being clams (*Ruditapes decussatus*) but also oysters (*Crassostrea* sp.), cockles (*Cerastoderma edule*) and– to a lesser extent– *Mytilus* sp. (see Table 4). However, there are still a few viveiros missing so that the actual number of both, number of “viveiros” and area extension, will slightly be larger (Cachola, pers. comm.).

### Finfish Aquaculture

Similar to the situation in Spain, different regimes of fish-cultures exist in the Ria: extensive, semi-intensive and intensive. Most common are the extensive and the semi-intensive forms, in the latter fry and feed being added (Santos, pers. comm.). In Portugal, extensive aquaculture is a relatively old activity dating back to ancient times. In the Ria Formosa lagoon system, it is either practiced in water reservoirs of salt pans or in specially constructed ponds where productivity depends entirely on the benthic organisms present (Gamito, 1997).

Recent figures of the DGPA (Direcção Gerale das Pescas e Aquicultura do Sul) reveal that, at present, there exist altogether nine active licensed aquaculture installations in the Ria (Arrobas, pers. comm.): five extensive, three semi-intensive, and one intensive<sup>46</sup>. These installations occupy an area of around 100 ha (Table 5). However, altogether 460 ha of the Ria Formosa area are registered for fishculture regimes (Cachola, pers. comm.). Hence, about 78.5 % of the licensed area is currently not used or the farms are inactive.

**Table 5 Fishculture Installations in the Ria Formosa**

Area [ha]	Production system	Species in culture
11.25	Extensive	Polyculture
1.5	Extensive	Polyculture
1.2	Extensive	Polyculture
3.6	Improved Extensive (*)	<i>Sparus aurata</i> , <i>Dicentrarchus labrax</i>
20	Improved Extensive (*)	<i>S. aurata</i>
12	Semi-Intensive	<i>S. aurata</i> , <i>Solea senegalensis</i>
14.4	Semi-Intensive	<i>S. aurata</i>
11.6	Semi-Intensive	<i>S. aurata</i> , <i>D. labrax</i>
25	Intensive	<i>S. aurata</i> , <i>D. labrax</i>
<b>Total 99.05</b>	<b>Total number: 9</b>	

Source: DGPA (Arrobas, pers. comm.)

(\*) Restocking with juveniles caught in the Ria or obtained from hatcheries in order to increase the production of fish of commercial value

<sup>46</sup> Similar to the situation in Cádiz it has been stated that the discrimination between semi-intensive and intensive aquaculture is not definite.

Cultivation farms in the Ria Formosa (both, finfish aquaculture farms and shellfish bottom culture) are individually or family owned. “Timar”, the largest finfish aquaculture company in the Algarve and situated in the Ria Formosa is the only significant exception (Pita et al., 2002). Here, besides the production for direct consumption, fry— mainly of the species *Sparus aurata*— is produced in hatcheries (Gamito, pers. comm.).

#### Gathering of Organisms (“Mariscage”) and Fishing activities

Parallel to the cultivation of bivalve mollusks on the cultivation plots and other fishing activities, there is a large activity related to the gathering of bivalves on natural banks and the collection of different invertebrates such as gastropods, crabs or polychaete worms on the flats and in the intertidal zone, undertaken by hand or adequate individual tools (Dinis et al., unpubl. interim reports, AQCESS project). The list of species harvested or gathered by hand is very long. However, the main species of interest are listed in Table 4. The major claw of the male fiddler crab, for example, is a local delicacy and thus a valuable economic resource for local fishermen (price in 1998: ~7.50 €/kg) (Oliveira et al., 2000). Worm species such as *Marphysia sanguinea* and *Diopatra* sp. are collected as bait and exported to Spain, France, and other countries (Erzini, pers. comm.). In general, many species are exploited by fishermen and tourists and it is a legal activity as far as it does not exceed 2 kg/species (Santos, pers. comm.). However, a lot of people not only collect for their own consumption but sell their products in larger quantities on the local market without having a license for the collection<sup>47</sup>. At present, there exist around 3000 licenses for the collection of bivalves in the Public Domain<sup>48</sup> (Arrobas, pers. comm.). Because of the fact that the leasers of the “viveiros” also need a license for the collection of seeds, their number (around 1300) is already included in the given figure.

In addition to the culturing and collection of marine organisms, artisan fishing is an important activity in the Ria where many people are involved in (Pita et al., 2002). Usually fishermen also hold a license for the collection or culturing of bivalves and thus the number of fishermen holding a license only for the purpose of fishing is not easy to say (Arrobas, pers. comm.). According to Santos (per. comm.) only a few

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<sup>47</sup> [http://europa.eu.int/comm/fisheries/doc\\_et\\_publ/liste\\_publi/studies/women/annex5\\_Portugal.pdf](http://europa.eu.int/comm/fisheries/doc_et_publ/liste_publi/studies/women/annex5_Portugal.pdf), accessed in July 2003

<sup>48</sup> For definition, see Annex I

fishery licenses for a variety of fish species such as *Diplodus* sp. (5-6 species), *Sparus aurata*, *Solea senegalensis*, *Dicentrarchus* sp. and the cuttlefish *Sepia officinalis* exist. Although being an ancient activity, fishing gear used in the Ria has remained artisan and is mainly limited to small gear. Nonetheless, a general increase in the fishery effort and in the efficiency of gear (e.g. the introduction of nylon) has led to large catches of juveniles which use the Ria as nursery site (Monteiro, 1989). The fishing gear that can be used legally in the Ria is regulated by a current legislation. Allowed are hook and line (including longlines), trammel nets, fish traps, push nets, jigs and lures. However, a lot of illegal fishing with beam trawls, beach seines and other not permitted gear still takes place (Pita et al., 2002).

#### 4.2.1 Facts on Production

In Portugal, shellfish production represents the major part of marine production (Pita et al., 2002). The importance of the Algarve in the national context in terms of shellfish production as well as of the main marine fish species sea bass, sea beam and -to a lesser extend sole- is represented in Table 6. In reference to the selected species given in Table 6, the Algarve accounts for around 70 % in quantity of the total marine production of the country.

**Table 6 Marine aquaculture production [in metric tons] of selected species for consumption in the different regions of Portugal (Provisional data of 2001).**

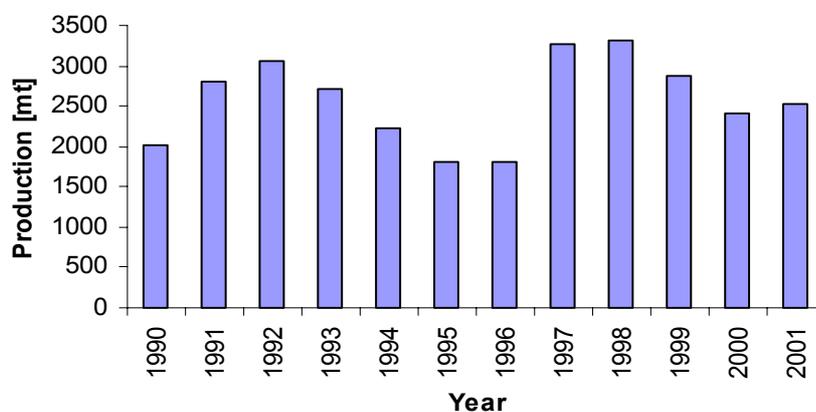
	Algarve	Alentejo	Centre	Lisbon and Vale do Tejo	Madeira	North	Total
<b>Main species</b>							
<b>Mollusks</b>							
<i>R. decussatus</i> (*)	2525.8		0.1	1.4			<b>2527.3</b>
<i>C. edulis</i>	24.2	0.6		3.4			<b>28.2</b>
<i>C. angulata</i>	375.4		117.1		72.5		<b>565.0</b>
<i>Mytilus</i> sp.	20.0			180.0			<b>200.0</b>
<b>Fish</b>							
<i>S. aurata</i>	874.5	129.2	95.1	662.5			<b>1761.2</b>
<i>D. labrax</i>	385.3	197.4	292.5	48.5		1.5	<b>925.2</b>
<i>S. vulgaris</i>	5.6	0.2	1.7	9.9			<b>17.4</b>
<b>Total</b>	<b>4211.8</b>	<b>327.4</b>	<b>506.5</b>	<b>905.7</b>	<b>72.5</b>	<b>1.5</b>	<b>6025.3</b>

Source: DGPA (Arrobas, pers. comm.)

(\*) Estimated production

The Ria Formosa is a major production area and of major importance in mariculture, both, at regional and national levels (Dinis et al. unpubl. interim reports, AQCESS project). Around 80-95 % of the national bivalve mollusk production takes place in the Ria Formosa (Procesl et al., 1999). According to the figures given by the DGPA, even 99 % of *Ruditapes decussatus*, the most important species in terms of

quantity and economic profit (Cachola, pers. comm.), was produced in the Ria Formosa in 2001 (see Table 6). Estimated production data of the last years of *R. decussatus* are depicted in Fig. 8.



**Fig. 8** Estimated production [in metric tons] of *Ruditapes decussatus* in the Ria Formosa. Source: DGPA (Arrobas, pers. comm.)

Compared to the situation around 15 years ago, when official clam production reached around 7000 tons in 1989 (data not shown), production declined to only 2000 tons in 1990 (Dinis, 1992). However, it has to be pointed towards the fact that the official production data have to be multiplied by a certain factor due to the fact that a high percentage of the bivalves, originating either from licensed bottom cultures or obtained by gathering activities, are sold on the market without either passing the purification or dispatching centers. Thus, official production data of the early 90s possibly represent only 20-30 % of the official production number whereas in the late 90s and beginning of the present decade the official figure can be augmented by approximately 50 %. Obviously –compared to the early 90s– more products pass the depuration process now due to stringent conditions concerning control of the water quality and labeling requirements as well as a rising awareness of the purchaser so that at present, the production in the whole Ria is estimated to be 3000 to 4000 tons/year (Manjua, pers. comm.). However, it is not possible to ascertain real mollusk production figures.

There are no figures about the production that has been obtained by means of fishing for the Ria Formosa lagoon alone. Within the Algarve fleet, the second most important of the whole country, the local fleet (boats  $\leq 9$  m in length) accounts for

85 % of the total numbers of registered boats (Pita et al., 2002). Parts of this fleet do not fish during winter time, it is usually multi-species and multi-gear in nature and in general there is no way to determine whether the catches derive from the coastal waters or the Ria (Dinis et al., unpubl. interim reports, AQCESS project). However, the importance of the Ria for the local fisheries is not only in terms of the quantity of fish and invertebrates captured but in the function of the lagoon as a habitat and nursery for juveniles of commercially important species. So far, 112 finfish species have been reported over the course of a two year project and it has been concluded that seabreams (Sparidae), sea bass (Moronidae), red mullets (Mullidae), grey mullet (Mugilidae) and sole (Solidae) are the most represented groups in the Ria (CEC, 2002).

#### 4.2.2 Socio-Economics

In the whole country there exist around 30,000 fishers and respective families and another 30 thousand persons and their families depending directly or indirectly on the fisheries sector (Pinho, 1999). The largest number of people employed in the fishery sector are inland and coastal fishery workers, and the Algarve is the region with the highest percentage of the working population that is involved in fisheries and aquaculture related activities (Pita et al., 2002). Taken, for example, the municipality of Olhão with Fuzeta, a community with a long fishery tradition, the fishery sector accounts for 21 % of the total enterprises of the municipality with 17 % of the resident population being employed (CCRAI, 1998).

From the socio-economic point of view, fishery and aquaculture represent one of the main important activities taking place in the Ria Formosa (see Table 7).

**Table 7 Main economic activities within in the Ria Formosa (not quantified).**

Main Sector	Activities
Fishery and Aquaculture	Fishing, Aquaculture, Harbors and traffic for vessels of fishery
Tourism	Touristic development, Recreational Navigation, Marinas, Golf courses, Beach tourism, Other nautical sports
Research (University of the Algarve)	
Urbanization	Urbanization, Infrastructure construction for access and for waste water
Nature Conservation	Management and planning
Shipping	Ports and Harbors, Vessel traffic, Petrol and Chemical Terminals
Transports	International Airport
Agriculture	Intensive and extensive agriculture in the watershed (pig and chicken farms)
Sand extraction	Sand extraction out of the major channels but

	also other parts of the Ria for construction purpose etc.
Salt extraction	

Changed after Dinis et al., unpubl. interim reports, AQCESS project, taken into account the talks with different people.

The fish-canning industry used to be quite important for locally caught fish but declining fishing rates resulted in many people losing their jobs and searching for alternative sources of income.

According to Arrobas (pers. comm.) bivalve culturing and therewith related activities could be the most important sector within the Ria Formosa next to the sector of tourism. The actual number of fishermen registered in the “Capitanias” (marine Authorities) is 3000. Given the fact that the fishery sector is usually a family business, including wife and children, there can easily be augmented another 1000 to 1200 people to the given figure. Moreover, there are people who are working in the converting industry and the sector of commercialization such as depuration, conservation and dispatching, leading to a number around 6000-7000 people employed in the bivalves and other related fisheries. This figure could even be higher since there are many people capturing without any license (Arrobas pers. comm.). Hence, it is estimated that altogether around 8-10,000 people are depending on the fishery sector in the Ria Formosa (Cachola, pers. comm.). Given the fact that at present the active population of the municipalities pertaining to the Ria Formosa amounts to 50,080<sup>49</sup>, approximately 20 % of the active population in the Ria Formosa is directly or indirectly dependent on the fishery sector.

The importance of the fishery sector –particularly of the bivalve culturing and harvesting/gathering activities –is very much attributed to the high productivity of the Ria Formosa lagoon system but also to the commercial value of the bivalves (Rosado & Bruxelas, 1995). Actual prices on the local market are: 13-14 €/ kg for *Ruditapes decussatus*, 2-3 €/ kg for *Cerastoderma edule*, 8 €/ kg for *Tapes aureus* and 5 €/ kg or 10 €/ kg for *Solen marginatus* with and without shell, respectively. Prices vary according to the sizes of the products and the time of the year. *Ensis* ssp. (*Ensis ensis* and *Ensis siliqua*) is a much desired product because it is part of a traditional plate. Also the Spanish people have a lot of interest in buying this species for selling them on their market (Arrobas, pers. comm.). Thus, the market price of razor shells can even go up to 20 €/ kg (Amaral, pers. comm.).

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<sup>49</sup> Data made available by the INE=Instituto Nacional de Estatística via email-request

Apparently, the sector of bivalve culturing and harvesting is no professionalized sector and quite a lot of people are performing this kind of business only for their own subsistence and for increasing the family's income. A lot of producers don't declare their products for not having to pay the high taxes. Also, many of the fishermen have secondary jobs, e.g. working in construction or in restaurants during summer time (Diaz, pers. comm.). According to Arrobas (pers. comm.), the President of the Council of Olhão puts it like this: "The area of the Ria Formosa is like a pillow of support when there is no employment".

### 4.2.3 Principal Problems

The most striking problems and effects that have been mentioned by the interlocutors and located in the cited literature in relation to the exploitation of marine bio-resources in the Ria Formosa are summarized in Box 4.

#### Box 4

##### **Water Quality**

Even though around 70 % of the lagoon water is renewed at each spring tide (Falcão & Vale, 1998) and improvements for the water circulation within the Ria have been introduced in recent years such as the artificial opening of the INDIA inlet in 1997 (Newton & Icely, 2002), sometimes water exchange in inner parts of the Ria is low. This is causing problems for the culturing units that are situated in these areas. Particularly during dead tides seasonal mortality of bivalve cultures has occurred as a result of toxic phytoplankton blooms and low oxygen concentration in combination with high temperatures of the water body. Such eutrophication problems can be attributed to non-specific sources (golf-course effluents, sewage water entering the lagoon, particularly at high season when capacity for water treatment is insufficient) but, however, there are indications that agriculture makes a greater contribution to nutrient inputs than sewage (Newton et al., in press) since the hydrographic basin of the Ria Formosa includes areas that are subjected to intensive poultry and pig rearing (Newton & Icely, 2002). Problems of local eutrophication can apparently also be related to organic sewage water (including loads of antibiotics, medicine) released into the Ria from the semi and semi-intensive form of fish aquacultures. However, so far assured information on that topic is very scarce. Mentioned losses in bivalve production over the last two decades can probably be attributed to the general deterioration in water quality (Newton et al., in press).

##### **Illegal Fishing and Over-Exploitation**

Illegal fishing activities include scuba diving to harvest bivalves and fishing with banned gears such as the beam trawl (Pita et al., 2002). Even though there do not exist reliable data to support effects of over-exploitation, there have been expressed many concerns about the intensification of fishing activities in the Ria and the resulting pressure on natural banks and juvenile stages due to the collection of seeds that are sown on the ground plots. Particularly the group of the razor shells is exposed to high pressure and the stock is expected to drastically decline within a few years because, due to their high market price, tons of this species are collected from the wild. They are not only gathered by hand in the intertidal zone but also collected by means of the illegal activity of scuba-diving.

##### **Robbery and Non-Declaration of Products**

A lot of bivalves are robbed from the ground plots –particularly at night time– which is

lowering the final yield of the leaseholder's culture plot. A lot of people get a grant from the government because they are unemployed but they still work in the Ria without declaring their products. This is particularly negative for the farmers since they hold their licenses officially and have to pay taxes for the legal production.

Apparently, high taxes are the reason for the non-declaration of the products. This causes a lot of problems in terms of political decisions: since if official production numbers are low little importance is attributed to the fishery sector and no funds are given for any further investments.

#### **Lack of Environmental Awareness**

Even though people are noticing that the increasing pressure on the Ria Formosa lagoon is having some negative effect on the natural resources (e.g. declining productivity, higher mortality), it seems that the exploitation of the organisms goes on without the necessary concern for maintaining these resources for future generations. In general, there is missing an ecologic way of thinking. According to certain interlocutors, the lack of environmental education, particularly of the elder generations, will partly be responsible for this phenomenon.

#### **Marketing Structures and Low Market Prices**

Concerning bivalves, there seem to be far too many intermediate steps between producer and consumer. So far, the price of the end products is not reflecting its real value and there has not been introduced a label that states origin and quality. As a consequence, it is even possible to find products from the Ria Formosa with a Spanish label in the north of Spain for a much higher price.

If talking about finfish there exist a lot of problems for the local producers concerning the market prices since many cheaper products are entering the market from foreign countries such as Greece.

#### **Bureaucracy and Lack of Control**

Many different legislations exist but nobody really converts them into practice. It seems that bureaucracy acts as a deterrent for many people to work and behave in a legal way or to establish a proper business. EU-legislations that are constantly being changed or renewed apparently complicate this situation. Furthermore, illegal activities concerning fishing or the construction on the islands are not controlled or cannot be controlled properly by the responsible bodies which are the "Capitania" and the Ria Formosa.

#### **Urbanization and General Human Pressure**

There is a lot of human pressure on the system due to the many activities that are related to the construction within and around the Ria Formosa. On the one hand, there are many illegal constructions on the islands which bring about negative effects such as the destabilization of the dune belt, the release of untreated sewage water into the lagoon or general waste problems. These islands have already been occupied for a long time with settlements that were and still are related to fishing activities (Bernardo et al., 2002) but no new installations are allowed any more. On the other hand, there is a lot of building activity taking place that is related to the increasing tourism around the Ria, implicating more pressure on the lagoon system as a whole.

There are also problems with the use of the lagoon in terms of recreational and leisure activities. Activities with larger over-seized boats are increasing and a stronger wave action is leading to the breaking off of the edges of salt marshes and bivalve culture plots. The impact of boats (gas and oil) on the bivalves has not been studied so far but it is also believed that it can partly be responsible for higher mortalities in summer time when boat activity is greatest.

#### **Introduction of Foreign Species**

In the 1980's the pacific oyster *Crassostrea gigas* has been introduced which is slowly but steadily replacing the less resistant but native species *Crassostrea angulata*. Also seeds of

the species *Ostra edulis* are imported from France. As a consequence, unfavorable genetic interchange is taking place with the high-quality native species (better taste) loosing terrain.

#### **Transformation of the Habitat (Dredging Activities, Sand Movement)**

Several years ago dredging of the main channels was introduced in order to improve the water circulation in the system and to stabilize the dune belt<sup>50</sup>. However, the effect on the system has not been studied well and the “viveiros” situated near the dredging activities are exposed to dropping down so that the edges need to be stabilized and sand movement on the “viveiros” has to be enhanced (see below). Besides, dredging is leading to a general reduction of the salt marsh area. Changes of the sediment patterns have also led to a decrease of seagrasses (*Zostera* sp.) with resulting higher loads of unfixed sand in the system. However, *Zostera* is very important for the trapping of bivalve-larvae and its disappearance could be of a long term problem for the recruitment of many species.

Not only for the purpose of stabilizing the sediments but also in order to improve the quality of the sediment for the growth of the bivalves (reduction of the anoxic layer), sand movement on the “viveiros” is taking place. This sand has been taken out of the system somewhere else and resulting effects on the natural sedimentation patterns are of still unknown dimensions. In general, geomorphologic processes are leading to the fact that the islands are getting smaller and that the lagoon is exposed to silting up. However, the sand work in the viveiros could enhance this natural process.

### **4.3 Wadden Sea Area of Lower Saxony, Germany**

The Wadden Sea area of Lower Saxony, Germany, is restricted concerning the exploitation of marine bio-resources. Except for the culturing of the blue mussel on defined ground plots, no further kind of aquaculture is performed on the spot, and the use of marine organisms is restricted to the harvesting of the blue mussel, *Mytilus edulis*, and the mixed form of shrimp and flat-fish fishing according to the season (Gubernator, 1995) (Table 8). Since fishing for flat-fish is almost exclusively performed outside the Wadden Sea (Gubernator, 1995), in the following, no reference is given to this kind of fishery.

**Table 8 Principal species exploited in the Wadden Sea area of Lower Saxony.** The list is based on the sources of written information as well as from interlocutors as listed in Annex III

<i>English term</i>	<i>Scientific Name</i>	<i>Manner of exploitation</i>
<b>Shellfish</b>		
Blue mussel	<i>Mytilus edulis</i>	Seed fishing, final growth on bottom cultures (cultivation plots)
<b>Crustaceans</b>		
Shrimp	<i>Crangon crangon</i>	Fishing (mixed coastal fishing)

Information compiled by personal communications

Concerning other species, it can be stated that at present no cultivation of potential species such as oysters is being performed in the Lower Saxonian Wadden Sea

<sup>50</sup> <http://www.pml.ac.uk/biomare/docs/Second%20questionnaire%20Sprung.doc>, accessed in July 2003

(CWSS, 2002) neither is there taking place any form of commercial culturing of macroalgae on the spot. However, projects are being performed in order to test the cultivation of macroalgae for the development of specific products in cosmetics or edibles (Walter et al., 2003). According to Gubernator (pers. comm.), predominant bivalve species such as *Ensis* ssp. could potentially be exploited commercially but apparently there is a lack of consumer demand that would justify any other marine mollusk fisheries. Cockle fishery (*Cerastoderma edulis*) which has been practiced in the past and where abundance is high has been banned for political reasons in 1992 due to a high pressure imposed by rising environmental concern (Seaman & Ruth, 1997) and is not allowed any more in the whole Lower Saxonian Conservation Area according to the Blue Mussel Management Plan (CWSS, 2002). For any further information about mollusk fishery and cultures in Germany, see Schlauch (1999).

#### Blue Mussel Fishing and Harvesting

The mussel fishing in Lower Saxony consists of a combination between the fishing of seed mussels<sup>51</sup> from natural beds and the culturing of the seeds. Fishing for consumption mussels is only permitted on sublittoral banks (CWSS, 2002). Seed mussels for stocking culture lots are fished by means of dredging at a size of 10-40 mm in areas of the Wadden Sea which previously have been selected by the fishermen and authorized by the State Fisheries Administration (Gubernator, unpubl. report). At present, 48 out of 187 locations of documented natural mussel beds in the eulittoral are excluded from fishery (CWSS, 1999). Officially, mussel seeds are fished up from the beginning of October until the end of February, and –with a special permission – between the beginning of May and the middle of June on the allocated banks which have been divided according to prior oral consultation between the fishermen. Equipment and procedure for the fishing of mussels have been described in Seaman & Ruth (1997).

In general, the German blue mussel culture is an extensive bottom culture (Seaman & Ruth, 1997). Seed mussels are run out on the culturing plots where they grow for 600-700 days until they reach the market size for consumption ( $\geq 5$  cm) and are harvested by means of dredging (Gubernator, unpubl. report). Fishermen have to submit an application specifying the location and size of the culture plot and state authorities will grant the plot at a nominal fee if there are no conflicts with other user

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<sup>51</sup> For definition, see Annex I

groups (Seaman & Ruth, 1997). In Lower Saxony, the maximum size of mussel cultures in use is restricted to 1300 ha (CWSS, 2002). At present, there exist altogether 32 culture plots of different sizes– ranging from around 8.4 ha to 150.8 ha– that are occupying a total area of 1274.82 ha. They are located in intertidal or subtidal areas and have been selected according to the experiences of the fishermen (Hagena, pers. comm.). Moreover, there are two smaller plots (altogether 5.44 ha) that are used for scientific purposes (data provided by Hagena, pers. comm.).

In the Wadden Sea area of Lower Saxony, investigations with long-lines are currently being performed for the purpose of developing a method for gaining additional seed mussels. Here, the lines act as collectors for the pelagic larvae. By means of this procedure it is aimed to improve the availability of seed mussels since natural recruitment on wild beds occurs irregularly (Walter & Liebezeit, 2001).

### Shrimp Fishing

Prawns are fished in the form of a mixed coastal fishery which is the largest fishery branch in German coastal water. In addition to flat-fish fishery, which only takes place off the Wadden Sea, trawlers carry out shrimp fishing in as well as outside the Wadden Sea (Gubernator, 1995). According to Hagena (pers. comm.), at present, there are 145 trawlers of this mixed coastal fleet performing shrimp fishing; they are split on 17 harbors along the coast. The fleet itself is fairly old (around 35 to 40 years) with boats of around 16-20 m length. Fishing grounds of this fleet are strictly separated. Every harbor has its own tidal creek system where fishing takes place. To a large extent, prawn fishing in Lower Saxony is still adapted to the tides (Gubernator, 1995). The fishery device used for shrimp fishing is the so-called “Baumkurre” which has been described in Walter (1996). It has been estimated that around one third of the Lower Saxonian Wadden Sea area is used for shrimp fishing –apart from the area in front of the islands (Gubernator, unpubl. report). Apart from shrimps fished for food consumption (consumable shrimps), in Lower Saxony, also smaller shrimps are allowed to be landed which are processed into animal food (fodder shrimps) (Gubernator, 1995).

#### **4.3.1 Facts on Production**

Since the middle of the 1980s the blue mussel stock of the Lower Saxonian tidal flats has declined which has been attributed to different factors such as predation by seabirds, parasites, macroalgal cover, pollutants, dredging and dumping of sediments

or storm and ice rafting but also to the direct effect of mussel fishing (see Herlyn & Millat, 2000 and related references). The development and estimated biomass of blue mussel beds in Lower Saxony determined by aerial photographs during the last twelve years is presented in Table 9.

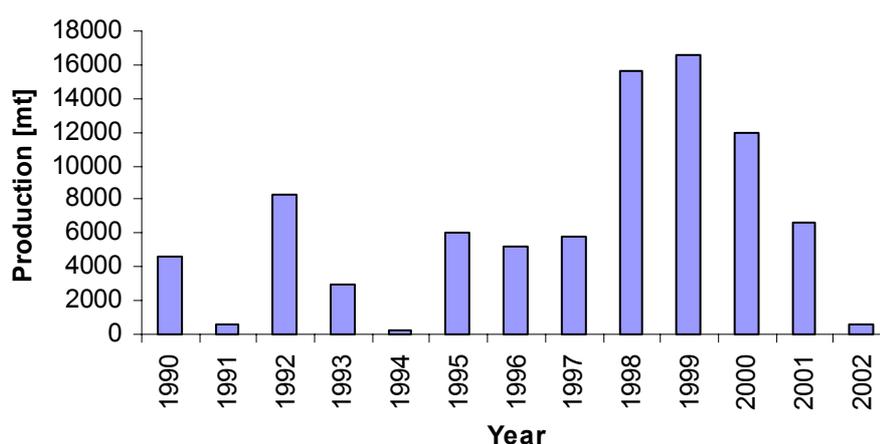
**Table 9 Development of blue mussel beds [ha] and total biomass of blue mussels [tons fresh weight] in Lower Saxony during the last ten years**

Year	Area [ha]	Estimated Biomass [tons fresh weight]
1991	2700*	46000
1992		
1993		
1994	1300	9000
1995		
1996	170	1000
1997	1280	25000
1998		
1999	2895	110000
2000	2342	70000
2001	1918	55000
2002	1700**	25000**

Data according to CWSS (2002)

\* Data from the period 1989-1991; \*\* TMAP Blue Mussel Workshop Wilhelmshaven 2003<sup>52</sup>

The decline of natural mussel beds brings about effects in production numbers. Average annual landings of mussels over the period 1991-2000 were 7332 mt gross weight (CWSS, 2002). But, however, similar to the observed figures given in Table 9, large fluctuations can be observed concerning the landings (production) of mussels during the last twelve years (Fig. 9).



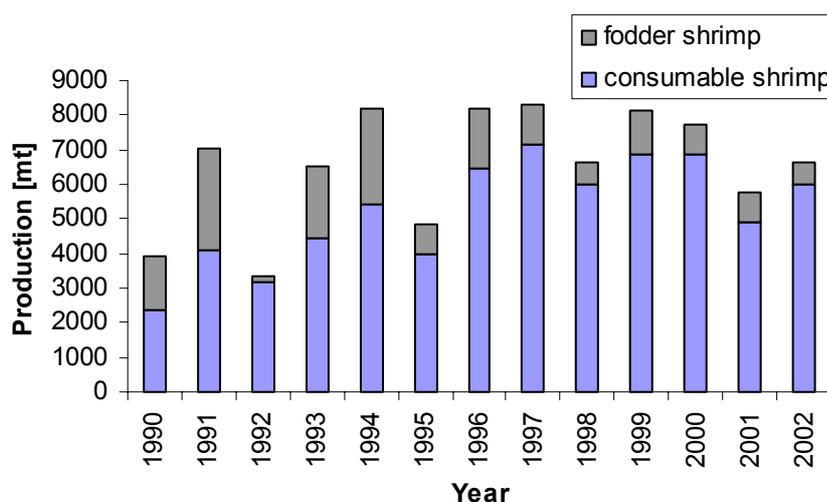
**Fig. 9 Average production [in metric tons] of the Blue Mussel in Lower Saxony during the last twelve years.** Source: State Fisheries Administration (Hagena, pers. comm.)

<sup>52</sup> <http://www.waddensea-secretariat.org/workshops/mussels/BM-minutes-2003.doc>, accessed in July 2003

Next to 1991 and 1994, in 2002 production has been among the lowest (642 mt). Reasons for the dramatic losses in 1991 and 1994 have been attributed to severe hydrographic conditions in the previous years such as storms, ice rafting, which caused recruitment failures (“Brutfall”) or destroyed existing mussel beds (Gubernator, unpubl. report). Nevertheless, on national scale production numbers of mussels gained in Lower Saxony are normally quite good (Hagena, pers. comm.).

*Crangon crangon* is among the most abundant macrofaunal species of the Wadden Sea area and the North sea. Around 90 % of this species is caught in the Wadden Sea and adjacent coastal waters until a depth of 20 m. Whereas during the last 25 years landings of the Wadden Sea states have increased annually by 280 t on average, in other regions numbers have declined (Buschbaum & Nehls, 2003). A general modernization of the fleet has caused the production to rise even though the number of fishing enterprises is decreasing (Gubernator, 1995). However, consumable shrimp production is the branch that gains the highest profit among the German fishery section and consequently production numbers are of high national importance (Hagena, pers. comm.).

Until two to three years ago more than 50 % of the Wadden Sea landings could be attributed to the German fleet but have now been surpassed by the Netherlands (Hagena, pers. comm.). Production numbers of consumable shrimps and of fodder shrimps during the last twelve years in Lower Saxony are depicted in Fig. 10. With a production of around 6640 mt, the year 2002 can be considered as a regular year concerning shrimp fishing.



**Fig. 10** Average production [in metric tons] of shrimps in Lower Saxony during the last twelve years. Source: State Fisheries Administration (Hagena, pers. comm.)

Landing of shrimps processed into animal feed is allowed in Lower Saxony. However, at an average of 86 % most of the landing can be ascribed to consumable shrimp. Generally and similar to the blue mussel, the production of shrimps is very much dependent on hydrographic factors such as temperature. Therefore, the amount of landings can vary drastically during the course of the year which nevertheless, is reflected in changing market prices (Gubernator, unpubl. report).

#### **4.3.2 Socio-Economics**

Generally speaking, the Lower Saxonian coastal fishery of mussels and shrimps plays only a subordinate role in the total system of the North Sea fishery (Gubernator, unpubl. report). According to Gubernator (pers. comm.), at present altogether 18 people are employed in the mussel fishery sector in Lower Saxony. The fishery itself is actually being performed by four companies situated in Greetsiel, Norddeich, and Hooksiel. They are holding five trawlers altogether. Commercialization of produced mussels takes exclusively place in The Netherlands and there is no processing industry along the coast, thus no indirect working places depend on this business.

Concerning shrimp fisheries, the situation is slightly different in that the predominance of The Netherlands in terms of commercialization is not exclusive. Around 60 to 70 % of the catches are directly sold to The Netherlands with the resting percentage being commercialized in Germany (De Beer, pers. comm.). However, pricing takes place in the auctions of The Netherlands and three Dutch wholesalers dominate the European market.

Generally, processing is not taking place on the spot any more. The last shrimp shelling machine on the Lower Saxonian coast has ceased its business due to little cost-effectiveness and shelling of shrimps is mainly performed in Morocco and Poland (De Beer, pers. comm.). According to Gubernator (unpubl. report), an estimated 15 people are employed directly and indirectly per coastal fishing vessel. Presuming an actual fleet of 145 vessels (Hagena, pers. comm.), a total amount of 2175 people are employed in shrimp fishing in addition to the above mentioned 18

persons. Given the fact that there is an economically active population of 307,600<sup>53</sup> people in the rural districts along the Lower Saxonian Wadden Sea coast, only around 0.71 % are employed in the Lower Saxonian Wadden Sea fishery sector. (sideline occupation).

According to Hagen (pers. comm.), sideline-fishery<sup>54</sup> or artisan fishery is of no significance in the Lower Saxonian Wadden Sea and only a few people exist that fish mainly on crabs by means of anchored gillnets or by means of baskets.

Generally, the fishery sector is judged to be economically stable (Gubernator, pers. comm.). However, there are some problems with young professionals and to around 99 % recruitment takes place out of the own families. At present, whole shrimps or only the meat of shrimps are sold at around 4 €/kg and 26 €/kg, respectively (own observation). For the year 2002, average producer prices for consumable shrimp and mussels have been attributed to 3.4 €/kg and 0.87 €/kg, respectively, which amounted to a revenue of 20.403.008 € (shrimps) and 559.000 € (mussels) (data from the State Fisheries Administration: Hagen, pers. comm.). Consequently, compared to shrimp fishing, mussel fishery is of less economic importance in Lower Saxony.

With tourism considered to be the most important economic activity in a structurally weak region (Hagen, pers. comm.), mussel and shrimp fishery contribute only to a small extend to the total income of the coastal region (Gubernator, 1995) –besides other activities such as harbors or the shipping industry. However, it is important to note that tourism and fishery cannot be judged separately from each other. A significant part of the generated income in the small port villages is attributed to the attraction that this traditional fishery trade brings about.

### 4.3.3 Principal Problems

The main problems mentioned by the interlocutors or in the cited literature concerning prawn and mussel fishery in the Wadden Sea of Lower Saxony are described in Box 5.

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<sup>53</sup> Source: Niedersächsisches Landesamt für Statistik, data from 2001. The active population of the counties Cuxhaven, Wesermarsch, Friesland, Wittmund and Aurich as well as the towns free of a county (“kreisfreie Städte”) Emden and Wilhelmshaven are taken into consideration for the calculation ([http://www.nls.niedersachsen.de/Tabellen/Wertschoepfung/VGR\\_Kreis.html](http://www.nls.niedersachsen.de/Tabellen/Wertschoepfung/VGR_Kreis.html)), accessed in August 2003.

<sup>54</sup> Sideline-fishery (“Nebenerwerbsfischerei”) is only considered as so if certain preconditions such as the realization of at least 2000 € profit/year are accomplished. Hence, it does not include sport fishery (Hagen, pers. comm.).

**Box 5****User Conflicts**

User conflicts within the Wadden sea area are of concern for the exploitation of mussels and shrimps in terms of the restriction of potential fishing grounds. Large dredging activities for the purpose of sand and shell extraction as well as for maintaining the depression in the river mouths (rivers Ems, Weser, and Elbe) are causing a decreasing stability and subsidence of the seafloor sediments which in turn lead to an overall decline of areas available for the development and existence of natural mussel beds. Moreover, the proposed construction of the deep harbor in Wilhelmshaven, planned windparks off the islands as well as the continuing construction of large cables and pipelines are further reducing potential fishing grounds. The use of harbors is quite intensive and the main shipping channels are running alongside the Lower Saxony coast. Apart from being a constant threat for the ecosystem and consequently the health of the fishery sector, these shipping channels are potential fishing areas that are excluded from fishing. Besides the above mentioned reasons for the decrease of potential fishing grounds, some areas within the Wadden Sea have been excluded from any kind of fishing activity due to protection and conservation measures (e.g. the area between the Weser and Elbe estuaries).

**Constant Recruitment of Seed Mussels**

According to Hagena (pers. comm.) the yearly recruitment of seed mussels can be considered as “the bottleneck” in the commercial mussel fishery. A combination of natural disturbances and an increasing fishery effort on seed mussels in years of low recruitment have been discussed as the reason for mussel bed declines in the Wadden Sea (Dekker, 2001). Since seed mussel fishery is indispensable for a stocking of the bottom culture plots, final production largely depends on the availability of mussel seeds.

**Predation of birds, particularly Eiderducks (*Somateria mollissima*)**

Eiderducks but also oystercatchers (*Hameatopus ostralegus*), predators of mussels and consequently dependent upon the biotopes of mussel beds, are of great concern for the fishermen. According to the National Park Act of Lower Saxony (§6) it is not allowed to chase away such birds. But, particularly eiderducks are good divers and can take away large amount of mussels, even from the sublittoral banks. Since mussels usually stick to each other, not only single individuals but whole bunches are pulled out of a mussel bank by the birds. Even though not all of the mussels are incorporated, due to currents, particularly in combination with storms, the mussel-clumps usually drift away from the mussel beds and are therefore lost for the fishermen.

**Introduction of Foreign Species**

The pacific oyster *Crassostrea gigas*, imported to the North Sea for aquaculture around 30 years ago in order to replenish the native but extinct species *Ostra edulis*, has started to colonize the local Wadden flats. The introduction of this non-native species was regarded as uncritical due to the low water temperatures of the North Sea (no natural production), but strong spatfall occurred in several years in the Oosterschelde estuary, The Netherlands (Wehrmann et al., 2000). Even though the possible impact of this species, at the meantime extended wild populations, on mussel banks in terms of competitor for food and habitat can not be foreseen so far, the dimension of its dispersion is of major concern.

**Transformation of the Habitat (Fishery Impact)**

Depending on the current political atmosphere, more or less friction between fishery and nature conservation authorities exist which are mainly related to the general removal of biomass, the selectivity of the gear and the change of the flora and fauna of the seafloor caused by fishing (e.g. disturbance of the bottom structure and the associated ecosystem or bycatch in the shrimp fishery) (Buschbaum and Nehls, 2003). Moreover, apparently seed mussel fishery competes with birds depending on mussels of the same size class (Herlyn & Millat, 2000) and hence from the point of view of nature conservation, mussel fishery is considered to be a problem in terms of food shortages for wintering birds after years of

little recruitment.

#### **EU-Legislations and Bureaucracy**

The orders of the European Community have to be converted into national law but are constantly changed and revised, a fact that causes rising bureaucracy and generally complicates regional decision making and management. Moreover, regional differences are not taken into consideration so that some of the legal constraints imposed by the EU are missing their target. For example, the reduction of the fleet capacity imposed by the EU has led to an disparity between the German and Dutch coastal fleet in terms of the size and catch capacity of the vessels used for shrimp fishing. Apparently, this brings about disadvantages for the German shrimp fishermen since the Dutch vessels can fish in much deeper water and all year round in fishing grounds of common interest. The fact that The Netherlands were able to restructure their fleet for shrimp fishery in a positive way can largely be attributed to the much more active Dutch fishery lobby in comparison to the German one. Generally, the decision making process taking place in Brussels is rather considered to complicate future perspectives of the fishery sector in Lower Saxony if the implementation of EU-regulations in the different countries differ from each other

For the mussel fishery, changes have been imposed in the frame of the EU-fishery fleet in terms of the registration of the vessels. For the future, the companies have to decide whether to register their vessels as fishery fleet vessels or as aquaculture vessels. Both types of registration bring about disadvantages, and the consequences on the mussel fishery sector can not be foreseen at that time.

#### **Marketing Structures**

Particularly concerning shrimp fishery, there is a large amount of intermediate steps from the producer to the final consumer with most of the steps being under the supervision of or even taking place in The Netherlands. Consequently, the profit margin of the producers in Lower Saxony is comparatively low. Moreover, pricing of the products takes exclusively place in the auctions of The Netherlands and there is a high market domination of three Dutch wholesalers.

## **4.4 Similarities and Differences**

### Protection status

As already mentioned in 3.4, the denomination of the Lower Saxonian Wadden Sea as a national park comprises a higher protection status in comparison to the two southern European coastal sites nominated natural park. In the latter, more activities are allowed in general terms. Furthermore, a national park belongs to the six protected area management categories of the International Union for Conservation of Nature and Natural Resources (IUCN) to which international criteria apply to that have to be complied with<sup>55</sup>. In contrast, a “natural park” is no official protection category but an additional predicate of an already existing sanctuary<sup>56</sup>.

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<sup>55</sup> [http://www.unep-wcmc.org/protected\\_areas/categories/](http://www.unep-wcmc.org/protected_areas/categories/), accessed in October 2003

<sup>56</sup> <http://www.ubavie.gv.at/umweltsituation/nationalparke/gebiete/info/rechtl.htm>, accessed in October 2003

### Exploitation

The most striking difference between the Bay of Cádiz and the Ria Formosa on the one hand and the Lower Saxonian Wadden Sea on the other hand is the fact that in the latter the commercial exploitation of organisms is restricted to two species (shrimps and mussels) whereby in the two southern coastal areas a large variety of species is used. Moreover, except of the culturing of seed mussels on the ground plots, in the Lower Saxonian Wadden Sea no kind of aquaculture is being performed for any other species such as finfish. Here, the two species of interest are either obtained by means of fishing (shrimps) or by a combination between seed mussel fishing from natural beds and the cultivation of the seeds on specified areas (Blue mussel)<sup>57</sup>.

Principally due to climatic conditions but also as a result of topographic and oceanographic circumstances (Erzini, unpubl. consultancy report), in the Ria Formosa and in the Bay of Cádiz similar species occur. In both areas, exploitation of those species takes place in similar manners. These forms of exploitation include:

- different regimes of aquaculture in traditional or transformed Salinas (both sites) as well as in specially constructed ponds (Ria Formosa),
- gathering and harvesting of invertebrates, bivalves or crustaceans
- bivalve culturing in the intertidal zones on ground plots that are either restocked by mussel seeds collected in the wild (Ria Formosa) or where seeds are supplied by hatcheries (Bay of Cádiz)
- artisan or recreational fishing by relatively small boats or from land.

However, whereas in the Ria Formosa the most significant official fishery activity is the culturing of clams (*Ruditapes decussatus*) in bivalve bottom cultures, in the Bay of Cádiz marine aquaculture of finfish species, particularly of the Gilthead sea bream (*Sparus aurata*), is the principal form of exploitation. This observance is supported by the fact that the ratio of the total area actively used for bivalve culturing to the total area actively used for aquaculture purposes is 4.6:1 in the Ria Formosa but 1:493 in the Bay of Cádiz. Hence, in the Bay of Cádiz the commercial exploitation of marine bio-resources is more one-sided than in the Ria Formosa. The reason for the fact that in two areas with similar preconditions (e.g. old Salinas,

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<sup>57</sup> It is important to note that investigations on marine bio-resources performed in research centres or universities are not considered in this context.

intertidal areas) the commercial use of organisms is directed towards two different activities has not been investigated any further but can possibly be attributed to traditional and cultural aspects as well as to the transformations and restructuring that have been taken place in the past, particularly in the Bay of Cádiz in response to the salt crisis in the first half of the twentieth century.

In both areas, the Ria Formosa and the Bay of Cádiz, artisan fishing with simple gear as well as the gathering and fishing of a large variety of different organisms have ever been a manner of using organisms and can thus be considered as a traditional occupation. However, these activities have gained more attention in that the number of people involved in this business has increased over the last years and that part of this activity is performed at the margin of the legal norms (concerning problems, see below). In contrast, even though artisan fishery is performed in the Lower Saxonian Wadden Sea to a small extent (Hagena, pers. comm.), its dimension is in no way comparable to the situation in the southern European coastal sites and consequently no subject matter in terms of the exploitation of marine organisms.

In terms of species that could potentially been exploited, current investigations are mainly restricted to the improvement of production measures for species that could be reared better in aquaculture (Ria Formosa and Bay of Cádiz). It seems that, in general, there is little investigation related to any new species that have not already been or are not exploited to a certain extent by now, such as macroalgal species. In the Ria Formosa there is one company situated within the area of a traditional salt pond, using the high solar radiation for the commercial production of microalgae for fish food or alginates. In the Bay of Cádiz a naturally occurring tunicate species is analyzed that is thought to contain substances against cancer, but, here it is an external enterprise that is performing the research. Missing local spirit for launching new enterprises for a use of further marine organisms (Bay of Cádiz), nontransparent bureaucracy (Ria Formosa) as well as a lack of consumer demand and rigid environmental regulations (Lower Saxonian Wadden Sea) are the main reasons for a relatively fixed situation in the three sites.

#### Facts on Production

The production numbers of the respective main species of commercial interest in the three sites cannot be compared directly with each other due to inconsistencies in:

- the principally produced species, e.g. Ria Formosa: clams, Bay of Cádiz: Gilthead sea bream, Wadden Sea: mussels and shrimps
- the main form of exploitation, e.g. Wadden Sea: fishing and mussel culturing, Bay of Cádiz: finfish aquaculture, Ria Formosa: clam culturing
- the relative proportion of the exploitation systems (e.g. extensive or (semi-) intensive aquaculture regimes) in the respective area
- the non-declaration of products or losses due to robbery (Ria Formosa, Bay of Cádiz).

Even though according to Walter (pers. comm.), direct selling of mussels of shrimps without any declaration also takes place to a very small extent in Lower Saxony, no black market for those products exists and it is not justifiable to talk about such a market (Hagena, pers. comm.). This is in contrast to the two southern European coastal areas. However, all three sites have in common that the production numbers of the respective species of interest are important at regional (Bay of Cádiz) or even on national level (Ria Formosa, in Lower Saxonian Wadden Sea at least concerning shrimps).

### Socio-Economics

Within the Bay of Cádiz, marine aquaculture is considered to be the main economic activity. In contrast, in the Ria Formosa and in a different sense also in the Lower Saxonian Wadden Sea fishery activities are among the principal economic activities but not considered to be the primary one. In all three sites, tourism is of great importance even though in the Bay of Cádiz it is exclusively taking place outside the limits of the natural park area. In the Lower Saxonian Wadden Sea, the direct contribution of the fishery sector to the total income of the coastal region is very small, but, its economic importance is strongly interconnected with the sector of tourism: the small fishing villages and therefore related traditional activities are considered to be part of the coastal landscape and of high attraction to the visitors of the region.

Calculation of employment numbers for the Ria Formosa and for the Bay of Cádiz in respect to the use of marine bio-resources is very difficult to perform due to a lack of reliable data (exact number of directly or indirectly employed people, actual number of active population in or around the respective regions) but also due to the difficulty in judging socio-cultural and structural interrelations (e.g. principal or

additional activity, dependence of family-members). However, an approximation of the number of people directly and indirectly employed/dependent on the fishery sector in relation to the active population in or around the area of the respective coastal region and the total area size has been calculated and is compared in Table 10.

**Table 10 Comparison of the three coastal areas Bay of Cádiz, Ria Formosa, and the Lower Saxonian Wadden in terms of people employed/dependent on the fishery sector**

	<b>Bay of Cádiz</b>	<b>Ria Formosa</b>	<b>Wadden Sea</b>
Active population (N°)	139,139	50,080	307,600
N° people directly or indirectly employed (dependent) on the fishery sector	~1130*	~8000-10,000*	~2200
% of active population employed in (dependent on) fishery	<b>0.81</b>	<b>20</b>	<b>0.72</b>
Total area size [ha]	10,000	18,400	277,700
People directly or indirectly employed (dependent) on the fishery sector	<b>0.1/ ha</b>	<b>0.4-0.5/ ha</b>	<b>0.008/ ha</b>

\*Including estimated numbers of fishing and collecting people

The percentage of people directly or indirectly dependent on the fishery sector in the Ria Formosa is outstanding and around 25 times higher than in the respective other two coastal areas. But, relating the total area size of the respective coastal region to employment numbers it can be stated that in the Lower Saxonian Wadden Sea far less people are employed in fishery compared to the situation in the Bay of Cádiz or in the Ria Formosa. Hence, the socio-economic dependence of people on the fishery sector is highest in the Ria Formosa and lowest in the Lower Saxonian Wadden Sea.

All three sites have in common that a large part of the exploitation activity is performed by small family-based businesses. This is true for the bivalve culturing in the Ria Formosa, the extensive form of aquaculture in areas of old Salinas in the Bay of Cádiz—if not carried out by the biggest aquaculture company “Cupimar”— and also for the fishery sector in the Lower Saxonian Wadden Sea.

In contrast to the situation in the Lower Saxonian Wadden Sea, in the Ria Formosa but also to a certain degree in the Bay of Cádiz, the exploitation of marine organisms cannot be considered as a professionalized sector –except for the bigger enterprises such as “Cupimar” in the Bay of Cádiz or “Timar” in the Ria Formosa. To a large extent, the exploitation activity is pertaining to a sector of population with little

economic possibilities, performed in an uncontrolled manner and without the desired declaration of the products.

In all three sites, none to very few additional value is added to the respective most important species in terms of the economic profit, namely clams (Ria Formosa), Gilthead sea bream (Bay of Cádiz) and shrimps or mussels (Lower Saxonian Wadden Sea). In Cádiz, an enterprise has apparently started operations for the elaboration of meals (precooking and selling)<sup>58</sup> of fish obtained from “Cupimar”. Here, a further processing of the primary product has been initiated.

Unfortunately, little is known on aspects concerning commercialization in the Ria Formosa and in the Bay of Cádiz. However, it appears that an important part of the local production is brought to the local and regional market. In contrast, in Lower Saxony it is striking that most of the commercialization and processing is performed and regulated by the neighboring country of The Netherlands.

### Principal Problems

A variety of problems is related to the exploitation activity of marine bio-resources in each of the three coastal areas (Table 11).

**Table 11 Survey of the principal problems of the Bay of Cádiz, the Ria Formosa, and the Lower Saxonian Wadden Sea**

Problems	Bay of Cádiz	Ria Formosa	Wadden Sea
Pollution/Water Quality	+	+	-
Robbery/Illegal Fishing	+	+	-
Lack of Control	+	+	-
Over-Exploitation of Stocks	+	- (except razor shells)	?
Introduction of Foreign Species	?	+	+
Low Market Prices	+	+	(+)
		(in aquaculture)	
High Production Costs	+	-	-
Marketing Structures	?	+	+
Bureaucracy	+	+	+
	(Shore Law 1988)		(EU-legislation)
Predation by Ichthyophage Birds	+	-	+
Urbanization and General Human Pressure; General User Conflicts	+	+	+
Transformation of the Habitat	+	+	+
Lack of Environmental Awareness	+	+	-
Recruitment of Young Stages	(+)	-	+

Legend: problem existent: +, partly existent: (+), probably existent: ?, not existent:-

<sup>58</sup> <http://www.diariodejerez.com/pg030304/provincia/provincia136529.htm>, accessed in August 2003

As a matter of fact, in the Bay of Cádiz and in the Ria Formosa, there are more problems of similar character compared to the situation in the Lower Saxonian Wadden Sea, most of them related to environmental pollution, illegal activities and a lack of control but also to a deficient environmental awareness. Nontransparent bureaucracy, habitat transformation but particularly human pressure in terms of illegal construction (Ria Formosa), urbanization (Bay of Cádiz) and general user conflicts (Lower Saxonian Wadden Sea) are problematic in all three sites.

#### 4.5 Summary

With regard to the following chapters, the most relevant conclusions are summarized in Box 6.

##### Box 6 Summary of the main statements

<b>Exploitation of marine bio-resources</b>	<ul style="list-style-type: none"> <li>• Commercial exploitation of a large variety of different species in the Bay of Cádiz and the Ria Formosa; Restriction of commercial exploitation to two organisms in the Lower Saxonian Wadden Sea</li> <li>• Only mussel-culturing in the Lower Saxonian Wadden Sea but no further aquaculture</li> <li>• Similar exploitation manners in the Bay of Cádiz and the Ria Formosa, but main species of interest differ from each other</li> <li>• Large uncontrolled gathering and fishing activities in the Bay of Cádiz and the Ria Formosa compared to the Lower Saxonian Wadden Sea</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Local production numbers in the Bay of Cádiz and the Ria Formosa of regional or national importance; production of the Lower Saxonian Wadden Sea of less importance in a national context</li> </ul>
<b>Socio-Economics</b>	<ul style="list-style-type: none"> <li>• Exploitation of marine bio-resources is a principal economic activity in the Bay of Cádiz but one among others in the Ria Formosa and the Lower Saxonian Wadden Sea</li> <li>• Socio-economic dependence on exploitation matters greatest in the Ria Formosa and lowest in Lower Saxonian Wadden Sea (see Table 10)</li> <li>• Usually small family-based businesses in all three sites</li> <li>• Little professionalism of the fishery sector in the Bay of Cádiz and the Ria Formosa</li> <li>• None to little value-addition to the main species of interest in all three sites (low level in value chain)</li> </ul>
<b>Principal problems related to the exploitation of marine bio-resources</b>	<ul style="list-style-type: none"> <li>• More problems of similar character in the Bay of Cádiz and the Ria Formosa: pollution, illegal activities, lack of control, deficient environmental awareness</li> <li>• Similarities in all three sites concerning non-transparent bureaucracy, habitat transformation, human pressure or user conflicts</li> </ul>

## 5 Assessment of the Status Quo

Referring to the previously outlined situation and problems, in this chapter the respective region is analyzed by pursuing two principal questions:

- Who is involved in the management of fishery resources and what does the respective current management approach look like?
- Does there exist a common societal mission statement (“Leitbild”) for the coastal area that can be deduced from the existing mechanism and requirements of the respective region?

Concerning the first question, reference is given to the main bodies responsible and selected regulations and instruments relevant for the management strategies actually being realized in exploiting marine bio-resources in the Ria Formosa, Bay of Cádiz and the Lower Saxonian Wadden Sea. This depiction is based on the material compiled during the information gathering process. Even though it is obvious that the quality and quantity of the information content is not comparable at any level, the respective description reflects the perceivable level of regulation of marine bio-resources in the three areas considered.

### 5.1 Bay of Cádiz

#### 5.1.1 Responsible Regulating Bodies

According to Barragán-Muñoz (pers. comm.), the Regional Ministries of the Environment and of Agriculture and Fishery (“Conserjería de Medio Ambiente, Consejería de Agricultura y Pesca”) can be considered as the two most important bodies for the regulation and management of marine bio-resources in the Bay of Cádiz (Table 12). Both administrations have competences in concrete topics. For the execution of their competences, there are different organs and directive centers (institutions) functioning below the respective Regional Ministries. For each providence, there exists a delegation whose director has to represent the competencies of the Regional Ministry in the respective area.

**Table 12 Most important bodies for the management and regulation of marine bio-resources in the Bay of Cádiz and the respective main competences**

Name of Institution	Main competences	Regional Ministry
<i>Various,</i> e.g. Head office for the	• Organization of the management of natural resources, encouragement for a	Environment

<p>Management of the Natural Environment, Head Office for Prevention and Environmental Quality</p> <p><i>Institutional representation:</i> Provincial Delegation of the Environment, <i>in particular:</i> Direction of the Natural Park Bay of Cádiz (PNBC)</p>	<p>rational use of the renewable natural resources</p> <ul style="list-style-type: none"> <li>• Protection, management and administration of protected areas</li> <li>• Promotion of programs for raising environmental awareness; ensuring the integration of social, productive and recreational use of natural resources</li> <li>• Sustainable exploitation of fishery resources</li> <li>• Previous evaluation, reduction and correction of consequences for the environment due to public or private actions</li> <li>• Surveillance, protection and recuperation of environmental quality; control of activities</li> <li>• Cooperation in the creation of new fields of employment within the protected natural spaces</li> </ul>	
<p><i>Various,</i> e.g. Head Office for Fishery and Aquaculture, Head office for the Investigation and Formation in Agriculture and Fishery</p> <p><i>Institutional representation:</i> Provincial Delegation of Agriculture and Fishery</p>	<ul style="list-style-type: none"> <li>• Organization and improvement of the fishery sector</li> <li>• Organization and promotion of fishery products, of their production means and sanitary</li> <li>• Organization of commercialization and markets</li> <li>• Organization and encouragement of related industries; food control</li> <li>• Investigation and transference of technology</li> <li>• Rural development, its planning, coordination and execution</li> <li>• Management and control of public assistance in the fishery sector</li> <li>• Fishery in inland waters, “marisqueo”, and aquaculture</li> </ul>	Agriculture and Fishery

Source: Internet<sup>59</sup>

Whereas the Regional Ministry for Aquaculture and Fishery holds the exclusive competence in subjects concerning aquaculture, competencies of the Regional Ministry for the Environment are related to the environmental space. Moreover, the General Delegation of the Coast (“Delegación General de Costas”) is responsible for the management of the maritime-terrestrial Public Domain (e.g. determination and delimitation of public terrain). Thus, different public administrations coincide in the same physical territory (Barragán-Muñoz, pers. comm.), a fact that certainly complicates any decision making processes and calls for a close cooperation between the administrative bodies in order to better achieve the proposed aims.

<sup>59</sup> [http://www.juntadeandalucia.es/medioambiente/org\\_funciones/competencias.html](http://www.juntadeandalucia.es/medioambiente/org_funciones/competencias.html); <http://www.juntadeandalucia.es/agriculturaypesca/publico/>, accessed in September 2003

The actual management of marine bio-resources in the Bay of Cádiz, precisely in the natural park area, is difficult to approach since there exist several legal and strategic instruments that are important for the use of the coastal stripe, the protection of the wetland zones and for the regulation of activities within the park area such as the performance of marine aquaculture (Abarca, unpubl. report). Even though not amplified in this context, international conventions such as Ramsar and the Bird and Habitat Directives as well as national or regional plans (e.g. Strategic Spanish Plan for the Rational Conservation and Use of Wetlands, “Plan Estratégico Español para la Conservación y Uso Racional de Humedales”, National Shores Act 1988<sup>60</sup>) have to be kept in mind. With respect to the specific national regulation of maritime fishery, “marisqueo”, and marine aquaculture, and based on the international code of conduct for responsibly fishery, Law 1/2002<sup>61</sup> is the principal legislation that establishes guidelines whose conversion should target at an equilibrated exploitation of the living resources.

Before proceeding management instruments relevant for the regulation of marine bio-resources in the Bay of Cádiz, in the following, there is an example of how the National Shores Act of 1988 has an affect on the activities related to the exploitation of marine bio-resources in the Bay of Cádiz (see Box 7).

#### Box 7

##### **Ley 22/1988 de Costas - Example**

The National Shores Act of 1988 is the principal normative instrument for the management of the coastal zone in Spain (Consejería de Medio Ambiente, 2003a). It has been designed to protect the coast in view of its public property character<sup>62</sup> and has a large effect on the Bay of Cádiz since most of the area forming the natural park is belonging to the Marine Terrestrial Public Domain (DPMT). Therefore, the use or exploitation of natural resources is only permitted by means of authorizations or concessions whose character is depending on the duration of the occupation and the character of additional installations<sup>63</sup>.

The demarcation process in the Bay of Cádiz incorporates the salt marshes in the public domain, habitats that have been mentioned explicitly in the law (Art. 3 (1a) Ley 22/1988 de Costas), but there are interpretation problems concerning the Salinas about which no reference is given in the respective act. Thus, a lot of conflicts arise between the administrative management of the area and private individuals who are performing aquaculture in the salt ponds (Abarca, unpubl. report). The readiness to invest is very low and there is a general retention of the banking sector to concede money for aquaculture

<sup>60</sup> Ley 22/1988, de 28 de julio de Costas ([http://www.juridicas.com/base\\_datos/Admin/122-1988.html](http://www.juridicas.com/base_datos/Admin/122-1988.html)), accessed in September 2003

<sup>61</sup> Ley 1/2002, de 4 de abril, de Ordenación, Fomento y Control de la Pesca Marítima, el Marisqueo y la Acuicultura Marina ([http://noticias.juridicas.com/base\\_datos/CCAA/an-11-2002.html](http://noticias.juridicas.com/base_datos/CCAA/an-11-2002.html)), accessed in September 2003

<sup>62</sup> <http://www.coastalguide.org/icm/spain.html>, accessed in June 2003

<sup>63</sup> <http://www.mma.es/costas/hm/dominio/comenta/regimen.htm>, accessed in September 2003

purposes. As a consequence, Salinas authorized for the cultivation of marine organisms have been abandoned and are in a state of complete deterioration which is also affecting the surrounding environment (see also 4.1.3). However, an adequate management of the Salinas in the Bay of Cádiz is believed to have a positive effect on conservation patterns as well as on aquaculture production (Abarca, unpubl. report) but for that purpose private initiative and investment seem to be indispensable (Bravo, pers. comm.).

In any case, the regulation and management of marine bio-resources is incorporated in the two most important planning instruments for the park area, the “Plan de Ordenación de los Recursos Naturales del Parque Natural Bahía de Cádiz, PORN” (Organizing Plan for Natural Resources) and the “Plan Rector de Uso y Gestión del Parque Natural Bahía de Cádiz, PRUG” (Ruling Plan for Use and Management).

### 5.1.2 Management Instruments PORN and PRUG

With the declaration of the Natural Park Bahía de Cádiz by Law 2/1989<sup>64</sup>, the legal frame for the regulation of this protected natural space has been established. The regulation itself is based on the objective of a sustainable use of the natural resources<sup>65</sup>. In line with the Law 4/1989<sup>66</sup>, one of the principal aims is the adequate organization and management of the natural resources as well as the establishment of norms for their protection, conservation and restoration (Art. 1 (2) Ley 2/1989; Art.1 Ley 4/1989). This is to be achieved through the elaboration of the planning instrument PORN whose objectives are outlined in Article 4(2) Ley 2/1989, and the PRUG in which the general norms for the use and management of the respective natural space are determined (Art. 13(1) Ley 2/1989; Art. 19 Ley 4/1989) (see Box 8). According to Article 13 (2) Ley 4/1989, the exploitation of the natural resources can be limited and even prohibited if it is incompatible with the aims that have been attributed to the creation of a natural park.

#### Box 8

**P.O.R.N. (=Organizing Plan for Natural Resources)**  
 ⇒ a planning instrument that establishes the adequate normative frame for the conservation of its natural resources and their economic exploitation under the principles of a sustainable development in the protected natural space

<sup>64</sup> Ley 2/1989, de 18 de julio, por la que se aprueba el Inventario de Espacios Naturales Protegidos de Andalucía y se establece medidas adicionales para su protección ([http://noticias.juridicas.com/base\\_datos/CCAA/an-l2-1989.html](http://noticias.juridicas.com/base_datos/CCAA/an-l2-1989.html)), accessed in September 2003

<sup>65</sup> <http://www.juntadeandalucia.es/medioambiente/prugbcadiz/decretocadiz.pdf>, accessed in September 2003

<sup>66</sup> Ley 4/1989, de 27 de marzo, de Conservación de los Espacios Naturales y de la Flora y Fauna Silvestre ([http://noticias.juridicas.com/base\\_datos/Admin/l4-1989.html](http://noticias.juridicas.com/base_datos/Admin/l4-1989.html)), accessed in September 2003

**General Objectives**

- Define the actual conservation status of the natural resources
- Determine the necessary limitations
- Pointing out the protection regimes which are to follow
- Promote the application of the conservation measurements
- Formulate the guiding criterions of the politics for public and private economic as well as social activities so that they will be compatible with the signaled requirements.

It is also aimed to inspire the creation of further development instruments such as the PRUG.

**P.R.U.G. (=Ruling Plan for Use and Management)**

⇒ A planning instrument that establishes the specific regulation for the use and the activities that are carried out in the respective protected natural space.

The PRUG is of strategic character and considered to be a development instrument of the PORN. It has to be elaborated in close relation to the objectives, instructions and norms established in the PORN and prevails urban planning.

Sources: Ley 2/1989; Ley 4/1989; Internet<sup>67</sup>

The plans PORN and PRUG, currently amended for the Natural Park Bay of Cádiz, are to replace the former plans that have been in force since 1994. Generally, it is foreseen to adapt the organizing and exploitation of the natural resources as well as the management criteria and regulation of the activities, respectively, to the actual socio-economic and physical-environmental circumstances of the park (Consejería de Medio Ambiente, 2003a,b). The organizing of the different activities and uses within the park is proposed in a new zonation plan for the area (see map in Annex IV). With respect to the special characteristic of each zone and the defined protection grade, appropriate rules are established. As stated in Consejería de Medio Ambiente (2003a), in the proposed zonation not only the existent uses are taken into consideration but also future tendencies and foreseeable responses of the ecosystem towards human intervention. Also, the possibilities presented by each zone for developing other forms of uses compatible with the conservation of the respective values are included. Even though the proposed zonation patterns given in the PORN are still subject to criticism and exposed to changes in terms of the exclusion or classification of certain areas (Abarca, unpubl. report), such a management approach can be classified as future-oriented and is thus looked upon favorably.

On the basis of the objectives and the zonation established in the PORN, planned projects and lines of performances that tackle the future conservation of natural

<sup>67</sup> <http://www.juntadeandalucia.es/medioambiente/prugbcaiz/decretocadi.pdf>, accessed in July 2003

resources and their sustainable exploitation in the Bay of Cádiz are outlined in the PRUG. With respect to the management of marine bio-resources, the most important performances as well as the bodies responsible for the execution of the respective actions to be performed are summarized in Table 13.

**Table 13 Actions proposed that are relevant for the management of marine bio-resources in the Bay of Cádiz and respective involved bodies**

<i>Action</i>	<i>Involved Bodies</i>
Plan of Sustainable Use of Wetlands	Regional Ministry of the Environment
Organization Plan for Marine Cultivations	Regional Ministry of Agriculture and Fisheries
Coordination Program for the Surveillance and Control of Fishing and Gathering/ Harvesting Activities	Regional Ministry of the Environment Regional Ministry of Agriculture and Fisheries SEPRONA*
Regulation of the species of interest for the gathering/ harvesting activities	Regional Ministry of Agriculture and Fisheries
Inventory and mapping of marine species	Regional Ministry of Agriculture and Fisheries
Campaigns to promote environmental awareness (gathering/ harvesting and marine cultivation)	Regional Ministry of the Environment Regional Ministry of Agriculture and Fisheries City Councils

Changed after Consejería de Medio Ambiente (2003b)

\*A nature protection service of the Civil Guard

It can be evaluated that the guidelines and proposed actions to be implemented in the planning instruments PORN and PRUG are very complex. Future regulation and management concerning the exploitation of marine bio-resources are an explicit integral part if not even among the most important. Strategies are principally based on a stricter regulation and control of any fishery activities (e.g. minimum sizes, authorizations), more involvement of scientific research and environmental education. For example, the gathering of organisms performed without a professional background but as a leisure activity, the recreational “marisqueo”<sup>68</sup>, is considered to be completely incompatible with the targets of the Natural Park Bay of Cádiz and thus prohibited in future (Consejeria de Medio Ambiente, 2003a). Furthermore, it is foreseen to maintain active traditional Salinas as a sign of identity of the Bay of Cádiz, e.g. by producing high-quality salt, in combination with the development of a form of aquaculture that is consistent with the conservation of the natural environment.

As far as it can be judged, it is anticipated not to expand the more intensive form of aquaculture in the Bay of Cádiz due to its negative effect on the environment (e.g.

<sup>68</sup> For definition, see Annex I

habitat transformation, water quality, attraction of ichthyophague birds) and instead preference is given towards alternative performances such as ecologic restoration and the promotion of compatible recreational or touristic activities. According to Abarca (unpubl. report), less production numbers obtained in aquaculture could be compensated by ticketing the high quality products originating from the traditional and most natural cultivation method with an eco-label of the park. However, such a kind of promotion is not only a question of publicity but also of the creation of an economic incentive by the administrative bodies in the sense of “if you give me money, I will do a good work” (Fernandez, pers. comm.). Hence, in the near future the practical implementation will certainly be a matter of importance.

The many intervening administrative competences in the park necessitate improving the overall coordination of the management (Abarca, unpubl. report). The park direction could function as the binding element canalizing matters of concern, e.g. upcoming projects, complaints, petitions, and raising the respective issues against the regulating bodies. As a consequence, management procedures would be more transparent and easier to approach, particularly for stakeholders and the public.

### **5.1.3 Short View on the Organization and Regulation of the Aquaculture Sector in the Bay of Cádiz**

Considering the fact that marine aquaculture is the principal economic activity developing in the Bay of Cádiz (Barragán-Muñoz, 2003) and in view of the difficulties the group of people involved in aquaculture currently has to face in the Bay of Cádiz, it is of particular interest to take a short look on if and how organization of people involved in this business and therewith related management takes place.

As already stated in 4.1.2, many of the aquaculture enterprises situated in the Bay of Cádiz are fairly small family-based businesses. A lot of them are part of an association such as the Association of Enterprises for Marine Aquaculture in Andalusia (“Asociación de Empresas de Acuicultura Marina de Andalucía, ASEMA”) or the Producer Organization of Marine Fishculture in Andalusia (“Organización de Productores de Piscicultura Marina de Andalucía, OPPMA”). Recently, there has been formed a further association in Cádiz pretending to group the small producers in order to facilitate the commercialization of their products (“Asociación de Pequeños Productores de Pescado de Estero de la Bahía de Cádiz”)

(Macías, pers. comm.). The advantages for the members of an association are exemplified on ASEMA and outlined in Box 9.

**Box 9****Advantages of an Association (e.g. ASEMA)**

- Representation and defence of the interests in front of the public administration (e.g. at present there are various actuaciones concerning the correct interpretation of the Ley 22/88 de Costas)
- Stimulation and promotion of investigations on topics related to aquaculture and the application of their results; diffusion of results
- Establishment of documentation services and information for the benefit of the associates

Source: Macía, pers. comm.; Internet<sup>69</sup>

As explained by García Lomas de Mier<sup>70</sup>, by means of incorporating the previously mentioned regional producer organization OPPMA into a nationwide association of Producer Organizations, it is aimed to carry out a process of differentiation of the own products (quality, freshness). This strategy will be of great importance, particularly for producers within the limits of the Bay of Cádiz, if productivity will be kept at a low level but where in turn higher prices have to be obtained for the high quality of the products.

In the Bay of Cádiz, some cooperatives exist for people involved in the gathering and harvesting of mollusks. However, there is no proof about the existence of any cooperative where people collecting other organisms such as crabs or worms are grouped. At any case, it is not necessary to be registered or organized in any kind of organization in order to perform marine cultures in the Bay of Cádiz (Macías, pers. comm.). Nevertheless, due to the many advantages, it seems to be necessary to count on the support of a body that serves as an interlocutor in front of the administration and which defends the interests of a whole sector in a joint manner. Vice versa, the general support on the part of the administration towards aquaculture enterprises has apparently improved since more importance is attached to strong association such as ASEMA. If the aquaculture sector in the Bay of Cádiz persists in future, it will most probably be even more important to participate in a large association.

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<sup>69</sup> <http://www.asemaonline.com>, accessed in September 2003

<sup>70</sup> <http://www.mispecies.com/reportajes/2002/asema/index.asp>, accessed in July 2003

### 5.1.4 Mission Statement

For the Bay of Cádiz, it is agreed upon that the actual reality of the exploitation of fishery resources is desolate. This topic is considered to be a problem of primary order. Uncontrolled use of fishery resources is assumed to be one cause. Another cause is the increasing deterioration of many Salina-saltmarsh areas where the traditional forms of exploitation (salt extraction and, more recently, marine aquaculture) have largely been abandoned (Consejería de Medio Ambiente, 2003a).

General and specific objectives pursued for the Bay of Cádiz, in particular concerning the management of marine bio-resources, as well as the thereof resulting mission statement are summarized in Box 10.

**Box 10 Objectives shown for the Bay of Cádiz and derived mission statement with regard to the future situation of marine bio-resources**

#### General Objectives for the Bay of Cádiz

- Guarantee the ecologic processes of the natural environment through protection, recuperation, and restoration of the ecosystems
- Make compatible the traditional uses of the natural park, in particular the exploitation of fishery resources, with the regeneration capacity of the natural resources and the maintenance of their biological cycles
- Guarantee the sustainable use and exploitation of the Salina-saltmarsh ecosystem giving priority to traditional activities and new forms of uses compatible with its conservation and the cultural legacy that are for the social and economic benefit of the population
- Promote and diffuse knowledge on the ecologic and socio-cultural values of the natural space
- Foster investigation as the indispensable instrument for the organizing and management process

#### Specific Objectives

##### *Concerning conservation*

- Recover and restore degraded habitats, in particular the Salina-saltmarsh ecosystem
- Generate up-to-date information on the condition of the natural resources on which conservation, restoration, and management measures can be based

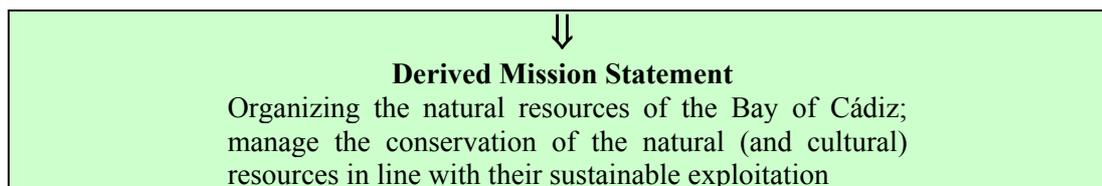
##### *Concerning sustainable exploitation*

- Make aware the group of producers and businessmen of the necessity to exploit the resources in a manner compatible with their conservation
- Consolidate and regulate the “professional marisqueo”<sup>71</sup>
- Control the condition of the resources exposed to fishing and gathering and assure their sustainable exploitation

##### *Concerning public use and environmental education*

- Get to know and consolidate recreational, didactic and touristic activities that are offered by the natural park and regulate their development in harmony with the conservation of the resources

<sup>71</sup> For definition, see Annex I



Source: Consejería de Medio Ambiente (2003a,b)

The mission statement is pursued by the planning instruments currently revised for the Bay of Cádiz, the “Plan de Ordenación de los Recursos Naturales, PORN” (Organizing Plan for Natural Resources) and the ”Plan Rector de Uso y Gestión, PRUG” (Ruling Plan for Use and Management) (see 5.1.2). The mission statement, however, does most presumably not mirror the common societal future vision on the park since little attention is attributed to the dichotomy between conservation of the natural resources and the evident importance of the Bay of Cádiz as an aquaculture production site at regional level. But, particularly the larger companies such as “Cupimar”, strive for an expansion of the (semi-)intensive form of aquaculture within the limits of the Bay of Cádiz. The companies are guided by economic drives since out of their perspective only a shift towards more intensive production systems would guarantee profitability on the national and international market (García de Lomas Mier, pers. comm.). Nevertheless, the desire to somehow arrive at an equilibrium between nature conservation and economy (Abarca, pers. comm.) is not intended to be reached by an intensification of aquaculture production systems but more directed towards other forms of uses compatible with the demands of the natural environment.

## 5.2 Ria Formosa

### 5.2.1 Responsible Regulating Bodies

Similar to the situation in Cádiz, many different bodies are involved in the management of the Ria Formosa and therein performed activities. The main institutions for environmental and fishery management of the Ria Formosa are depicted in Table 14.

**Table 14 Relevant institutions involved in the environmental and fisheries management of the Ria Formosa**

<b>Name of Institution</b>	<b>Main competences</b>	<b>Ministry</b>
Natural Park of Ria Formosa (Parque Natural da Ria Formosa, PNRF)	<ul style="list-style-type: none"> <li>• Management of the Ria Formosa</li> <li>• Participation on management and attribution of permits within the Ria</li> </ul>	Environment and Land Planning

	Formosa area <ul style="list-style-type: none"> <li>• Littoral plan of the Ria Formosa</li> <li>• Local institution of the Institute of Nature Conservation</li> <li>• Participates in licencing of economical activities within the Natural Park</li> </ul>	
Institute of Nature Conservation (Instituto de Conservação da Natureza, ICN)	<ul style="list-style-type: none"> <li>• Littoral plan of the Ria Formosa</li> <li>• Management of the Ria Formosa</li> <li>• National plan of biodiversity and nature conservation</li> </ul>	Environment and Land Planning
General Directorate of Fisheries and Aquaculture (Direcção Geral das Pescas e Aquicultura, DGPA)	<ul style="list-style-type: none"> <li>• Implementation of Ministry of Agriculture and Fisheries policy at regional level</li> <li>• Aquaculture licenses and fiscalization</li> <li>• Catch statistics</li> </ul>	Agriculture and Fisheries
Regional Directorate of Environmental and Land Planning (Direcção Regional do Ambiente e Ordenamento do Território, DRAOT)	<ul style="list-style-type: none"> <li>• Implementation of Ministry of Environment policy at regional level</li> <li>• Land planning and management</li> <li>• Nature conservation</li> <li>• Use of public domain</li> <li>• Environmental fiscalization</li> <li>• Monitoring (e.g. water quality)</li> <li>• Blue flag</li> <li>• Authority of environmental impact assessment at regional level</li> <li>• Licencing of economical activities</li> <li>• Watershed management</li> </ul>	Environment and Land Planning

Changed after Dinis et al., unpubl. interim reports, AQCESS project

Since most of the major part of the Ria Formosa has been declared natural park (*Decreto-Lei n° 373/87 of 9<sup>th</sup> of December*), the administration of the Ria Formosa Natural Park can be considered as the principal authority responsible for the management of the respective area (Dinis et al., unpubl. interim reports, AQCESS project). The key institution in charge of fisheries management is the General Directorate of Fisheries and Aquaculture. For related questions, the national institute IPIMAR (“Instituto Português de Investigação das Pescas e do Mar”) is consulted and plays an advisory role in the decision making processes. The regional section of the IPIMAR in Olhão together with the fisheries and ecologic group of the “Centro de Ciências do Mar” (CCMAR) of the Universidad do Algarve has been studying different aspects of the local fisheries for many years. Both institutions are contributing to the assessment of the main fishery resources in the Ria Formosa, and general working relationship is judged to be good (Dinis et al., unpubl. interim reports, AQCESS project).

Apart from the responsible bodies summarized in Table 14, the port administration, marine and airport authorities as well as the different municipalities surrounding the Ria hold specific competences and have certain influences over the management of

the area. Hence, similar to the Bay of Cádiz, it is obvious that the realization of any proposed aims will be difficult if no close cooperation between the diverse regulating bodies takes place. This is also reflected by the fact that apparently none of the numerous documents of technical or social character elaborated by the different authorities in the past years have succeeded their aim to identify and find solutions to the management of natural resources, the safeguarding of the heritage as well as the organizing of economic activities. This situation is expected to change by means of the elaboration of a more global plan for the littoral area (ICN, 2003).

### 5.2.2 Important Management Instruments

At present, it appears as if in Portugal a lot of effort is put into the planning and regulation of activities performed in a given physical territory, including the littoral space. In general, land planning policy is based on a land management system at national, regional and municipal levels with all of them being responsible for preparing and implementing land management tools<sup>72</sup>. National plans, sector-based plans and special plans are the three existing levels of land development and protection plans which are applied all over the country and which are compounded in a complicated puzzle<sup>73</sup>.

Concerning management of the Ria Formosa territory, the Plan for the Land Management of the Coastal Area, “Plano de Ordenamento da Orla Costeira (POOC)” (see Box 11) for the respective Algarve region as well as the Management Plan of the Ria Formosa Natural Park, “Plano de Ordenamento e Regularmento do Parque Natural Ria Formosa (POP NRF)” (see Box 12), are important planning and management instruments. The latter is belonging to the classification of the Plans for Protected Areas (“Planos de Ordenamento de Áreas Protegidas, POAP”). The POOC like the POP NRF are special plans. Of the two plans, only the new POOC in its preliminary version, currently open for public discussion (state: July 2003), has been made available.

#### Box 11

##### **P.O.O.C. (=Plan for the Land Management of the Coastal Area)**

also named “Coastal Zone Master Plan” to which the whole Portuguese coastal zone is subject to

⇒ A planning instrument aimed to establish regimes for safeguarding the natural resources

<sup>72</sup> <http://www.jrc.es/cfapp/eneriure/Reports/PRT%20pla.pdf>, accessed in July 2003

<sup>73</sup> <http://www.algarveresident.com/stories/showstory.asp?ID=1583>, accessed in July 2003

and values, assuring the permanence of indispensable systems and the sustainable utilization of the area of concern

**General objectives**

- Management of the different uses and specific activities in the coastal zone
- Classification of beaches and regulation for their recreational use
- Valorization and qualification of beaches
- Orientation for the development of specific activities in the coastal zone
- Defence and conservation of nature

Objectives and structure of the POOC are laid down in the Decree-Ley nº309/93<sup>74</sup>

Source: ICN (2003)

The elaboration of the POOC for the region Vilamoura Real–Vila Real de S. António which includes the Ria Formosa Natural Park was started in September 1996 and has been promoted by the Ministry of the Environment through the Water Institute and the Institute of Nature Conservation (INC) (ICN, 2003). The process is accompanied by a technical commission<sup>75</sup> constituted for the purpose of enveloping different entities and for taking into consideration of the different view point as well as the other existing plans, projects or programs<sup>76</sup>. Such an integration of different entities into the elaboration of a planning instrument can be judged positively as far as a thorough cooperation is ensured.

Similar to the PORN in Cádiz but more detailed, the POOC foresees a division of the whole Formosa territory into zones of different uses (see map in Annex IV). Activities allowed or to be forbidden are defined in an accompanying regulation.

Concerning the exploitation of marine bio-resources, regulations are given in the description of the lagoon space which is divided into three different subcategories: restricted use, conditioned use, and sustainable use of resources. These subcategories correspond to an increasing liberality with reference to specific human activities and take into consideration the exploration of marine resources but also aspects concerning pollution, navigation, or the extraction of inert material (ICN, 2003). In general, by means of the implementation of the subcategories, it is mainly aimed to save the special values of the respective area and to guarantee the full functioning of natural processes. For marine resources, some special rules are given in that, for

<sup>74</sup> Decreto-Lei n.º309/93 de 02-09-1993

([http://www.diramb.gov.pt/data/basedoc/TXT\\_LN\\_2044\\_4\\_0001.htm](http://www.diramb.gov.pt/data/basedoc/TXT_LN_2044_4_0001.htm)), accessed in October 2003

<sup>75</sup> In this case consisting out of representatives of the municipalities of Loulé, Faro, Olhão, Tavira, Vila Real de S. António and Castro Marim as well as of different entities such as ICN, DRAOT, PNRF (Instituto da Conservação da Natureza, 2003)

<sup>76</sup> <http://7mares.terravista.pt/fronteira/faqs.html#sign>, accessed in July 2003

example, in the lagoon space of conditioned use fishing and “mariscage” is only allowed to professional fishermen holding a license, or that the same space is only designed for an exploration of marine resources in an extensive manner. There are specific requirements for holding a license or concession for fishing activities, “viveiros” or the gathering of organisms and the installation of systems for aquaculture production is restricted to confined areas in order to minimize the negative impacts of this activity. It is obvious, that the given regulations target at a more controlled exploitation of the natural resources which is one of the principal problems of the Ria, but, the effective implementation of the set rulings remains unclear. Nevertheless, in the said POOC which includes the Ria Formosa territory, a scenario is selected that is situated between the two extremes of no intervention into nature at all on the one hand and expansion of the physical occupation by means of rigid interventions on the other hand (ICN, 2003). Hence, it is recognized that a certain kind of artificial intervention such as a periodical dredging of the channels has to be carried out in order to sustain but at the same time to control the equilibrium of the littoral system and therein performed activities such as the exploitation of marine organisms.

The second of the special plans applying to the management of the Ria Formosa, the “Plano de Ordenamento e Regulamento do Parque Natural Ria Formosa, POPNRF” (see Box 12) is currently being amended but unfortunately no information on the current state of the art of the revision has been made available. However, the general aim of the new POPNRF is to update the information of the former POPNRF of 1991<sup>77</sup> and promote better management tools for the park direction (Noronha, pers. comm.). At present, no precise statements can be given on any new regulations concerning the exploitation of marine bio-resources apart from the rules depicted in the former plan.

#### Box 12

**P.O.P.N.R.F. (=Management Plan of the Natural Park Ria Formosa)**

A plan that defines the preferential manner of use of the protected area

***Main Objective***

⇒ Optimization of the use of the natural resources as well as an efficient participation of all public and private entities that are somehow linked to the park area

Source: Internet<sup>77</sup>

<sup>77</sup> Decreto-Regulamentar n.º2/91 de 24-01-1991

([http://www.diramb.gov.pt/data/basedoc/TXT\\_LN\\_3602\\_1\\_0001.htm](http://www.diramb.gov.pt/data/basedoc/TXT_LN_3602_1_0001.htm)), accessed in September 2003

Similar to the POOC, in the POPNRF the whole Ria Formosa territory is divided into different zones of use. Again, the zonation of the lagoon area is in line with different restrictions concerning the exploitation of marine resources (namely aquaculture and salt extraction). Without getting into detail, reference is given to the character of an activity (extensive or intensive form) or the nature of installations of such exploitations as well as to licencing requirements.

As it has been stated by Noronha (pers. comm.), in the past, less attention has been attributed to the wetlands but more to the terrestrial part of the Ria. By means of the new plans, this former approach is supposed to change since the importance of managing the still existing marine resources has finally been recognized. Thus, it is foreseen to restrict the use of the natural resources only to the actual users. Water quality is of fundamental value for the many exploitation activities in the Ria, and new and better rulings and control are foreseen to maintain or improve the current situation (Noronha, pers. comm.).

It can be concluded that there exist at least two planning instruments that apply to the same physical territory. As stated by Sena (pers. comm.), these special plans are very important but, usually, their application is quite difficult. Since in both plans, the respective regulations are translated into a geographic map which can be considered as a fundamental element for the management of the area, it is obvious that the plans have to be thoroughly coordinated. Otherwise, no adequate regulation and management of important activities such as an effective and regulated exploitation of marine organisms is guaranteed.

### **5.2.3 Special Notes on the Organization and Management of Fishery Activities**

The fishery management in the Ria Formosa is of great concern due to the problems outlined in 4.2.3 such as illegal fishing and gathering of organisms as well as over-exploitation of stocks, robbery, and non-declaration of products.

Generally, fishery management is performed by means of technical measures such as minimum legal landing sizes, minimum mesh sizes, minimum percentages of by-catch as well as limits regarding the quantity and type of gear that can be used. For one of the most important activities, the gathering of organisms, at least 60 species are listed that are allowed to be caught by hand or simple gear (Dinis et al., unpubl.

interim reports, AQCESS project). Moreover, licencing is an important measure in order to control fishery activities in the Ria Formosa. The park authority together with the General Directorate of Fisheries and Aquaculture are the main bodies responsible for the authorization of licenses (see Table 14). Whereas the park authority is giving the approval for the use of the public domain, that is for the use of the land (user license), the DGPA is in charge of the respective fishery activity, e.g. the production in the “viveiros” (producer license). Apart from both authorities, the commission for the licensing process also consists of representatives of the fishery institute IPIMAR which analyses the data and expresses recommendations. Final decision making takes place in the main office of the DGPA in Lisbon but is based on the proposal coming from the regional authorities in the Ria Formosa (Cachola, pers. comm.).

Even though regulations seem to be quite complex and –even more important– cooperation between the different authorities is existent, the given regulations are apparently not efficient in controlling overall fishery activities. Different lines of performances are actually taking place in order to improve the situation. Hence, for a better knowledge on the development of stocks, an ongoing research project is focusing on the fish community, habitat use, and recruitment in the Ria Formosa (Dinis et al., unpubl. interim reports, AQCESS project). Moreover, there are intentions to increase local fisheries by means of restocking, e.g. through the release of reared juveniles, or by habitat improvement such as the creation of artificial reefs in front of the coast (Pousão, pers. comm.). Changes are foreseen concerning the amount of licenses to be authorized, but, in this regard given statements differ from each other: According to Cachola (per. comm.), no new licenses for any new “viveiros” (at present around 1300) and the therewith related collection of seeds will be given even though the final decision depends on the results of the evaluation presently performed for the new Ria Formosa management plan. In contrast, Noronha (pers. comm.) states that in order to control better the collection of organisms, more licenses will be given for this kind of activity. Whatever these changes with regard to licenses will look like, it can be concluded that they are considered to be an important measure for a future management of the activities related to the exploitation of marine bio-resources.

Particularly for the bivalves, problems related to the non-declaration of products and general marketing structures can largely be attributed to difficulties in the

organization of the producers in the Ria. The current situation is briefly described in Box 13.

**Box 13****About the Organization of Bivalve Producers**

In the Ria Formosa, there exist two cooperatives, “Cara” and “Formosa”, and two associations, “APPA” and “Vivmar”. According to Manjua (pers. comm.), both types of organizations serve as an interlocutor for their members if there is the need to communicate with the responsible authorities such as the park authority or the “Capitanias”. However, both of them should have much more importance than they actually have. For example, it seems as if too little political support and no real opportunity to discuss is given to the associations so that the interests of the members cannot be defended properly (Manjua, pers. comm.).

Whereas the “Formosa” cooperative is working on projects for an environmental education of producers in the Ria (Amaral, pers. comm.), the “Cara” cooperative has established the only depuration centre that exists for the whole Ria Formosa where depuration, tagging and certification takes place. As legally demanded, all producers –regardless of being a member of “Cara”– should pass their products through the depuration centre, but, in fact, this is not taking place. Hence, there is only very little control over effective production data and it is difficult for the “Cara” cooperative to plan work and expenses. Moreover, the non-declaration of products has a large effect on the market prices: If possible, a lot of producers sell their products separately at higher prices which in turn complicates the task of the cooperatives to plan and create the market or to invest in marketing plans (Manjua, pers. comm.).

Generally speaking, there is no overall coordination in the control of the chain of bivalve mollusks production. So far, it is not clear how this current situation is about to change. Stricter control and clarification of the competences of the different authorities is demanded (Manjua, pers. comm.), but also a rising awareness for the natural environment and production patterns, e.g. by educational programs.

**5.2.4 Mission Statement**

For the Ria Formosa, the elaboration of a mission statement that is particularly focusing on the exploitation of marine bio-resources proves to be difficult. On the one hand, this can be just a problem of adequate information to be available for such an elaboration. On the other hand, it can be due to the fact that explicit aims specifically focusing on the use of marine bio-resources within the Ria Formosa are simply missing. Nevertheless, the mission statement depicted in Box 14 gives an impression on the aims and objectives that are currently followed up for the Ria Formosa, focusing on those that are related to aspects concerning marine bio-resources.

**Box 14 Objectives shown for the Ria Formosa and derived mission statement with regard to the future situation of marine bio-resources**

**General Objectives for the Ria Formosa**

- Protect and conserve the whole lagoon system, including its flora, fauna, and respective habitats
- Promote and optimize an adequate use of its natural resources, assuring the continuity of evolutionary processes
- Promote the cultural, social and economic development of the resident population
- Regulate recreational activities in accordance with the natural and cultural resources
- Organize the different uses and specific activities, orientation of their development
- Protect and valorize the natural resources and the historic and cultural heritage

**Specific Objectives**

*Concerning conservation*

- Generate information on the status of natural stocks
- Supervise and monitor water quality to maintain resources and exploitation activities
- Maintain traditional activities ("viveiros", salt extraction)

*Concerning sustainable exploitation*

- Regulate and control any fishery activity (professional and recreational fishing, gathering of organism, "viveiros"), e.g. by stricter licensing procedures and increased supervision
- Increase productivity by means of a better management, e.g. artificial restocking

*Concerning public use and environmental education*

- Educate people about the importance of their natural environment



**Derived mission statement**

Overall organizing, regulation and better control of activities, including those related to the exploitation of marine bio-resources; maintain or better harmonize existing uses and make them compatible better with the capacity of the natural environment

Source: ICN (2003); Internet<sup>78</sup>; Personal communications

It has to be stated that the specific objectives and the thereof derived mission statement have predominantly compiled from the different interlocutors. No explicit targets concerning the exploitation of marine bio-resources have been formulated in the principal plan to be available on the future management of the Ria Formosa Natural Park, the "Plano de Ordenamento da Orla Costeira (POOC) from Vilamoura to Vila Real de Santo António" (see 5.2.2). This can possibly be attributed to the fact that tourism and construction are still considered to be the main pressure activities for the Ria Formosa. Consequently, their regulation is still of primary order. However, there is a common consensus on the need for a better regulation and

<sup>78</sup> Decreto-Lei n.º 373/87 de 09-12-87 ([http://www.diramb.gov.pt/data/basedoc/TXT\\_LN\\_1176\\_1\\_0001.htm#b0009](http://www.diramb.gov.pt/data/basedoc/TXT_LN_1176_1_0001.htm#b0009)), accessed in September 2003

management of marine bio-resource in the Ria (pers. comm. by different interlocutors). Also from the official point of view, the exploitation of live natural resources for human consumption is explicitly emphasized as one of the most important economic activities taking place in the littoral fringe of the coast on which many people depend and live on (Instituto da Conservação da Natureza, 2003). Nevertheless, the observed lack of explicit targets and strategies concerning the future regulation of marine organisms reflects that, in comparison to Cádiz, the situation in the Ria Formosa is still not judged to be predominantly desolate.

### 5.3 Wadden Sea Area of Lower Saxony

#### 5.3.1 Responsible Regulating Bodies

The main institutions involved in fishery management in the Lower Saxonian Wadden Sea National Park are listed in Table 15.

**Table 15 Main institutions involved in the fishery resource management of the Wadden Sea National Park of Lower Saxony.** This list is not exhaustive.

Name of Institution	Main competences	Ministry
State Fisheries Administration	<ul style="list-style-type: none"> <li>• Fishery surveillance, particularly control of national and international regulations, e.g. mesh sizes, catch quota, minimum sizes</li> <li>• Surveillance of quotas for certain species by means of logbook inspection</li> <li>• Statistical analysis of catches</li> <li>• Promotion of measures concerning purchase and modernization</li> <li>• Blue Mussel Management</li> <li>• Professional advice on any measures concerning fishery</li> <li>• Licencing procedures</li> </ul>	Alimentation, Rural Area, Agriculture and Forestry
National Park Administration (NPA)	<ul style="list-style-type: none"> <li>• Administration in general, finance</li> <li>• Protection and monitoring, research</li> <li>• Supervision of the NP regulations</li> <li>• Working out of guidelines, drafts and programs for the further development of the National Park</li> <li>• Coordination of various research projects</li> <li>• Public relations and environmental education</li> <li>• Estimation and surveillance of total mussel stocks</li> </ul>	Environment, Nature Conservation and Nuclear Safety

Source: Internet<sup>79</sup>

<sup>79</sup> <http://www.bremerhaven.de/stadt/abehoerde/fischerei.html>; <http://www.mu.niedersachsen.de/Nationalparke/index.htm>, accessed in September 2003

The situation in Lower Saxony is similar to the situation in the Bay of Cádiz and in the Ria Formosa. Different bodies or institutions are involved in the regional management due to the many different activities taking place in the Wadden Sea.

Apart from two principal authorities (Table 15), the Common Wadden Sea Secretariat (CWSS) can be considered as an important body for the management of the different activities taking place in the whole Wadden Sea area. But, none of the agreements or documents set up by this secretariat are of statutory obligation. The CWSS was established in Wilhelmshaven, Germany, in 1987 as the secretariat for trilateral cooperation between Denmark, Germany, and The Netherlands. Its primary task is to support, initiate, facilitate, and coordinate the activities of the collaboration<sup>80</sup> which also includes trilateral policies and agreements that are concerning fisheries, particularly with relation to shellfish. In the Wadden Sea Plan (WSP)<sup>81</sup> adopted in 1997, trilateral targets were formulated concerning the mussel and cockle fishery in the tidal area of the cooperation area of the three countries. For example, it was decided that the current area of the mussel culture lots will not be enlarged and that the negative effects of mussel fishery are limited by permanent closure of certain areas. Again, it has to be stressed that the elaborated targets are not legally binding, but, the Wadden Sea plan has been a guidance for the elaboration of fishery plans such as the Blue Mussel Management Plan for Lower Saxony (see Box 17).

Furthermore, the CWSS is partly facilitating the trilateral Wadden Sea Forum (WSF) which was set up in 2002 by the governments of Denmark, Germany, and The Netherlands (Box 15).

#### Box 15

##### **Wadden Sea Forum (WSF)**

⇒ an independent discussion forum of representatives of various user and interest groups as well as local and regional authorities from the trilateral Wadden Sea area

##### ***Main target***

⇒ to develop strategies for a sustainable development in the Wadden Sea region

Tasks of the different thematic groups installed by the WSF:

- Collect, analyze and assess relevant information,
- Develop proposals for the most appropriate scenarios,
- Elaborate recommendations and proposals for strategies applicable for the selected scenarios,

<sup>80</sup> <http://www.waddensea-secretariat.org/trilat/structure/CWSS.html>, accessed in August 2003

<sup>81</sup> <http://www.waddensea-secretariat.org/management/Plan.html>, accessed in August 2003

- Warrant the necessary dialogue with the organizations not presented in the WSF.

Source: Internet<sup>82</sup>

The thematic group on fisheries concentrates on the different sectors of fishery (e.g. blue mussel, cockle, shrimp), marketing aspects, sustainability aspects of fishery, national policies, employment, passed and expected developments as well as future perspectives. Proposals for the strategies developed by the WSF will be submitted to the 10<sup>th</sup> Governmental Wadden Sea Conference in 2005<sup>82</sup>.

At present, the forum is in the transition from discussions on possible scenarios to the elaboration of strategies. Apparently, this takes a long time since different ideas exist on the future of the region (WWF, 2003). Whether the thematic group on fisheries will actually contribute to achieve the main aim of creating a common comprehension for a sustainable development of the Wadden Sea region can not be answered at present (Rösner, pers. comm.). Nevertheless, the establishment of such an independent stakeholder platform for the Wadden Sea region can be regarded as a positive step towards a common approach to the future situation of the Wadden Sea, in particular to the many problems related to user conflicts: not only information gathering and exchange are facilitated by the forum, but, moreover, the participants are demanded for *jointly* elaborate future strategies for the region.

However, concerning coastal fishery in Lower Saxony, management is largely bound to existing legislations and thereof developed procedures.

### 5.3.2 Fishery Management

Due to the federal political structure, in Germany, the government enacts national laws which are usually completed through the jurisprudence of the Federal States called “Länder” (Buck et al., 2003). As a consequence, the Länder are principally responsible for the laws which deal with environmental protection and the activities performed in the respective territory. National legislations such as the Nature Protection Law (Bundesnaturschutzgesetz, BNATSchG<sup>83</sup>) are giving the overall frame for the implementation of orders on a regional scale.

It has to be emphasized that the Wadden Sea area is comprehensively protected by national laws and international agreements. Moreover, most of the German sector has been provided with the highest protection status which is that of a national park (see

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<sup>82</sup> <http://www.waddensea-forum.org/index.htm>, accessed in August 2003

<sup>83</sup> BGBl. 2002 I, p. 1193

3.3). As a consequence, the National Park Law (NPL) of the Lower Saxony Wadden Sea in its revised version (“Gesetz zur Neufassung des Gesetzes über den Nationalpark Niedersächsisches Wattenmeer”<sup>84</sup>) is among the most relevant legal bases for determining the activities within the park area (see CWSS, 2002). With reference to the mussel and shrimp fishery, the most important facts are outlined in Box 16.

#### Box 16

##### National Park Law (NPL) of Lower Saxony

###### *General Objective*

⇒ the conservation of species and biotopes as well as the continuation of natural processes.

According to § 5 (NPL), the national park area is divided into three different conservation zones, each with a different protection status (Fig. 5). Defined areas of the most protected zone are excluded from shrimp and mussel fishery as well as from the setting of bottom cultures (§ 9 (1,2) NPL)<sup>85</sup>. Consistent with the NPG, 31 mussel beds are excluded from fishery since they are situated in non-fishery areas. Altogether, at present around 30 % of the National Park area are permanently closed for mussel fishery (Farke, pers. comm.) whereby the major part (33,000 ha) is formed by the area between Weser and Elbe, the so-called “Wurster Küste”, an apparently unattractive area for fishery (Schlauch, 1999). Whereas fishing for consumption mussels can merely be performed on sublittoral banks (§ 9 (2) NP) seed mussel fishing is only allowed in the framework of a management plan (see Box 17) jointly issued by the fishery and nature protection authorities (see Table 15) in taking account of the aims set down in § 2 NPL.

However, fishery legislations such as the State Fisheries law of Lower Saxony as well as the Lower Saxony Coastal Fisheries Legislation (see below) are more relevant in terms of the specific regulations of fishery in the Lower Saxonian Wadden Sea. The implementation of regulations and current management strategies for the exploitation of mussels differ from those performed for the shrimp fishery and are therefore treated separately in the following.

#### Specific Regulations and Management Concerning Mussel Fishery

The regulation of mussel fishery is mainly incumbent on the federal state of Lower Saxony. National legislations are still more relevant than international ones (Hagena, pers. comm.), but, decisions made in Brussels will have a lot more influence in the near future (Walter, pers. comm.). So far, relevant statutory ordinances for mussel fishery have been given by the State Fisheries law of Lower Saxony

<sup>84</sup> Nds. GVBl. 2001, p. 443

<sup>85</sup> The detailed denomination and description of the areas are listed in attachment I of the NPG.

(“Niedersächsisches Fischereigesetz, Nds. FischG”)<sup>86</sup> as well as by the Lower Saxony Coastal Fisheries Legislation (“Niedersächsische Küstenfischereiordnung, Nds. KüFischO”)<sup>87</sup>. Moreover, in the exercise of mussel fishery in the Wadden Sea, regulations of the Lower Saxonian Nature Conservation Law (“Niedersächsisches Naturschutzgesetz, NNatG”) on especially protected biotopes have to be taken into account<sup>88</sup>. The Nds. KüFischO regularizes the mussel fishery. In general, this includes regulations concerning fishery on wild mussel beds, seed mussel fishery, minimum sizes of seed mussels, and of consumption mussels (§ 10 Nds. KüFischO). No quotas are given for the landing of mussels. According to § 17 Nds. FischG and § 10 Nds. KüFischO, fishery for mussels is bound to a permit which is given by the State Fisheries Administration and which has to be issued yearly. At present, there exist five permits for seed mussel fishery which are divided among four mussel fishing companies. In practice, seed mussel fishery is managed as follows: the respective fishing companies regularly examine the status of the wild mussel beds in the eu- and sublittoral in order to decide which banks are interesting for seed mussel fishery. Twice a year, in springtime and in autumn, a written application is submitted to the State Fishery Office in Bremerhaven which decides which beds are allowed to be fished. Afterwards, the mussel beds opened for fishing are justly divided among the companies (Gubernator, pers. comm.).

For the setting of a culturing plot, an additional approval is needed from the State Fisheries Administration (§ 17 (2) Nds. FischG) which has to be renewed after a period of five years. Before the approval is given, an authorization procedure has to be performed if and to what extent the setting of bottom cultures inhibits other activities in the respective coastal waters (e.g. shrimp fishery). The management of the culture plots (presently 34 in Lower Saxony) is then at the responsibility of the fishermen. Harvesting of consumption mussels from the culture plots is without further restriction, apart from complying with the regulation on the minimum size ( $\geq 5$  cm) of the mussel.

At present, Blue Mussel fishery in Lower Saxony is regulated in the frame of a management plan, valid from the period 1989-2003 (Box 17). The legal framework for the regulation of mussel fishery is not changed by the plan.

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<sup>86</sup> GVBl. 1978, p. 81

<sup>87</sup> Nds. GVBl. 1992, p. 321

<sup>88</sup> <http://www.umwelt-online.de/recht/natursch/laender/nds/lgl.htm>, accessed in October 2003

**Box 17****Blue Mussel Management Plan of Lower Saxony**

Due to the alarming situation of the status of eulittoral mussel beds in the Lower Saxon Wadden Sea in 1998 a Management Plan (“Bewirtschaftungsplan”) for the fishing of blue mussels was signed by the Lower Saxonian Ministers responsible for fisheries and nature conservation with goals regarding an effective conflict-solving combination between economic needs and ecological aims (CWSS, 1999). This concerns a safeguarding of both, an undisturbed development of intertidal mussel beds as well as a sustainable seed mussel fishery.

As a measure and based on a classification of existing mussel beds, a number of 17 eulittoral beds with a high potential of development have been excluded from seed mussel fishery for an initial five-year period in addition to the 31 sites already excluded from fishery due to the National Park Law. Thus, out of 187 documented mussel beds altogether 48 have been excluded from fishing (CWSS, 2002).

The allocation of areas open for seed mussel fishing is performed by the State Fisheries Administration Bremerhaven whereby the National Park Administration is consulted in the procedure. Scientific research is carried out for the purpose of evaluating the effects of the measures entailed in the management plan (e.g. annual stock inventory, population assessment, side development). At present, the plan is being revised and, based on the scientific results, will be updated at the end of 2003.

Such a plan exclusively directed to the management of one specific species can be judged positively since it can be more concentrated on the conflict solving of a particular matter of concern, e.g. mussel fishery. This contrasts the broader management approaches in the Bay of Cádiz and in the Ria Formosa. However, according to Walter (pers. comm.) the elaboration of such a management could certainly be improved. For the Blue Mussel Management Plan both sides, nature conservation and fishery, have to perform the recording of the stocks and there is a meeting once a year where the figures usually differing from each other are discussed. Hence, in order talk about identical data and to discuss the situation on the same basis, it could be more reasonable to jointly carry out the assessment of the stocks. But, apparently interpersonal difficulties prevent an amelioration of the current performance (Walter, pers. comm.).

**Management of the Shrimp Fishery**

In contrast to the mussel fishery where regulation is mainly incumbent on the federal state of Lower Saxony, shrimp fishery is largely influenced by European measures. Since 1970, the European Community as an institution of a decentralized management has been governing the restructuring of the German sales organization as well as of the cutter fleet (Gubernator, 1995). In general, fishery management

performed by the European Union is very extensive and a large variety of orders exist which are incorporated into national laws.

For the Wadden Sea shrimp fishery, no catch quotas are imposed by any EU-legislations and international catch regulation is only performed by technical measures such as mesh sizes or the composition of the catches (Gubernator, unpubl. report). On the regional scale, the technical measures for the maintenance of the stocks are pointed out in § 7 Nds. KüFischO. Limitations for the catching of shrimps only affect fodder shrimps which are not allowed to be landed in the first half of the year (§ 8 (4) Nds. KüFischO). Generally, shrimp fishery is allowed in most of the Lower Saxonian Wadden Sea National Park, but excluded in certain areas belonging to the most restricted zone (§ 9 (1) NPL).

Apart from technical measures, arrangements for catch quotas have been established which are negotiated newly from month to month between the producer organizations. This is no EU-regulation but a voluntary restraint performed in order to maintain producer prices at an adequate level (Hagena, pers. comm.) and of particular importance for counterbalancing the market domination in The Netherlands. The general organization of fishermen as well as the development of the related EU-project “Trilateral Cooperation and Networking of North Sea Shrimp Producer Organizations”, coordinated by the Chamber of Agriculture in Weser Ems, is outlined in Box 18.

#### **Box 18**

##### **Organization of Fishermen and “Pesca”-Project**

In general, fishermen are organized in producer organizations (PO's) which guarantee the compliance with the market requirements and the coordination of the product's sale. In addition, the PO's represent the interests of the producers and the merchants on a regional and national scale (Gubernator, unpubl. report). In Lower Saxony, there exist two PO's (Weser-Ems and Elbe-Weser) recognized under EU law. Fixed contractual purchasers, altogether around 10-12 in Lower Saxony (De Beer, pers. comm.) receive the shrimp landings of which around 60-70 % are directly transported to The Netherlands, the principal bulk purchaser for German shrimp landings.

In order to counterbalance the predominance of two Dutch wholesale companies for North Sea shrimp on the European market and to regulate better the situation in the shrimp market, a cooperative effort among producer organizations of the three countries Germany, Denmark and The Netherlands started in 1992 with the goal of founding a recognized trilateral association of PO's (LWK, 2002). Since 1998, the secretariat for the coordination of the project has been located in Oldenburg at the PO Weser Ems. The framework for the

founding of such an association was finally set by the Council Regulation (EC) No. 104/2000<sup>89</sup> on market structure regulation and on export regulation (EC) No. 2508/2000<sup>90</sup> of the European Commission (LWK, 2002).

The objectives of the project are summarized as:

- An increase of the effectiveness of producer-initiated market regulation measures according to EC 104/2000
- A structuring of decision-making processes to solve conflicts
- A warrantee and increase of quality of the product
- A stabilization and improvement of the producer's economic situation by coordinated self-management of fisheries.

Since 1998, it has principally been agreed upon market-regulating measures such as catch limit regulations by means of weekly quotas in order to stabilize producer prices. According to the PESCA evaluation and final report (LWK, 2002), general improvements of the trade have been noticed and better revenues have been reported for the fishermen. This fact has mainly been attributed to the started trilateral cooperation which is generally enjoying a stronger negotiating position than the individual PO's were before.

However, until now the project has not been concluded as planned with the signing of a binding contract for the establishment of a trilateral association recognized by the EU. This is due to the fact that after the Dutch cartel authority "NMA" also the German cartel office started an investigation on whether the trilateral cooperation violates competition law (LWK, 2002). The trilateral agreements are considered as competition limiting and trade influencing. According to Breckling (pers. comm.) the EU is currently elaborating a paper that is going to permit trans-national associations of producer organizations.

Even though the above described trilateral agreements between the different producer organisations were exclusively made for economic reasons (De Jong, pers. comm.), they can be considered as an important step towards a sustainable way of shrimp fishing in the Wadden Sea with social, economic and ecological benefits (WWF, 2003). Apart from guaranteeing an acceptable income for the fishermen, catches and fishery effort were decreased and thereby reduced the amount of bycatch.

It can be concluded that the market regulation measures performed by the PO's are in line with the demands of the EU in encouraging sustainable fishery (WWF, 2003). But, they are also a good example of how difficult it proves to break through long established marketing structures and related legal regulations. However, it is obvious that the success of a project as described above would be important in order to sustain fishery in the long term but also to reduce fishery effort as demanded by nature conservation.

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<sup>89</sup> Council Regulation (EC) No 104/2000 of 17<sup>th</sup> December 1999 on the common organization of the markets in fishery and aquaculture products

<sup>90</sup> Council Regulation (EC) No 2508/2000 of 15<sup>th</sup> November 2000 laying down the detailed rules for the application of the Council regulation (EC) No 104/2000 as regards optional programmes in the fishery sector

### 5.3.3 Mission statement

For the elaboration of a mission statement of the Wadden Sea particularly focusing on the exploitation of marine organism in the area pertaining to Lower Saxony, it has to be taken into account that this area is not delimited as the Bay of Cádiz and in the Ria Formosa. In fact, the Lower Saxonian Wadden Sea is part of an ecosystem subject to trans-national activities concerning its protection and management that have been discussed regularly at the trilateral conferences of the German, Dutch, and Danish Governments for many years. Generally, it can now be stated that the preservation of the characteristic features of the entire Wadden Sea is declared environmental policy (Oeschger, 2000), an achievement of almost 20 years of political cooperation on international nature conservation. Therefore, the general objectives for the Wadden Sea National Park outlined in the first part of Box 19 are largely adopted from the targets formulated during the 8<sup>th</sup> Wadden Sea Conference in Stade, Germany, 1997 in the frame of the Trilateral Wadden Sea Plan (WSP)<sup>91</sup>.

Concerning fishery, specific objectives and thereof deduced mission statement given in Box 19 are related to the situation in Lower Saxony even though most of it could also apply to the other Wadden Sea areas.

**Box 19 Objectives shown for the Lower Saxonian Wadden Sea National Park and derived mission statement with regard to the future situation of marine bio-resources**

**General Objectives for the Wadden Sea National Park**

- Preserve an intact natural environment which maintains the diversity of habitats and species and its ecological integrity
- Promote a sustainable use
- Maintain and enhance values of ecological, economic, social, historic-cultural, and coastal protection character offering enjoyment for the inhabitants and users
- Foster an integrated management of human activities considering the socio-economic and ecological relationship between the Wadden Sea and the adjacent areas
- Create a common comprehension for a sustainable development of the Wadden Sea region
- Generate an informed, involved and committed community

**Specific Objectives**

*Concerning conservation*

- Maintain the coastal fishery sector in such a way that is stays profitable for the fishermen, and for contributing to the “maritime flair” of the small villages along the coast
- Maintain a healthy environment
- Gain more knowledge on the actual stocks, particularly on shrimps

<sup>91</sup> <http://www.waddensea-secretariat.org/tgc/Wsp/0-Preface.html>, accessed in October 2003

➤ Concentrate more on the research of sublittoral mussel banks

➤ Create “non-use” areas, e.g. zones excluded from fishery, and concentrate uses in others\*

*Concerning sustainable exploitation*

➤ Use fishery resources in a sustainable way

➤ Find additional forms or better techniques for obtaining sufficient seed mussels

➤ Find better techniques for further reducing the amount of bycatch in the shrimp fishery

➤ Create a more flexible fishery management capable of reacting to changes (e.g. co-management)

*Concerning rising awareness*

➤ Foster the country’s cultural identity with the fishery sector

➤ Increase the position of coastal fishery in general (stronger fishery lobby)\*\*

⇓

**Derived Mission Statement**

Maintenance of a healthy ecosystem in which the sector of coastal fishery is an integral part; optimizing the existing structures in such a way that a sustainable use of the natural resources as well as a profitability for the fishermen is guaranteed

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\* Exclusively demanded by nature conservation authorities

\*\* Particularly demanded by representatives of the fishery sector

Source: Internet<sup>92</sup>, Personal communications

The specific objectives for the exploitation of marine organism, which means mussel and shrimp fishery in Lower Saxony, have predominantly been compiled from the statements of the different interlocutors. Nevertheless, most of the objectives outlined in Box 19 and the related vision are a subject matter in most of the meetings about the future development of the Wadden Sea. In this connection, the thematic group on fisheries of the Wadden Sea Forum is principally concerned with the discussion of the position of fisheries in a future world and with the elaboration of strategies for a sustainable development of the Wadden Sea.

The mission statement elaborated can be considered as a common one. Nature conservation as well as representatives of fishery want to maintain a regime of nature protection and to keep the fishery sector alive, but, contradicting views exist on how to put it into practice (Rösner, pers. comm.). For example, on the part of the fishery sector, more flexibility is demanded for the fishermen to work within a given framework, such as in the form of a co-management, in order to better react to the changes of the natural environment (Gubernator, pers. comm.). But, certainly not desired by the respective sector is the requirement expressed on the part of nature

<sup>92</sup> <http://www.waddensea-secretariat.org/tgc/Wsp/0-Preface.html>, accessed in October 2003

conservation to zone the area of the Wadden Sea in order to create more coherent areas excluded from any kind of usage.

According to De Jong (pers. comm.), the sector of fishery as well as other forms of exploitation of marine bio-resources are not a prevailing matter of fact in the current political discussions in Lower Saxony. Of more concern are topics like tourism, offshore windparks or the extension of harbours. A possible explanation for that might be the fact that in terms of coastal fishery a status quo has been achieved by which the often contradicting parties of nature conservation and fishery somehow come to terms with although a change for the better is very much anticipated. This is in strong contrast to the situation of the Bay of Cádiz and the Ria Formosa where much more “movement” is currently taking place in order to improve the overall situation.

## **6 View on the European Level**

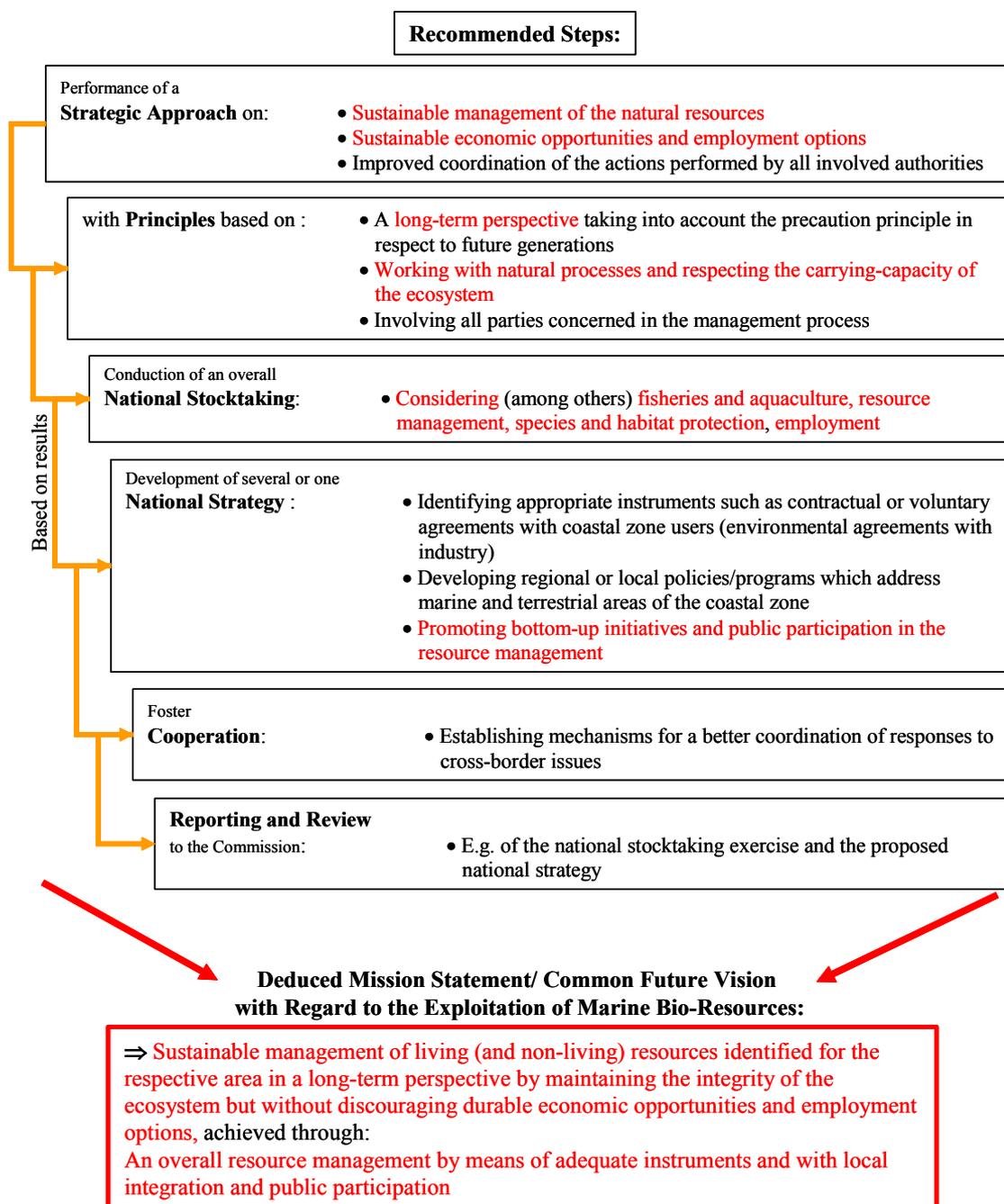
In the following, the assessment of the current exploitation situation of marine bio-resources at the three coastal sites is discussed with respect to the European vision of resource management within the framework of Integrated Coastal Zone Management (ICZM). Moreover, with regard to the mission statements of the three coastal areas considered, conclusions are formulated on:

- the applicability of EU-recommendations at local or regional scale,
- local/regional efforts to promote adequate management strategies,
- the role of an early participation, and
- the transferability of experiences of one coastal area to the other.

### **6.1 The European Mission Statement**

Based on the Communication from the Commission to the Council and the European Parliament on “Integrated Coastal Zone Management” in Europe (COM, 2000), recommendations for the implementation of an ICZM in Europe have been formulated by the European Community. Reflecting on several topics and instruments, the member states are asked to develop national ICZM strategies and point to a particular future vision in terms of the development of European coastal

regions<sup>93</sup>. With regard to the future aims concerning the exploitation of marine bio-resources, the respective steps as well as the mission statement derived from the recommendations are outlined in Fig. 11.



**Fig. 11 Mission statement on the exploitation of marine bio-resources derived from EU-recommendations on ICZM.** Source: Internet<sup>93</sup>

<sup>93</sup> Council Recommendations of the European Parliament and of the Council of 30<sup>th</sup> May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC) (<http://europe.eu.int/comm/environment/iczm/home.htm>), accessed in September 2003

The mission statement developed according to the given EU-recommendations on ICZM is obviously of very general character without any specific advices concerning resource management in coastal areas (Fig. 11). Most likely, this statement is also valid for considerations of many other explicit sectors such as tourism or cultural heritage where it is likewise aspired to find a balance between people and the quality of the coastal environment. But, at European Community level, concerning the common future vision of European coastal zones, only guidelines can be established. The development of appropriate measures for a certain region can merely be performed properly on a local scale by those who know about the respective weak points, peculiarities, and possibilities for a lasting future development. How can this be put in relation to the three coastal areas considered and what does it imply?

## 6.2 Evaluation

The mission statements elaborated in chapter five for the management of the exploitation of marine bio-resources in the respective coastal areas (see chapter 5), are largely in agreement with the European mission statement adopted from the EU-recommendations on ICZM. A sustainable exploitation of natural resources while maintaining the biological diversity as well as improving the quality of life of human communities are a matter of fact in the Bay of Cádiz, the Ria Formosa, and the Lower Saxonian Wadden Sea as well. Slight differences exist in the setting of priorities which in turn is related to the varying prevailing matter of concern. For example, in the Bay of Cádiz, the current state of fishery resources is the focal point in the formulation of targets and management approaches. In contrast, in the Ria Formosa and in the Lower Saxonian Wadden Sea, the regulation of fishery resources is not of predominant importance but one critical topic among many others.

➤ ***First conclusion: The mission statements of the coastal areas considered are in line with the general framework given by the European Union.***

However, the elaboration of adequate strategies in order to accomplish the desired targets as well as their implementation and evaluation are another matter of fact. It is striking that even though differences exist amongst the three coastal areas in terms of the natural landscapes and also concerning the manner and type of organisms exploited, similar difficulties exist in dealing with the management of marine bio-resources (see chapter 4). Most likely, the many different authorities, laws and orders

which regulate the interface between fishery/aquaculture and nature conservation are partly responsible for the difficulties in development and implementation of adequate management strategies. This is apparent in all three coastal sites. It can be supposed that the overlapping of responsibilities as well as inter-agency conflicts or personal discords between single persons in charge make nontransparent structures even more difficult.

➤ ***Second conclusion: Intransparent agency structures as well as nondistinctive competencies aggravate the implementation of a mission statement.***

Apart from the administrative situation on the local or regional scale, it seems as if the European fisheries policy is rather complicating the marine resource management in defined coastal areas. The objective of the Common Fisheries Policy (CFP) “*to provide for sustainable exploitation of living aquatic resources and of aquaculture in the context of sustainable development, taking account of the environmental, economic and social aspects in a balanced manner*”<sup>94</sup> can generally be judged positively. But, very often, problems arise when the universally formulated demands of the European Union are applied on a regional or local scale. For example, the imposed reduction of the fleet capacity as a means to diminish fishing effort has brought about large economic disadvantages for the Lower Saxonian shrimp fishermen in comparison to the Dutch (see 4.3.3 and 5.3.2). Here, historically grown structures (e.g. the Dutch way of commercialization) as well as the strong appearance of The Netherlands as a “Fishery State” have more influence on the local situation than legislations imposed by the European Union.

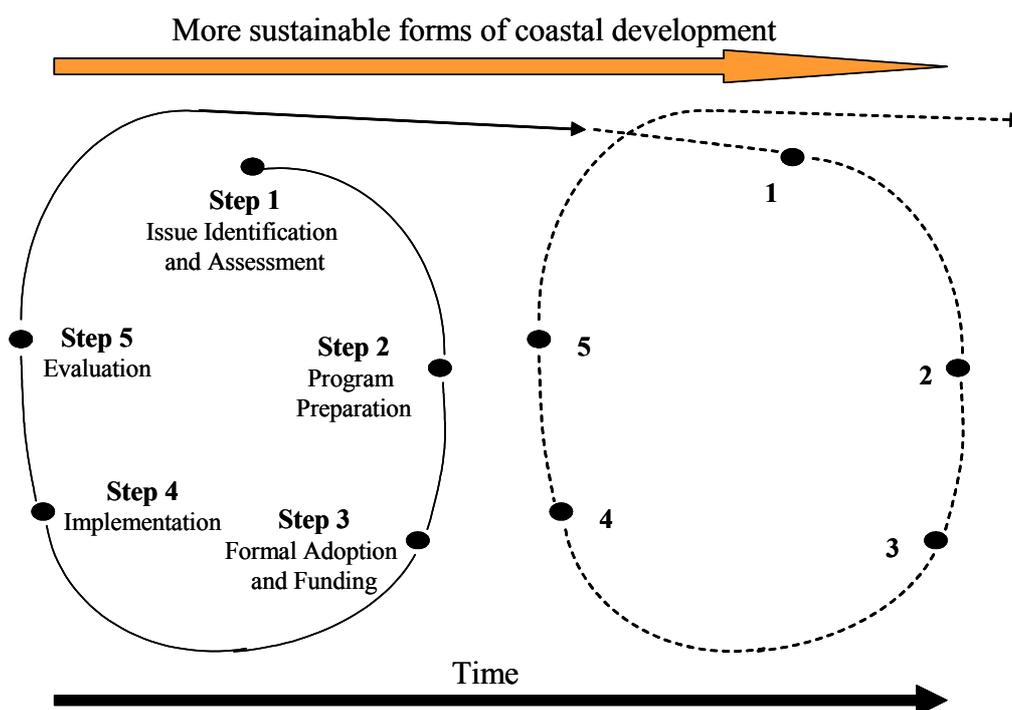
In this regard, the establishment of Regional Advisory Councils (RACs) “*to enable the Common Fisheries Policy to benefit from the knowledge and experience of the fishermen concerned and of other stakeholders*”<sup>94</sup> shall contribute to achieve the disposed objectives of the CPF. But, again, since the term “region” refers to such large geographic areas as the Mediterranean, the North Sea, or the Baltic Sea (Breckling, pers. comm.), such an establishment is far away from a solution on a local scale.

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<sup>94</sup> Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy, [http://europa.eu.int/comm/fisheries/doc\\_et\\_publ/factsheets/legal\\_texts/docscom/en/r02\\_2371\\_en.pdf](http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/r02_2371_en.pdf), accessed in September 2003

➤ **Third conclusion: Interaction between the international goals of the European fisheries policy and the local characteristics of a coastal area is still lacking.**

In all three coastal areas, great effort is undertaken in order to improve the overall resource management, and different lines of structures and performances are developed (see Chapter 5). But, if we compare the actual management performances in the Bay of Cádiz, the Ria Formosa, and the Wadden Sea with a certain policy cycle (Fig. 12), at present the three sites are localized in different steps. This cycle describes the approach towards a more sustainable form of a coastal development out of the perspective of an integrated coastal management as a process consisting of different steps.



**Fig. 12 Steps of the Integrated Coastal Management (ICM) policy cycle.** Source: GESAMP (1996) in Olsen et al. (1997)

Without referring to concrete actions associated to each step at this time, both in the Bay of Cádiz and in the Ria Formosa current management practices are somewhere situated between step 1 and 4. Issue identification and analysis of the stretch of coast in question (step 1) as well as the preparation of a policies and action plan (step 2) are currently being performed (see 5.1.2. and 5.2.2). Formal adoption of

the plans as well as their implementation are about to follow (steps 3 and 4) whereby the situation in the Bay of Cádiz seems to be a little bit more advanced in terms of proposed actions to be pursued (see Table 13). In contrast, natural resource management in Lower Saxony has already partly entered an evaluation process (step 5). At least, this is true for the Blue Mussel Management Plan which was implemented in 1998 (see 5.3.2., Box 17). The large complexity and singularity of a certain coastal area as outlined and exemplified in the chapters 3 to 5 for the Bay of Cádiz, the Ria Formosa, and the Wadden Sea strengthens the assumption that the time it takes to complete such a cycle differs largely from site to site. Most presumably, there are regional distinctions concerning the time needed for a certain step or the period it takes to advance from one step to the following. For example, according to Cachola (pers. comm.), the elaboration of the management plan for the Ria Formosa, the POPNRF, has not been concluded at present even though the revised version should have been finished by the middle of 2003 (see 5.2.2). As a consequence, formal adoption and implementation of the plan (steps 3 and 4) will be lagged.

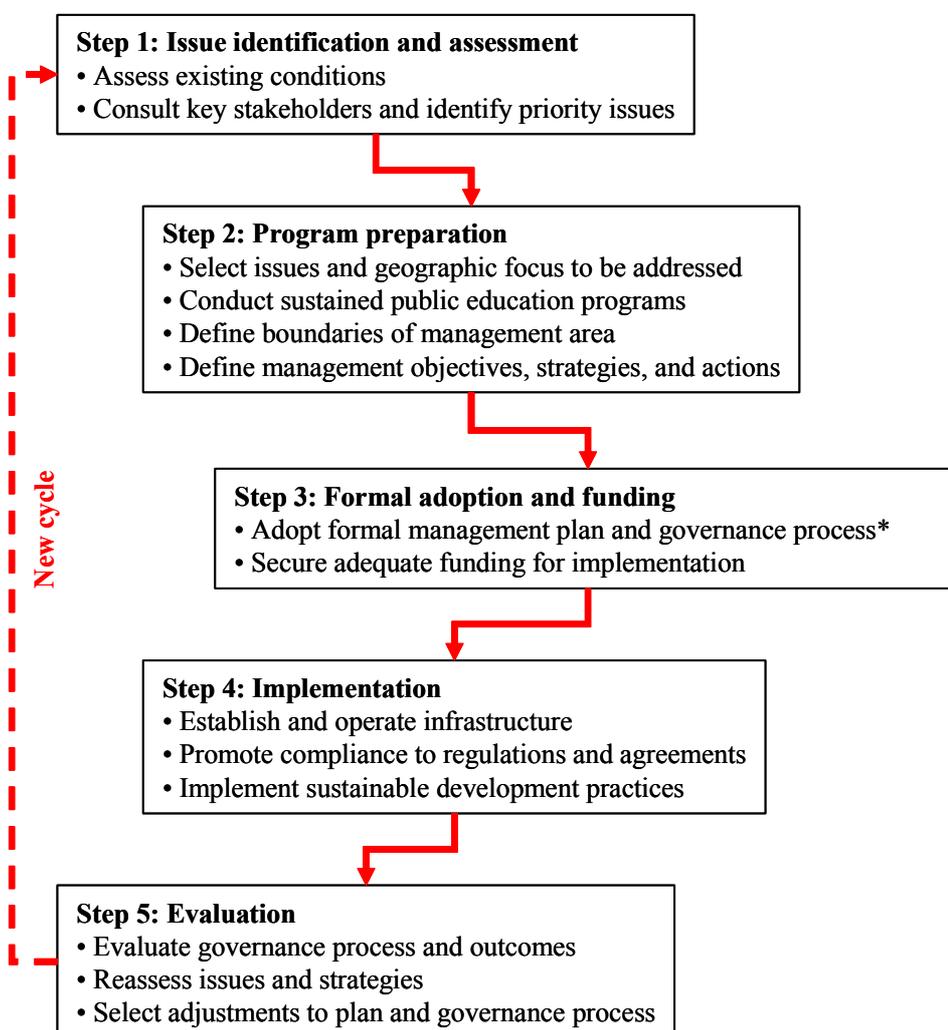
Policies in a certain coastal area might have already gone through one or more cycles, depending on the time it needs to complete a sequence of cycles and the duration and intensity of management already performed in the area concerned. The Wadden Sea National Park area, for example, has been subject to international management approaches for almost two decades. During this time, medium-term objectives such as use restriction (see 5.3) have been approached by now.

The above mentioned facts lead to the conclusion that the present situations (steps) of the coastal areas considered are not equal and it is therefore not justifiable to judge whether one coastal area performs a better management than the other.

➤ ***Fourth conclusion: Management performed in a certain coastal area is closely associated to the local circumstances and not at any case comparable to the time needed for elaboration and implementation of management policies in other sites.***

Priority actions can be attributed to each of the steps mentioned in Fig. 12 which help to develop methodologies or instruments for analysis and improvement of

coastal management concepts. Proposed essential actions associated with each step of the ICM policy cycle are outlined in Fig. 13.



**Fig. 13 Needed actions related to each step of the ICM policy cycle.** Adopted from Olsen et al., (1997). \*:The term “governance process” refers to the instrument by which management strategies are tested and constantly improved in order to move towards more sustainable forms of development.

Even though not explicitly following an ICZM strategy, most of the actions performed in the Bay of Cádiz, the Ria Formosa, and the Lower Saxonian Wadden Sea are naturally part of a policy concerned with coastal management or, more precisely, the management of natural living resources. The development of coastal management plans such as it is the case in the Bay of Cádiz and in the Ria Formosa (see 5.1.2 and 5.2.2), but also specific instruments such as the Blue Mussel Management Plan (see 5.3.2, Box 17) are to be mentioned in this context.

However, programs could be more successful. An agreement on major issues should be negotiated at a very early stage among stakeholders both in and out of

government. Moreover, the specific objectives should explicitly be formulated, a fact that in itself is usually a major achievement (Olsen et al., 1997).

➤ ***Fifth conclusion: An involvement of stakeholders as well as an explicit formulation of specific targets at a very early stage is of overall importance for the success of an integrated management approach.***

Regardless of their actual position within such a coastal management policy cycle, people operating in different coastal areas can certainly learn from each other. For example, coastal managers of the Bay of Cádiz or the Ria Formosa can learn from the experiences of the independent discussion forum established for the trilateral Wadden Sea area (see 5.3.1., Box 15), an area which has already been subject to coastal management for a long time. Likewise, for the elaboration of a land use management concept as currently performed for the marine part of Lower Saxony (“Raumordnerisches Konzept für das niedersächsische Küstenmeer”), it could be instructive to survey coastal management plans such as the detailed POOC developed for the area around the Ria Formosa (see 5.2.2, Box 11).

In the Ria Formosa, an interesting integrative tool was tested which has not been mentioned so far, a participatory modeling project aimed at the development of a management plan for the Ria Formosa<sup>95</sup>. With the contribution of local stakeholders, different scenarios for the existing management opportunities for the Ria Formosa were investigated during a series of four mediated modeling workshops. Moreover, an analysis of different policy action alternatives was performed in order to tackle the existing environmental and socio-economic pressures in the Ria Formosa. Among others, problems concerning bivalve and finfish cultivation and exploitation were an important issue. Even though after the final session it remains unclear if and how the obtained results will actually be implemented or can contribute to a management plan (pers. observation), such a dynamic modeling process serves as a good example of how local actors can be involved early in decision making. This learning experience of the stakeholder group participating in the construction of the model was considered to be the most important outcome<sup>95</sup>.

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<sup>95</sup> [http://gasa.dcea.fct.unl.pt/ecoman/projects/RiaFormosa/modelo\\_e.htm](http://gasa.dcea.fct.unl.pt/ecoman/projects/RiaFormosa/modelo_e.htm), accessed in September 2003

➤ *Sixth conclusion: Experiences gained from the application of certain management tools in a particular coastal area can serve in other areas as the basis for the development of adequate management strategies.*

It can be summarized that integrative management tools have to be developed according to the local conditions. The guidelines or actions outlined in Fig. 13 as well as experiences from other coastal sites can help to improve already existing lines of performances.

Finally, it can be agreed upon that “individual” aspects such as the exploitation of marine bio-resources cannot be treated separately from other features of the coastal area considered if an integrative management is desired.

➤ *Seventh conclusion: The management of marine bio-resources is one among many other aspects to be considered in an integrated management approach of a coastal area.*

## 7 Future perspectives

In order to complete the view on the three coastal areas, in the following, reference is given to the opinions of different interlocutors interviewed about the future development of exploiting marine bio-resources in the Bay of Cádiz, the Ria Formosa, and the Lower Saxonian Wadden Sea.

### 7.1 Natural Park Bay of Cádiz

Own observations as well as conversations with different people have revealed that the predominant view of the Bay of Cádiz and related exploitation matters is pessimistic or at least difficult to judge (Fernandez, pers. comm.). Degradation of the prevailing Salina-saltmarsh ecosystem but also of the cultural values is a very apparent feature of the park. Obviously, many sites belonging to the park are not subject to any protection, a fact causing further pollution and destructive habits.

It is commonly agreed on the fact that the present instruments are insufficient for a proper management of the activities and resources of the Bay of Cádiz. This is reflected in statements such as:

*“Since 1983 I have been following planning options for the Natural Park Bay of Cádiz and even though a lot has been said, investigated and decided, not even 20 % of the desired changes towards the better have been performed in order to improve the situation during the last 20 years”* (Osuna, pers. comm.) or *“...the Bay of Cádiz has to be put under a very extended protection since in the last 25 years that I am living in this area this site has deteriorated to a great extent”* (Arias, pers. comm.)

However, the most pessimistic scenario on the future development of the Bay of Cádiz has been put like this:

*“..the area of the saltmarshes will extend further. At the same time the field of aquaculture will disappear in this region (no profitability) so that an additional 2000 ha of surface will be abandoned. The actual condition of the area (plus remains of the cultural heritage) will deteriorate because the sea will enter the bay forth and forth, destroying any left remains of ancient salt ponds. Urbanisation around the park will enhance which will lead to larger loads of waste entering the park area. One of the most important wetlands of the Spanish peninsula will be completely deteriorated. Because of the fact that the richness of the park slowly disappears, a further population growth of the five surrounding municipalities is predictable. Finally, today's area of the natural park will be reduced around five times. Salinas and adjacent channels will be filled with sediments, dry out and ultimately turn into salty deserts. It will not be possible to perform any kind of economic activity within the area of the Bay of Cádiz any more and consequently no more income will be generated“* (Perez, pers. comm.).

Not only from the point of view of nature conservation but also for the aquaculture society, the expectations on the development of aquaculture in the Bay of Cádiz are pessimistic, regardless of the fact whether it concerns small family-based enterprises or larger companies such as “Cupimar”:

*“If we don't care, the whole aquaculture activity will disappear from the region and shift to other regions of Andalusia or of the country. Consequences will be bad for our region”* (García de Lomas Mier, pers. comm.).

Little cost-effectiveness of the aquaculture sector gives rise to the supposition that:

*“...the form of intensive culturing will be abandoned sooner or later and only the extensive traditional form will be preserved in future times due to its historic character by those owners who have interest in doing so. However, the latter form of exploitation (...) will always be very limited and not profitable”* (Arias, per. comm.).

Hope exists for the future of the Bay of Cádiz that an equilibrium between the conservation aspect of the natural park and the economic needs will form an equilibrium that presumably

*“will slightly be in favour of the protection of the environment”* (Abarca, pers. comm.).

But, how can this dichotomy be put in line with the development of a better cost-effectiveness of the aquaculture-sector in the Bay of Cádiz? New concepts could be directed towards concentrating the more intensive forms of aquaculture in concrete zones of the park with extensive aquaculture installations grouped around in order to buffer the contamination originating from the intensive type of production (García de Lomas Mier, pers. comm.). Organic-rich water from the intensive aquaculture could also be conducted into shallow basins where a lot of biomass of macro- and microbenthic organism could develop and on which birds would feed, a system that could even be combined with a form of ecotourism directed towards bird-watching (Perez, pers. comm.).

The last suggestion is pointing towards the idea of a “diversification of activities and/or resources”, a statement that has been expressed by various interlocutors, e.g. bird-watching, rural, and cultural tourism, the production and own commercialization of high-quality salt, “Flor de Sal”. Though, some alternative forms of exploitation are already performed by a few aquaculture businessmen such as organizing touristic events to see and take part in the traditional fishing out of a typical “estero” and to eat the products afterwards (Arias & Drake, 1999), a promotion of this type of activities is needed.

Therefore, management approaches are desired for the future that shall be directed towards creating more additional economic activities and combining activities. New ways should be found to make use of the existing natural resources instead of only working on the question of how to develop the aquaculture sector in such way that an equilibrium between conservation and economy can be established. According to Perez (pers. comm.), aquaculture could certainly be part of a new concept and even improve the degraded character of the park,

*“..for example, if 5 ha are used for cultivation the surrounding 20 ha should be cared for and maintained as well”.*

It can be stated, that many ideas exist about the future development of the Bay of Cádiz even though the point of departure does not seem to be very promising. The need for a combination of different actions and instruments as well as of a better

communication between authorities about matters concerning the future development of the natural park Bay of Cádiz can best be summarized by the following statement:

*“More private inversion has to take place in this sector, (...). Public administration has to protect and guard, norms have to be respected and the quality of the product has to be maintained. There are different models which could be converted into practice in order to combine the needs of the different stakeholders. Therefore, if there is set a limit for the expansion of the semi-intensive form in our area, subsidizing has to take place in order to compensate such measures. It is also possible to combine the extensive form of aquaculture with tourism which generates income which would otherwise be gained by more production in the semi-intensive form. In every aspect, the different parties have to try to understand better the other part and it cannot be said “no” to everything without thinking about the herewith resulting consequences for a certain group”* (García de Lomas Mier, pers. comm.).

## 7.2 Natural Park Ria Formosa

In contrast to the situation in Cádiz, the future development of the Ria Formosa is generally considered to be better, but concern has also been expressed. The starting point seems to be more advantageous than in Cádiz since most of the interlocutors consider that the overall environmental quality has been improved over the years. The lagoon system and related exploitation activities is judged to be stable as far as the quality of the water and circulation patterns are maintained or improved (see below), but uncertainties exist about the general carrying capacity of the system:

*“Until now the health of the lagoon is good, but we don’t know how close we are to the “turning point” (...). If we are still far away from it, the system will be stable for many years. However, if the ecosystem will qualitatively change very much there will be less production in general and also a decline in the production of a lot of species. This in turn will lead to a decline of a lot of economic activities that depend on the status of this system”* (Santos, pers. comm.).

According to the interlocutors, a positive future reality of the Ria Formosa is bound to many conditions that have to be fulfilled before and a general prediction of future conditions seems to be difficult since

*“...everything will depend on the political decisions of the country that will take place in a certain time”* (Arrobas pers. comm.)

Moreover, uncertainties are expressed in relation to the control of activities as well as to the water quality of the lagoon. Referring to the latter, it has been stated that:

*“...the quality of water is the most important thing to maintain the resources and related activities”* (Arrobas, pers. comm.)

and that if a good water quality is guaranteed,

*“the long-term survival of the Ria will be no problem, if not, the system will collapse”*  
(Santos, pers. comm.).

Contradicting views exist on the sustainability of the use of marine bio-resources in the Ria. On the one hand, there seems to be no apparent sign for an over-exploitation of bivalve stocks, except of the group of razor shells (Amaral, pers. comm.). Also concerning finfish species, the Ria is considered to be in a surprisingly good status (Erzini, pers. comm.). On the other hand, there is the feeling that the exploitation of resources is increasing even though there are no adequate data that support such an assumption (Santos, pers. comm.). But, even fishermen seem to realize that

*“20 years ago there was more and bigger fish. They know that some of their activity is harmful but there is the situation that: if I don't catch the fish, my colleague will catch it, so I'll better do it myself”* (Erzini, pers. comm.).

Generally, it is commonly agreed that a lot has to be done in order to keep the whole system and therein performed exploitation activities sustainable in the long term. Suggestions are directed towards more monitoring, a reduction of the exploitation effort, more applied scientific research as well as more control in terms of professional and recreational fishery, farming, and illegal activities. Moreover, human intervention in terms of dredging and maintaining the main channels open for guaranteeing water circulation is considered to be indispensable for the future development of the Ria (Gamito, pers. comm.) and for the exploitation of marine organisms,

*“since we have no hydraulic forces to do so (...). However, this kind of management is very money-consuming and I am afraid that people dependent on the culturing activities can not afford this on their own (...). Thus, all the other activities performed in the environment, above all tourism, have to contribute to this maintenance and management. Otherwise the activity of culturing (and also others) will not be sustainable”* (Fonseca, pers. comm.).

Similar to the situation in Cádiz, there is the need for creating synergism between different activities and the implementation of environmental compatible activities. A special program called “Local encouragement for the development and foundation of employment in the Ria Formosa” (Animação local para desenvolvimento e criação de emprego na Ria Formosa) as part of the European program “Equal” can be considered as a first step into the right direction. This program is currently taking place in the Ria Formosa and aims to provide new jobs for the local population by revitalizing activities that are in line with the given natural conditions such as the traditional way of salt or bivalve production but also by fostering ecotourism

(Navalho, pers. comm.). Since in contrast to the Bay of Cádiz, tourism within the limits of the Ria Formosa natural park has already been established to a large extent, it is believed that especially the starting up of small businesses related somehow to ecotourism will have future.

*“For example, people can be taken to the “viveiros” to show them the way of culturing. So far, there exist just a few boats that are picking up people to show them a little bit of the Ria, but there could be done much more”* (Navalho, pers. comm.).

Good examples already exist which show

*“that the coexistence of tourism and the nature park is possible (...) such as the visitor card of the resort “Quinta do Lago” Here, a lot of activities are related to the natural environment and it is somehow ridiculous that the bird species *Porphyrio porphyrio* which is the symbol of the park has its largest breeding colony around the lakes artificially created in the golf course of the resort”* (Ramos, pers. comm.).

However, particularly out of the scientific perspective, it is agreed upon the fact that the future development of the Ria and any exploitation activities are heavily dependent on a better exchange, control, and availability of information, as well as on bringing the different stakeholder groups more together.

*“There is an urgent need for a group that integrates several powers such as scientists, producers, politicians, managers etc.”* (Santos, pers. comm.). Furthermore, *“the Ria Formosa needs an observatory that collects and controls data, analyzes trends and so on (...). All data are spread out and there are no comprehensive works (...). Even inside the institution of the university there is a lack of platform in order to bring people and their knowledge together”* (Dias, pers. comm.).

It appears as if a lot of knowledge exists about the Ria of which no use is made. Such a forum would allow an assessment of the overall situation and facilitate decisions on future lines of investigations to find answers to concrete questions and suitable management strategies. Moreover, the dialogue between the different stakeholder groups would be encouraged as it is the case with the trilateral Wadden Sea Forum.

Apparently and as mentioned by many interlocutors, there is a need to set up concrete objectives for the Ria which is summarized as follows:

*“You have to have goals and objectives in order to maintain the Ria Formosa sustainable. All people must be put together in this subject since the conservation of nature supports tourism, supports the general quality of life, supports the sector of science and technology, supports any future economic activities, and also any exploitation activities”* (Fonseca, pers. comm.).

It is not quite clear how effective the implementation of the revised management plans “Plano de Ordenamento da Orla Costeira (POOC)” and the “Plano de

Ordenamento e Regularmento do Parque Natural Ria Formosa (POPNRFF)” will be, but whatever process is taken, it is clear from the statements compiled that definite targets are required for the general future development of the Ria and, particularly, for the future use of marine organisms.

### 7.3 Wadden Sea Area of Lower Saxony

When talking about the Wadden Sea fishery sector, namely mussel and shrimp fishery, it can generally be stated that there is a diverse appreciation of the different interlocutors on the future development of the Lower Saxonian Wadden Sea. The viewpoint is ranging from quite negative via neutral to generally positive, and therefore, the Wadden Sea has an intermediate position between the Bay of Cádiz and the Ria Formosa in terms of the future outlook out of the perspective of the interlocutors. On the one hand, it has been stated by representatives of the fishery sector that

*“mussel and shrimp fishery are very traditional branches which will persist in the actual frame”* (Gaumert, pers. comm.) and that *“coastal fishery is not endangered but will stay an important economic factor along the coast”* (Breckling, pers. comm.).

On the other hand, particularly if considering the current marketing situation and the rising influence of international laws passed in Brussels, the outlook is not considered to be very good. Rather, it is believed that:

*“the marketing structures of The Netherlands won’t break away and hence the career of the fishermen will get even more unattractive than it already is (...). In general, the career will be less profitable since the high prices achieved through direct commercialization of the final products are not reaching the producers”*. Moreover *“we will have to cope with rising bureaucracy”* (Gubernator, pers. comm.) and *“the amount of fishing vessels will continue to be reduced which will mainly be due to the EU-legislations that are originating in Brussels”* (Walter, pers. comm.).

The apparent incertitude concerning the future development of the Wadden Sea fishery is largely related to the difficulty in recruiting young professionals. As explained by De Beer (pers. comm.),

*“there are only very few trainees and there is little motivation for learning the trade of a fishermen (e.g. irregular work schedule) even though the income is quite good”*.

Generally, it is commonly agreed that the future of the current form of the Wadden Sea fishery largely depends on whether the business will stay profitable for the fishermen in the long term. This is also of concern for the few shrimp commercialization businesses along the Lower Saxonian Wadden Sea coast.

*“We want the fishermen to have a future since we are very much dependent on them”* (De Beer, pers. comm.).

Drastic changes in the current form of marketing are supposed to improve the current situation as well as a larger flexibility for the fishermen to work within the given legal frame (Gubernator, pers. comm.). But, in addition, more activity is demanded on the part of the coastal fishery sector:

*“If the sector of fishery wants to maintain or even strengthen its identity and importance in coastal areas, it has to show more presence and do something for its image (...). There could exist, for example, something like a “Road of North Sea Shrimps” that goes along the coast through the little villages (...). I also wish that the representation of fishery (the lobby) generally showed more presence such as it is performed by Mrs. Gubernator for the mussel fishery”* (Breckling, pers. comm.).

The last sentence is supported by the statement that

*“in Lower Saxony, the situation is somehow paralysed. Politicians don’t want any kind of problems and it also seems as if, in comparison to Kiel where the main decision making for Schleswig-Holstein takes place, the city of Hanover is too far away from the Lower Saxonian coast”* (Marencic, pers. comm.).

Evidently, large differences already exist between the different German coastal states concerning the management of coastal fishery, differences that certainly have an influence on the future development of this sector. In this regard, it has been expressed that

*“in Lower Saxony there are no innovative ideas concerning fishery. In contrast, in Schleswig-Holstein there are clear arrangements (...). A framework agreement between the Ministry and the fisheries sector seems to meet the targets of sustainable fishery and is planned on a long-term basis. This brings about advantages for both sides, fishery and nature conservation (...). In general, in Schleswig-Holstein there are more oral agreements between the different sectors such as with the shrimp fishermen. Here, they have voluntarily agreed not to fish in a certain area during the moulting of a certain bird species”* (De Jong, pers. comm.). Referring to this, *“such agreements have resulted to be positive for the general solution finding of problems* (Marencic, pers. comm.).

The Wadden Sea Forum (WSF) can be considered very valuable for bringing together the different stakeholder groups since it

*“seems to be a possible platform for the common finding of new strategies “* (De Jong, pers. comm.). This conclusion is attributed to *“the impression that the forum is judged positively by the different parties and (that) problems are presented in an open way”* (De Jong, pers. comm.). Nevertheless, *“a common forum only makes sense if the outcome of the discussions is put into action. Talking and interchanging opinions is not enough”* (Vesper, pers. comm.).

Within the frame of the forum, concrete proposals for future scenarios have to be presented at the end of 2004 by each of the thematic groups (De Jong, pers. comm.). It is hoped that advanced and commonly accepted measures will be developed this time and

*“that the WSF creates an atmosphere in which more comprehension exists for the interests and concerns of the other party”* (Rösner, pers. comm.).

Nevertheless, some concern is expressed about whether the thematic group of fisheries will contribute to the aim of the WSF to come to solutions in a mutual agreement between the different stakeholders or among the participating fishermen:

*“The engagement and readiness to discuss is stronger among the Dutch fishermen.”* They *“are much more interoperable”* (Rösner, pers. comm.).

Still, as stressed by many interlocutors, there certainly exist possibilities to improve management and techniques. For example, suggestions concerning the mussel fishery have been given in that

*“there could (...) be established a kind of “fond” for years where recruitment is poor, e.g. in forms of areas which are usually excluded from fishing but which can be used in certain years”* (De Jong, pers. comm.).

This proposal is in line with the demand of representatives of nature conservation to

*“concentrate the use in certain areas and exclude it in others”* (Marencic, pers. comm.)

but somehow contrasts the idea of general display of

*“coastal areas (...) as a preference area for the “small” fishery. However, for this an actual planning process that guarantees such a determination would be needed”* (Breckling, pers. comm.).

Even though it cannot be stated up to this time whether the WSF will come to terms with topics such as the proposed zonation of the Wadden Sea territory, the existence of such a stakeholder platform can judged to be a great advantage compared to the circumstances in the Ria Formosa where such a forum is urgently demanded.

In any case, changes for the Wadden Sea fishery sector are on hand, changes which call for a mechanism by means of which existing structures are constantly examined and adapted to new circumstances. This is particularly necessary in view of climate changes which will certainly bring about transformations of the Wadden Sea territory:

*“We can expect that the Wadden Sea will get smaller, that tidal changes will be larger, that sediments will get coarser (...). We definitely will have changes but can only hypothesize since we don't know what and when they will happen”* (Kröncke, pers. comm.).

Apart from transformations of the present habitat, the introduction of foreign species such as the Pacific Oyster, most probably favored by higher water temperatures, will in the short run certainly have an impact on all fishery activities in the short run, particularly on the mussel fishery (Hagena, pers. comm.). Recently started scientific investigations have already lead to the supposition that

*“the Pacific Oyster will establish itself in the Wadden Sea (...). Concerning displacement of the Blue Mussel, I don’t really know. But, oysters grow older, their filtration rate is higher and settlement is apparently more effective. Possibly, in future we will have a competition of space between mussels and oysters” and “maybe we will see a shift of the mussels towards more sandy substrates”* (Wehrmann, pers. comm.).

Thus, if mussel fishermen want to keep their business in the present form, they

*“will definitely have to spend more time on sorting out oysters during the harvest of mussels”* (Wehrmann, pers. comm.).

It is very difficult to predict how with the above described situation on the invasion of the Pacific Oyster can be coped with, a reality that can’t be dismissed any more.

Ideas exist in that it could be tried to

*“establish a market based on production and commercialization of oysters from the wild. It could be a branch of fishery based on the marketing of exclusively wild oysters”* (Wehrmann, pers. comm.).

However, whatever lines of management the responsible bodies will be able to take for the coastal fishery sector, it has to be stressed that, on the part of the fishermen, there certainly exists the readiness and the aim to perform a long-lasting form of fishery. In view of existing dissidents in current discussion forums,

*“the historical development has to be kept in mind: first of all, there was the fishery and only afterwards there arose the awareness for nature conservation. Particularly fishery needs time for this kind of development. Therefore, a certain time for a development in terms of dialogue and new strategies is indispensable and has to be taken into account”* (De Jong, pers. comm.).

Generally, it seems to be difficult to predict future reality of the Wadden Sea coastal fishery sector since political and social developments always have a large effect on the future actuality. Nevertheless, if thinking in a positive way, it is assumed

*“that the social tenor of conserving the Wadden Sea as a whole is stable” and that “in the long term, the coastal fishery sector will be consistent with this development”* (Rösner, pers. comm.).

With regard to the previous chapters, it can be stated that the local stakeholders in the three coastal areas considered are all concerned about the respective situation of the coastal site. They are also aware of the need for a management better adapted to

the local circumstances. Most of them have specific ideas and visions concerning future perspectives which are worth to take into account for the development of promising future management strategies.

## **8 Summary and General Conclusion**

The three coastal areas Bay of Cádiz, Spain, Ria Formosa, Portugal, and Lower Saxonian Wadden Sea, Germany, are presented in terms of the exploitation of marine bio-resources and related problems. Current management strategies are examined and a related mission statement is elaborated for each of the three coastal areas. Moreover, deductions on the applicability of EU-recommendations at local or regional level, local efforts to promote adequate management strategies, and the possibility of transferring experiences gained in one coastal area to the other are formulated. Obtained conclusions are as follows:

- **The mission statements of the coastal areas considered are in line with the general framework given by the European Union.**
- **Intransparent agency structures as well as nondistinctive competencies aggravate the implementation of a mission statement.**
- **Interaction between the international goals of the European fisheries policy and the local characteristics of a coastal area is still lacking.**
- **Management performed in a certain coastal area is closely associated to the local circumstances and not at any case comparable to the time needed for elaboration and implementation of management policies in other sites.**
- **An involvement of stakeholders as well as an explicit formulation of specific targets at a very early stage is of overall importance for the success of an integrated management approach.**
- **Experiences gained from the application of certain management tools in a particular coastal area can serve in other areas as the basis for the development of adequate management strategies.**
- **The management of marine bio-resources is one among many other aspects to be considered in an integrated management approach of a coastal area.**

For the present study, local knowledge has been used as the principal source of information. Even though it is obvious, that a wide range of stakeholders related to the exploitation of marine bio-resources in the three coastal sites concerned is not covered, the method of combining information obtained in dialogues with literature and internet sources can be judged positively. Great disposition and interest to talk about principal aspects related to exploitation matters as well as contributions to the information content by means of unpublished material have been encountered. This gives rise to the assertion that the inclusion of local actors into information gathering processes and subsequent elaboration of management strategies is indispensable and should be promoted in future projects.

## 9 Literature

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## Annex I: Definition of Words

“Capitania”	(Port.): Marine Authorities
Conservation Area	Consists of the trilateral areas of conservation as defined in § 10 of the Leeuwarden Declaration: “...- in The Netherlands, the areas under the Wadden Sea Memorandum including the Dollard; - in Germany, the Wadden Sea national parks and protected areas under the existing Nature Conservation Acts seaward of the main dike and the brackish-water limit including the Dollart; - in Denmark the Wildlife and Nature Reserve Wadden Sea. “ (see <a href="http://www.waddensea-secretariat.org/tgc/MD-Leeuwarden.html">http://www.waddensea-secretariat.org/tgc/MD-Leeuwarden.html</a> )
“Estero”	(Span.): Part of an ancient salt production ponds; having usually been transformed in order to use as semi-intensive production earthponds for finfish species
Professional “marisqueo”	Extractive traditional activity performed on foot and directed exclusively and with selective and special tools towards one or various invertebrate marine species for human consumption; only allowed to those holding a license issued by the Spanish Ministry of Agriculture and Fishery that states the professional character of the activity
Public Domain	A part of coastal strip to which the general land-use rights do not apply by law. Its utilisation is approved by the state, by the means of concessions ( <a href="http://www.io-warnemuende.de/homepages/schernewski/Littoral2000/docs/vol3/Littoral2002_05.pdf">http://www.io-warnemuende.de/homepages/schernewski/Littoral2000/docs/vol3/Littoral2002_05.pdf</a> ).
Seed mussels	Immature mussels used for stocking culture lots (German: “Besatzmuscheln”)
Salinas	Syn.: salt pans, salt ponds; areas where seawater is evaporated by the sun to yield salt
Users	Direct, actual users of the coast or respective area (e.g. fishermen, aquaculture operator) and indirect or potential users (e.g. members of an environmental group, members of the public, future generations)
“Viveiro”	Portuguese word for “ground-pots” or cultivation plots, intertidal areas on which poly-culturing of different bivalve species is performed in an extensive manner
Wetlands	Under the Convention on Wetlands (Ramsar, Iran, 1971) “wetlands” are defined by Articles 1.1 and 2.1 as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent of temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.” Wetlands “may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands” ( <a href="http://www.ramsar.org/key_guide_list_e.htm">http://www.ramsar.org/key_guide_list_e.htm</a> ).

## Annex II: Questionnaire

The following questionnaire was used as a guideline for obtaining information and opinions from different stakeholders concerning the exploitation of marine bio-resources in the three study sites concerned. However, depending on the particular character of the conversation and the need for certain information, conversations have also been conducted uncoupled from the following questions. In the following Annex III, the given answers often refer to the number of a certain question as listed below.

### I. Species groups exploitation of marine bio-resources

1. What kind of species that are naturally occurring in the respective area are actually being cultured/used:
  - extensively? How does this look like?
  - intensively? How does this look like?
  - used in other forms (artisan fishing, harvesting...)
2. Which are the most important species (groups) in terms of quantity, how much?
3. Which are the most important species (groups) in terms of the economic profit?
4. What is the surface [ha,km<sup>2</sup>] actually being occupied for cultivation (infrastructure: dams, channels, waster-water basins etc.)?
5. What kind of species that are naturally occurring in this area are thought about to be used or could potentially being used in near future times?
6. What is limiting this so far?

### II. Problems encountered

7. What kind of problems is facing the exploitation of the bio-resources (aquaculture, harvesting etc.) at the moment and what is their effect upon the marine resources?
  - Related to pollution from the environment (industrial waste, eutrophication)?
  - Problems for the environment originating from culturing activity (“by products”)?
8. Are there any problems related to over-exploitation of the stocks and how is this manifested?
  - Declining recruitment rate/over-fishing
9. Are there any problems related to competitive usages in the respective area and how do they look like?
  - Tourism
  - National park
  - Industrial activity
  - Other land uses
  - Others
10. Whom is the major conflict with?

### III. Socio-economic impact

11. How important is this kind of business for the local population (economic efficiency)?
12. How many people are employed in this business?
13. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?

14. What is the main form of processing on land (type of enterprises)?
15. Are there any licences given for the culturing of these marine organisms?
16. By whom and how much per year?
17. Are there any problems related to these licencing requirements and regulations?
  - Misuse
18. What are the bodies of control?
19. What are the most relevant legislations of the country/of the region related to this topic?
20. What kind of other economic activities are generating income in this region? Are there any synergisms between them?
  - Tourism
  - Salt making
  - Sand extraction
  - Others
21. What is the most important one (including the culturing/harvesting activities)?
22. How important are any traditional aspects concerning the culturing methods or species groups?
23. How would you judge the perception of the usage (of the marine bio-resources) by the society?

#### **IV. Future perspectives**

24. Do you think that the actual form of usage of the marine resources is a sustainable one?
25. What could be improved?
26. Has there anything been learned from the past (natural and socio-cultural developments)?
27. What are the visions/scenarios for the future?
28. How could they be transferred (management options)?

## Annex III: Records of the Interlocutions

### BAY OF CÁDIZ, SPAIN

ALBERTO ARIAS GARCÍA, Scientist, Institute of Marine Science in Andalucía (ICMAN), Cádiz

#### **1. What kind of species that are naturally occurring in the respective area are actually being used/cultured?**

Among many other fish species that are entering the inlets/estuaries of the traditional salt pans during high tide, the following ones are used for human consumption (see p.153): *Chelon labrosus* (Liseta), *Liza aurata* (Alburejo), *Liza ramada* (Alburillo), *Dicentrarchus labrax* (Robalo o Lubina), *Anguilla anguilla* (Anguila), *Liza saliens* (Zorreja), *Dicentrarchus punctatus* (Baila), *Mugil cephalus* (Seranillo), *Sparus aurata* (Dorada), *Solea senegalensis* (Lenguado), *Atherina boyeri* (Perreje), *Diplodus annularis* (Mojarra), *Diplodus sargus* (Sargo). The first ten are of major economic importance since they form the very typical fish fauna of the salt pans (adapted to higher concentrations of salt) and thus can always be found in the inlets/estuaries.

Other principal species that can be found in the intertidal region –principally in the channels outside the ancient salt pans– and which are used either as bait for fishing or as ingredients for dishes of the local gastronomy, are (see p. 142): *Marphysa sanguinea* (gusana de sangre), *Diopatra neopolitana* (gusana de canuillo), *Nereis diversicolor* (miñoca), *Scrobicularia plana* (almeja de fango), *Tapes decussatus* (almeja fina), *Tapes aureus* (perrillo), *Cerastoderma glaucum* (verdigón), *Solen marginatus* (muergo), *Murex brandaris* (cañailla), *Mondonta turbinata* (burgaillo), *Upogebia deltaura* (cigalita), *Palemonetes varians* (camarón), *Palaemon serratus* (camarón de porreo), *Uca tangeri* (boda de la Isla), *Carcinus maenas* (coñeta). However, these species can be considered as a very small and limited resource with only a marginal economic importance.

Other species that are used for human consumption are: *Panaceas japonicas* (langoustine japans), *Tapes Philippinarum* (almeja japónica) y *Crassostrea angulata* (ostión). Before, also the species *Tapes decussatus* (almeja fina) was consumed which was also tried to be cultivated but, however, due to the introduction of the foreign species *T. philippinarum* and the resulting extrusion of *T. decussatus*, this last mentioned species is hardly be found any more.

#### **2. Which are the most important species (groups) in terms of quantity, how much?**

In general, the fish species mentioned in answer one are the ones which can mostly be encountered in the traditional inlets/estuaries; they are used for human consumption. There are no major changes concerning the abundance that has been depicted in the 90s (see p. 155). However, the abundance changes slightly with the site-specialties of the respective inlet/estuary. Generally, no recent figures exist about the actual abundance. *Sparus aurata* is now the principal species cultured in extensive and intensive form.

In 1993, the production of fish in the inlets/estuaries (group of 10 principal species) by means of extensive culturing amounted to 385 kg/ha/yr. There are no recent numbers.

Benthic macro-invertebrate species which occur in greater abundances, such as *Hydrobia minoricensis*, *Chironomus salinarius*, *Microdeutopus gryllotalpa*, *Hydrobia ventrosa* are of no commercial interest but more of interest in terms of its ecological value as food for higher species.

#### **3. Which are the most important species (groups) in terms of the economic profit?**

All of the 10 mentioned fish species are used for human consumption and are therefore of economic interest, but, *Sparus aurata* is the most important species concerning the economic profit since it can best be cultured in the improved extensive and intensive form. Before, it has also been tried to culture *Solea senegalensis*, at least in the extensive form of culturing, as this species has a high economic value. However, this kind of culturing has not been proofed to be profitable for the people performing aquaculture. Thus, in the ancient salt pans there is only taking place the culturing of *Sparus aurata* and to a very little extend the culturing of *Tapes philippinarum*, the last being of little economic importance.

#### **4. What are the techniques applied?**

The mentioned ten fish species are cultured in the extensive form which is the most natural one. Furthermore, improved measures (=improved extensive aquaculture) and intensive culturing are applied for the species *Sparus aurata* (a thorough description of the cultivation methods applied: extensive aquaculture, improved extensive aquaculture and intensive aquaculture is given in my publications). Also the mentioned mollusk species are grown in hatcheries in a semi-intensive form with the seed being sown. The culturing of *Panaeus japonicus* is not taking place any more, this species is more or less collected by hand.

**5. What is the surface [ha, km<sup>2</sup>] actually being occupied for cultivation (infrastructure: dams, channels, waster-water basins etc.)?**

I do not know exactly and it is even difficult to calculate since a lot of former salt pans that have been used in an extensive form for aquaculture some areas have been refilled with earth material for gaining new ground for construction purposes. Before, the area of aquaculture probably amounted to around 10.000 ha.

**6. What kind of species that are naturally occurring in this area are thought about to be used or could potentially being used in near future times?**

The production cost of a species has to be lower than its market price since otherwise there is no profitability in the production. Up from many attempts with different species, for example, with *Panaeus japonicus*, only *Solea senegalensis*, *Sparus aurata* and *Dicentrarchus labrax* have proven to be successful. However, only *Sparus aurata* is cultured in improved extensive and intensive form since it best supports the restrictions of the environment (high salinity, great amount of individuals per area). With invertebrate species there could be done something, however, no one has an interest in develop or apply new techniques in this area. For example, the species *Artemia salina* which occurs in great quantities in the salt pans and which is of great interest for food in the aquaculture business could be used by means of some kind of management. However, this species gets imported from Brazil where production costs are much lower. Some macroalgal species are also abundant in the area (e.g. *Ulva lactuca*), but nobody would actually launch a new enterprise with other species.

**7. What is limiting this so far?**

The salt pans have actually reached their limit concerning the cultivation of organisms. Moreover, the nature park legislation does not allow any further transformations since most of the former salt pans are within the limit of the National Park. For many people, the nature park is an obstacle for any further changes (e.g. amplification of the municipalities). Since the ancient salt pans also have a traditional value, they mainly serve as a political tool within the whole discussion about usage, transformation, application of the legislation etc.

**8. What kind of problems is facing aquaculture at the moment (against the environment)?**

Out of the perspective of a producer, the main problem can probably be attributed to illegal fishing. Fish is taken out of the inlets/estuaries before it has reached the market size and the producer loses the income due to a lesser number of individuals that rest in the inlet until the time of capturing.

**9. Are there any problems related to pollution that is originating from the environment (industrial waste, eutrophication)?**

Problems exist concerning the quality of the water that is entering the inlets/estuaries in which production takes place (see below). Contamination originating from urban and industrial pollution has apparently improved after the construction of the purification plant in San Fernando (interior part of the bay) a couple of years ago. However, there are no actual data about the water quality at the moment but a study is currently being performed concerning this topic. Water quality is also deteriorating due to the naval industry which is using many different toxic substances for ship painting etc. as well as due to the many roads that crossing the area of the Natural Park (i.e. release of lead).

**10. Are there any problems for the environment originating from the culturing activity (“by products”)?**

The intensification of aquaculture in *Sparus aurata* causes problems due to the high liberation of organic substances originating from the intensive culturing. This in turn amounts to the deterioration of the quality of water.

**11. If yes, what is their effect upon the marine resources?**

There have been observed low levels of oxygen and high mortalities of fish species in the inlets. Due to high densities of fish in a given area it can also be observed a shift in the avifauna towards fish-eating species such as *Ardea cinerea* (Garzas reales), *Egretta garzetta* (garcetas), *Phalacrocorax carbo* (cormoranes).

**12. Are there any problems related to over-exploitation of the stocks?**

No over-exploitation of the natural stocks can be observed in the estuaries/inlets since only the amount of fish that naturally enters and grows in the traditional salt-pans is exploited.

**14. Are there any problems related to competitive usages in the respective area and how do they look like?**

Within the limits of the Natural Park it is not any more possible to perform any kind of transformations. Thus, for many producers the establishment of the Nature Park prevents the development towards more intensive forms of aquaculture. Concerning other activities, industry can be regarded as a competitive sector that negatively influences the marine resources due to its contaminating character (see question 9).

So far, tourism has not been present in a great extend within this area (of the Nature Park) so far. Therefore, there is no actual competition between those sectors. Problems exist because people are

generally not aware of the nature so that waste is thrown into the inlets and channels, thus polluting the environment.

**16. How important is this kind of business for the local population (economic efficiency)?**

Very small, there is only a very limited amount of places of employment within this sector. Around 200 people work within “Cupimar” the biggest enterprise for fish production in an intensive form. Besides, only a small number of additional private owners exist.

**17. Are the effects (of using the marine-bio-resources) positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

As far as I am concerned, it can not be regarded as a form of covered unemployment. The owners that are maintaining the salt pans to perform some kind of extensive aquaculture are having some other kind of income (e.g. local business) and are generally quite wealthy people. The business of aquaculture alone would certainly not generate enough income. Therefore, the maintenance of the salt pans for aquaculture purpose is only performed in order to keep alive the traditional aspect.

**19. What is the main form of processing on land (type of enterprises)?**

The captured fish originating from the extensive aquaculture is directly transferred to the local market without any kind of elaboration. It is even appreciated by the locals if the fish is still a little bit muddy since then its origin is evident.

Fish produced by “Cupimar” is only treated for conservation purpose that is fish is put on ice for sending it to other parts of the country (e.g. north of Spain).

**20. How important are any traditional aspects concerning the culturing methods or the species groups?**

Traditional aspects can be considered as very important, at least concerning the extensive form of culturing which has been performed ever since during salt extraction. The intensive form of culturing is a relatively recent one (since the 80s) so that here we can not talk about any kind of tradition.

**21. Are there any licenses given for the culturing of these marine organisms?**

I am not sure.

**23. Are there any problems related to these licencing requirements and regulations?**

Not sure, most probably not.

**24. What are the bodies of control?**

The “Junta de Andalucía” (Council of Andalusia).

**25. What are the most relevant legislations of the country/of the region related to the usage of the marine organisms in the respective area?**

The legislation for the environment; the legislation for fishing; the “Ley de la Costa” (Law of the Coast).

**26. What kind of other economic activities are generating income in this region? Are there any synergisms between them?**

The sector of tourism does not generate a lot of income for the National Park area itself since up to now the awareness of the local population about the environment is not very high. There does not even exist a real centre of the park where explanations about and peculiarities of the park can be found in an appropriate form.

However, concerning conservation purpose and the approach of the public to the park, activities have been started. There have been constructed paths through parts of the park that can be used by the public in order to get an impression about the environment and for the observation of birds.

Furthermore, there exists a local enterprise (“Emisan”:

<http://www.cadizayto.es/emisanviajes/excursiones.html>) that offers some kind of ecotourism: excursions by boat through the Bay of Cádiz or the simulation of traditional fishing activities in ancient salt pans. Furthermore, there are trips to ancient salt pans which are filled with fish where the tourists themselves can rent fishing gear, fish on their own and fry the fish afterwards.

**27. What is the most important one (including the culturing/harvesting activities)?**

For the enterprises, aquaculture can be considered as one of the main activities of local income.

**29. Do you think that the actual form of usage of the marine resources is a sustainable one?**

My perception of the sustainability of our natural bio-resources in terms of the conservation of the natural habitat as well as in terms of the economic benefit in this area is quite pessimistic. There exist 10-12 salt pans which have been transformed for being used in intensive aquaculture, three of them have already been abandoned because there is no cost-efficiency. The aquaculture is not profitable. As an example serves the history of “Cupimar”, which some years ago was mainly producing adult fish (*Sparus aurata*). However, now the production has mainly shifted towards the production of fry which is sold to other hatcheries afterwards (for production in open-sea cages). For the local areas the production of fry-fish has resulted to be the most cost-effective business. The production of adult fish is still maintained but every time results to be less profitable (e.g. declining market price of *S. aurata*). As far as I am concerned, the form of intensive culturing will be abandoned sooner or later and only the extensive (traditional) form will be preserved in future times due to its historic character by those

owners who have interest in doing so. However, the latter form of exploitation of the marine resources will always be very limited and not profitable.

### 30. What could be improved?

Owing to its ecological value the protected area of the Nature Park where the traditional salt pans can still be found should be preserved and ecotourism could be promoted any further. The contaminating influence of the naval industry could be reduced. The intensive form of aquaculture could be abandoned completely (no profitability) and the structure of the traditional salt pans could be maintained where it is still possible in order to conserve this special feature.

### 31. Has there anything been learned from the past (natural and socio-cultural developments)?

Traditional salt pans require a thorough maintenance because otherwise they will deteriorate (best example: state-owned salt pans). This kind of maintenance (for some kind of extensive aquaculture production) is and will always be performed by the owners according to the money and interest they have in maintaining the structure. That will not change in future times.

### 32. What are the visions/scenarios for the future?

That the Nature Park “Bahía de Cádiz” will have to be put under a very extended protection since in the last 25 years that I am living in this area this site has deteriorated to a great extent.

### 33. How could they be transferred (management options)?

Politics has to be more aware of the whole area and much more political support has to be given to the area of the Nature Park. Any kind of further transformations within the park area have to be prevented by political means. The owners of the ancient salt pans should be given subventions so that they can maintain traditional structures. Two or three salt pans should be restored and accessible to the public so that the traditions about the salt which are also expressed in the local festivities (“fiesta de la sal”) will be kept alive and visible. However, who will be in charge of that if it is not supported by the politics?!

## ALEJANDRO PEREZ HURTADO DE MENDOZA, Scientist, Faculty of Marine and Environmental Sciences, CASEM (University of Cádiz)

### 1. Concerning organisms that are exploited (apart from fish species) or could be exploited in the future

There are cultures of *Tapes decussatus* (Almeja fina), *Ruditapes philippinarum* (Almeja japónica), *Crassostrea angulata* (Ostión), *Pnaeus kerathurus* (Langustino) but there is also taking place an organized capturing (in form of cooperatives) of *Cerastoderma edule* (Berberecho), *Ensis ensis* (Navaja), *Nereis diversicolor* (Gusano de fango) in the intertidal area (mudflats).

There are a lot of more species of which could be made use of, e.g. different plants species of the salt marshes (as a natural remedy/ medicine). Furthermore, there could be taken more advantage out of the richness of our bird fauna.

### 2. Concerning the Nature Park Bahía de Cádiz – actual situation

Around 3000 ha of the actual 10,000 ha natural park area is immobilized that means no kind of activity is being performed and most of the area is abandoned. Only around 600 ha are used for the intensive form aquaculture and more than 1000 ha are Salinas. Solutions have to be searched for which allow a generation of economic activities but also a regeneration of the (biologic-cultural) diversity that has been lost.

### 3. What are the biggest problems?

A lot of species are collected without any kind of license and furtive fishing is taking place to a large extend which leads to over-exploitation of the stocks. Furthermore, there is a lot of urban contamination entering the Nature Park area and last but not least the intensive form of aquaculture, even though only occupying an area of around 600 ha, releases large amounts organic material into the surrounding channels (artificial food, high density of species).

### 4. What could be improved?

The idea is to regenerate the ancient salt ponds, to revolutionize the Salinas with some kind of complementary economy. This could include any form of ecotourism, related to the aquaculture activity and to the large amount of associated birds. It could also mean any kind of rural tourism that is related to the cultural values of the area (old windmills, traditional Salinas). There could even exist a rural school so that learning about nature and cultural activities takes place on the spot. However, the historical-cultural values have to be recovered and money has to be inverted in order to improve the actual situation of the ancient salt ponds. Thus, a balance between an economic richness and the aspect of conservation existed. People over here are only thinking about how to develop the aquaculture sector, considering it as the only way to perform any economically useful activity. However, my idea is to diversify the activities.

Concerning the water carrying large amounts of organic waste originating from the intensive form of aquaculture, it could be conducted into shallow basins where a lot of biomass of macro- and

microbenthic organisms would develop on which birds would feed. This in turn could be combined with ecotourism (bird watching).

There is another aspect that is related to the economic benefit. French enterprises are purchasing the salt produced in our Salinas at a price that is ten times less than the final selling price of this salt on the market. They declare it as an ecologically produced salt, as “Flor de sal”. We are missing such a form of exploitation of our resources.

#### **5. What are the previsions?**

I believe that the area of the salt marshes will extend further. At the same time the field of aquaculture will disappear in this region (no profitability) so that an additional 2000 ha of surface will be abandoned. The actual condition of the area (plus remains of the cultural heritage) will deteriorate because the sea will enter the bay forth and forth, destroying any left remains of ancient salt ponds etc. Urbanization around the park will enhance which will lead to larger loads of waste entering the park area. One of the most important wetlands of the Spanish peninsula will be completely deteriorated. Because of the fact that the richness of the park slowly disappears, a further population growth of the five surrounding municipalities is predictable. Finally, today's area of the Nature Park will be reduced around five times. Salinas and adjacent channels will be filled with sediments, dry out and finally turn into salty deserts. It will not be possible to perform any kind of economic activity within the natural park area any more and consequently no more income will be generated.

#### **6. What are the visions for the future and how can they be converted into practice?**

The park should be reconstructed and a diversification of resources (activities) has to take place. Aquaculture should grow and be performed in such a way that, for example, if 5 ha are used for cultivation the surrounding 20 ha should be cared for and maintained as well. In general, reserves within the park have to be created, illegal fishing and collecting has to be regulated and additional forms of an economic benefit (for the park) have to be searched for and explored.

### MANUEL LOPEZ, Biologist and technical adviser of the Natural Park “Bahía de Cádiz”

#### **1. What kind of species that are naturally occurring in the respective area are actually being cultured/used and of commercial value?**

In extensive aquaculture it is the species that are naturally occurring in the Salinas. However, around 80 % of them are of no great commercial value. The intensive form of culturing is applied to *Sparus aurata* (Dorada) and, to a lesser extent, to *Dicentrarchus labrax* (Lubina). The dorada is the most profitable species.

In some intertidal areas, there is also cultured the pacific oyster and the *Tapes philippinarum* (Almeja japonesa).

#### **2. Which are the most important species (groups) in terms of the economic profit?**

Dorada y lubina. In intensive culturing, dorada is the species of which the cultivation process has mostly been optimized. Lubina is also produced to a larger extent, mainly in “Cupimar”, but the production of fry has not been so efficient.

#### **3. What is the surface [ha, km<sup>2</sup>] actually being occupied for cultivation (infrastructure: dams, channels, water-basins etc.)?**

Most recent data say: For extensive aquaculture there are actually been requested 2.013 ha of which in 580 ha no actual cultivation activity is currently taking place. Intensive culturing is actually been performed in an area of 635 ha (see PORN).

#### **4. What kind of species that are naturally occurring in this area are thought about to be used or could potentially being used in near future times and what is limiting this exploitation so far?**

I think there exist a lot of species (groups) that could potentially been exploited. There are actually taking place pilot projects performed by a Galician enterprise, with an ascidia species (*Ecteinascidia turbinata*) that is thought to contain substances against cancer. Furthermore, there are further species of interests of which no commercial use has been performed, e.g. a Piranha-species that has been introduced a long time ago which serves and could potentially serve for the alimentation for other fish species. Moreover, *Artemia* sp. is captured but this resource is also not exploited commercially (used in big enterprises for aquaculture). In any case, a diversification would have to take place that is an adequate form of commercialization had to be found with the exploitation being performed by means of cooperatives.

Concerning algae, there are species of interest (e.g. *Enteromorpha intestinalis*) but out of my point of view occurring quantities are too small for a commercial exploitation. In any case, the management of the salt ponds would have to be improved drastically if any exploitation of further organisms or species groups was performed in future. In general, there is only interest in new resources if they are thought to be of commercial interest, e.g. with the substance originating from the mentioned tunicate species *E. tunicata*. However, there is no local initiative concerning aspects of the exploitation of new

bio-resources which can be seen in the fact that the pilot project about *E. tunicata* is performed by an external Galician enterprise.

**5. What kind of problems is facing the exploitation of the bio-resources (aquaculture, harvesting etc.) at the moment and what is their effect upon the marine resources?**

The principal problem can be seen in the discharges originating from the surrounding urbanization. Even though there is now the sewage treatment plant there are still small channels of no purified water and organic material entering the zone (small but scattered sources). As far as I am concerned, contamination originating from the naval has no notable effect on the marine bio-resources. Furthermore, there is a form of uncontrolled fishing in the area of the Park which leads to alterations of the environment, such as turbidity of the water body and changes of the bottom structure which in turn alters the composition of species in the salt ponds. Areas are still taken away due to construction purposes (e.g. amplification of the railway-lines) or due to the local refilling of salt ponds with solid material. This will not change in future times since urbanization around the park is increasing and will increase any further so that more industry and more contamination originating from traffic will affect the living resources.

**6. What kind of problems exists for the environment that is originating from any culturing activity?**

As far as I am concerned there is no major contamination originating from the aquaculture activity, at least if the extensive form of aquaculture is performed. However, the transformation of the habitat is a much bigger problem since here alteration of the water level or alterations of species composition (e.g. more ichthyophage bird species) is taking place. Due to being more profitable, each the culturing channels/ponds are getting more profound and bigger every time so that hydrodynamic conditions change and the original structure of the salt ponds gets lost. This could only be prevented if the improved extensive form of culturing were commercialized any better (“ecotiquet for quality”) by the proper administration.

**7. Are there any problems related to over-exploitation of the stocks and how is this manifested?**

Well, I can only refer to qualitative data but they say that the effort to catch the same amount of fish and other species is around 4 times higher than 10-15 years ago. So there is a big problem with illegal fishing/collecting and the capturing of juveniles. Just to give an example, every day there is a large amount of small boats fishing illegally in the Bay of Cádiz. Consequently less fish enters in the estuaries/channels of the salt ponds for any further growth and the biomass of fish for people employed in the traditional form of aquaculture is decreased.

**8. Are there any problems related to competitive usages in the respective area and how do they look like?**

Within the Nature Park area there is quite a variety of rubble resting from the ancient buildings. First of all it does not look nice even though it has a traditional origin. Secondly there is a problem with associated fauna such as rats which live within these rests but which bring about further problems such as diseases etc.

Many people believe that military activities that have been performed in adjacent areas (near the beach) have been a limit for further activities. As far as I am concerned, those areas which had been excluded from any other kind of usages have prevented the contraction on the beaches, bringing about the existence of some virgin beaches in littoral areas next to the park which otherwise would also look like the beaches of the city of Cádiz.

(See answer of question 20)

**9. How important is this kind of business for the local population (economic efficiency)?**

The income originating from aquaculture and collecting activities is low and most of the people employed in this sector depend on further subvention for their business. Thus, the importance of this activity is very minor and only a secondary support for any other kind of income. If the whole sector was more organized, the benefit of this activity would be much bigger. Up to now not even the own family can be maintained.

**10. How many people are employed in this business?**

I believe there are less than 100 people living alone from this business. However, in their spare time there will be around 4-5000 people collecting and fishing but they will not be able to live on that.

**11. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

This is no fundamental source of income. I consider the whole activity to be a form of a covered unemployment since a lot of other economic activities take place apart from the capturing of marine bio-resources.

**12. What is the main form of processing on land (type of enterprises)?**

Only the primary product is sold on the local and national market and thus no additional value is added to the raw products. (Also “Cupimar” is depending on subsidies coming from European funds since competition with products originating from foreign markets is very high).

A similar situation occurs with the salt ponds. Of the five resting salt ponds which are still in use (four within the limits of the park, one out of its boundaries) only one of them has “extended” in terms of packing the salt on the spot.

**13. Who is giving the licenses for the culturing of these marine organisms and how much?**

Licenses are given by the Council for Agriculture and Fishing (“Consejería de Agricultura y Pesca”). See document!

**14. Are there any problems related to these licencing requirements and regulations?**

There exist licenses for the culturing activity after there has been introduced the “Ley de Costas” at the end of 1988. A lot of users don’t make use of them even though the holding of a license is only possible if production takes place. However, no one is verifying if any kind of activity takes place, so the licenses are not taken away.

**15. What are the bodies of control?**

Licenses are given by the Consejería de Agricultura y Pesca. Previously, a concession for a particular use of the terrain has to be given by the state authority since here we are talking about the “Dominio Público Marítimo Terrestre (DPMT)” (Public maritime-terrestrial domain) which –by law- belongs to the public.

**16. What are the most relevant legislations of the country/of the region related to this topic?**

Ley de Costas, the legislations of the Autonomous Region and the documents concerning the ordination of which actually the PRUG (Plan Rector de Uso y Gestión) is being revised (every four years)

**17. What kind of other economic activities is generating income in this region? Are there any synergisms between them?**

Actually there are no real synergisms of the economic activities in the region (tourism, industrial activities and activities situated in the sector of services) and some kind of diversification would have to be performed in order to improve the situation. Concerning the cultivation of organism, this activity is and has always been a very “individualistic” business that stays within the own family and where there is no great interest to associate with other owners or activities. Here, it is not very easy to change the minds. Accessibility of the public towards these areas is still quite problematic (not very well seen by the owner) and thus a possible touristic exploitation is herewith prevented. However, some activities are starting such as the demonstration of the traditional fishing activities in the old salt ponds.

Activities for the Nature Park, promoted by the administration have been initiated. The construction of a proper visitor centre of the park is about to start; we are still waiting for some license requirements. Also some footpaths have been created which are guiding through the park. However, there is still a lot that has to be improved (information tables, signs etc.).

**18. What is the most important one (including the culturing/harvesting activities)?**

Beach-tourism can be regarded as an important source of income, but this is not directly related to the park area.

**19. How important are any traditional aspects concerning the culturing methods or species groups?**

Fundamental, but unfortunately knowledge related to these activities is getting lost due to the intensification of this activity (alteration of the traditional form), even though this form of aquaculture will not be profitable on the long run.

**20. How would you judge the perception of the usage (of the marine bio-resources) by the society?**

The presence of this usage is given due to the long tradition of this activity. Therefore, there is some kind of “affection” related to it. But, at the same time, waste is thrown away into the salt marshes and salt ponds upon which the culturing activity depends. There is thus no real perception and respect related to the environment and there is missing a lot of knowledge about the environment as a whole.

**21. Do you think that the actual form of usage of the marine resources is a sustainable one?**

No, since the intensive form which is promoted any further is creating a very distinctive form of the usage, transforming everything. Each time the strength for capturing the same amount has to be increased.

**22. What could be improved?**

A diversification of the resources could be promoted (e.g. tourism, other activities). Products originating from the area/the park could better be commercialized through a better administration.

**23. Has there anything been learned from the past (natural and socio-cultural developments)?**

No, at least not from the errors. Things (traditions, cultural heritage) that are lasting from the path are still being abandoned but it seems that is will be turn a little bit to the better.

**24. What are the visions/scenarios for the future?**

My scenario of the future is that there will be more infrastructures around the park which will negatively effect any exploitation of the natural resources. However, visions (wishes) include the hope

towards an increase in the usage of public transport as well as of taking more advantage of the natural resources by means of a better management.

### **25. How could they be transferred (management options)?**

Local issues concerning coordination have to be improved since the vision of the different municipalities for the future seems to differ from each other. A lot of them still see the Nature Park Bahía de Cádiz and its potential of natural resources as a limit for further urbanization.

## **FRANCISO BRAVO, Head of the Park Administration “Natural Park Bahía de Cádiz”**

### **Catchwords about society and aquaculture**

Compared to other activities (e.g. agriculture), the activity of aquaculture has started very late (less sensibility about the quality of these products? About one third of the income is expended on accommodation but not on food).

Compared to the National Parks, the Nature Parks (such as Bahía de Cádiz) are of less protection and usually more activities are permitted within its limits.

### **1. What kind of economic activities are important in this area and are there any synergisms between them?**

The economy originating from culture activities is of minor importance for the region. In relation to this very populated area the percentage of income originating from the exploitation of natural marine resources is very small. Also the amount of people employed in this sector is very small.

Beach-tourism is most probably one of the most important economic activities for the region (e.g. Germans in “Chiclana de la Frontera”). Furthermore, the naval industry continues employing a larger amount of people and finally the services sector is of great importance for this region.

Synergisms between the different activities are of great importance, at least for the Nature Park Bahía de Cádiz. Since last year there exist footpaths through some parts of the Nature Park area which can be used by visitors and activities have started to show to the tourist the traditional activity of fishing in the salt ponds. This will not be the case with fish farms where intensive culturing is taking place since due to the high technical development there is not much to see anymore.

### **2. Concerning the actual usage of the natural marine bio-resources, what could be improved?**

I believe that there does not have to exist only one form of usage/exploitation of the resources since it all depends on the form of management. Many sites where extensive culturing could be performed are not cared for properly and the state of the environment is neglected. The (semi-)intensive form of culturing could be worse as it actually is but it should be adapted even more towards the given circumstances of our area. In general, there is missing a private initiative that guarantees the well-being of the natural environment.

Concerning the administration, there is still missing a lot of coordination and dialogue between the different “controllers” of the exploitation. Here, we are trying to improve the relation towards a more direct contact. This was actually missing before.

### **3. What has been learned from the past?**

Before, the extraction of salt has been performed, with the exploitation of natural marine bio-resources being only of secondary importance. Afterwards the cultivation of these resources was performed as the main aim, but, somehow this is still quite residual. However, more usage could be taken out of the natural living resources. This also includes old constructions such as the mills that are a part of our cultural heritage. They are abandoned but could be much more attractive for some kind of eco- and cultural tourism if management was improved by administration.

### **4. What are the visions and scenarios for the future and how can they be transferred?**

This is a complicated topic. However, the fluidity and the dialogue within the administration have to be improved, but, slight changes towards the better can already be detected. The Nature Park has to be supported by an evident legislation. There exists the PORN, and the PRUG, which is actually been revised. These documents have to be facilitated to a large variety of people so that certain topics can be discussed in between them.

The planned visitor centre with concrete objectives will be of great importance. In general, the instruments for a thorough management have to be elaborated any further since there are still a lot of obscurities.

## **PEPE OSUNA, Biologist and member of the ecological group “Ecologistas en Acción”:**

→ Also representative of the ecologists in the “Junta Rectora” of the Nature Park Bahía de Cádiz (“Ecologistas en Acción”: Ecological Group at a national level, around 99 % of the Spanish ecological groups are grouped here (Federation in 1983))

### **1. What kind of species that are naturally occurring in this intertidal area and salt ponds of the Nature Park area could potentially be used in near future times?**

A lot of other species apart from those who are actually being exploited such as the fish species “urta” (*Sparus caeruleostictus*), “breca” (*Pagellus erythrinus*), “baila” (*Dicentrarchus punctatus*). There should be tried and investigated much more as has been done so far. Furthermore, the enterprises performing an intensive form of aquaculture (as far as I am concerned, what they call semi-intensive is an intensive form of culturing) such as “Cupimar” should be obliged to conduct the water coming out of the culturing tanks through culturing systems of mollusks, therewith the water released into the environment would be much cleaner. Generally speaking, different mollusk species should be tried to be cultured. I also do not understand why there is no profit taken out of *Artemia* sp. which is of great abundance in the salt ponds.

## **2. What is limiting this so far?**

According to my opinion, the concept of aquaculture which is actually been performed by “Cupimar” was initially not intended. When the head of the enterprise, at that time also a high politician, bought the terrain (before 1988 that is before the “Ley of Costas” went into force) this area was definitely planned to be used for tourism installations. With the new restrictions brought about by the legislation of the “Ley de Costas” aquaculture development within the old salt ponds was amongst the most promising concept that was allowed. Afterwards, monopolization (by “Cupimar”) took place on the market within this area which inhibits the development of new enterprises and consequently new ideas on the market.

## **3. What kind of problems is facing the exploitation of the bio-resources (aquaculture, harvesting etc.) at the moment and what is their effect upon the marine resources?**

First of all there is the infrastructure: the area of the park is very fragmented and has been manipulated very much by human beings. Therewith have been occurring a lot of changes related to the hydrodynamics such an alteration of the circulation of the water masses within the interior part of the bay (caused by the construction of bridges, railway lines). Thus, life cycles of organisms which had been adapted to the original circumstances are now being affected by these changes, including the organisms that are exploited or used commercially. Furthermore, until six months ago the waste water of around 200.000 people was emptied into the Bay of Cádiz and there is still waste water that is originating from the municipality of San Fernando introduced into the channel “Santi Petri”. Thus, until now not all sewage pipes have been connected to the local sewage plant.

## **4. What kind of problems exists for the environment that is originating from any culturing activity?**

As far as I am concerned, the problems originating from aquaculture activities have a very strong impact upon the environment. Concerning the intensive form of aquaculture, the production is not adapted to the normal life cycle of the organisms. Vegetation has been destroyed for the transformation of the former salt ponds into basins for aquaculture. Moreover, there is quite a large amount of solid and liquid organic material released and the amount of fish eating birds such as Cormorants has increased, repressing the abundance of limicoles. For me the only solution to improve the mentioned aspects would be to go back to the traditional form of (extensive) aquaculture.

## **5. Are there any problems related to over-exploitation of the stocks and how is this manifested?**

I believe that even though there have been performed a lot of studies in the Bahía de Cádiz so far very few of them are related to this kind of topic. This, for example, is shown by the fact that only recently there has been discovered a natural mussel bank of *Venus gallina* which is situated very close to the beach in the outer part of the bay. The same is true for another natural mussel bank of the species *Solen solen*. In general, population dynamics should be studied to a much larger extend in order to know more about this kind of problems. Since due to the fishing gear used by smaller boats, a lot of destruction of seagrass (e.g. *Zostera* sp.) has been taken place in the last years, I am sure that this has a negative influence on the recruitment rate of a lot of different species.

## **6. Are there any problems related to competitive usages in the respective area and how do they look like?**

Concerning tourism, problems which are directly related to the park, no. This park is not attractive for visitors because there is missing a vertical landscape (different sizes of shrubs and trees). Thus, curiosity is not high enough for this special environment of the Nature Park area. Indirectly, tourism is of course a negative aspect when we are talking about the reduction of the Nature Park area for building constructions which are related to the expansion of the tourism resorts. In general there is still taken away important salt marsh area for the gaining of new terrain, for the proper university, for example. Now there is planned the construction of a second bridge from Cádiz to Puerto Real. This construction will definitely will have an impact on the park area and also on the hydrodynamic changes in the water body caused by the positioning of the pylons of the bridge.

## **7. How important is this kind (aquaculture, recollection) of business for the local population (economic efficiency)?**

I think it is quite big because at least “Cupimar” is given work to a determined amount of people. There are many others which derive some benefit from the collection of seafood or small-scale

fishing. However, for the second mentioned group this activity is only a marginal economic subsistence that helps to maintain the family.

**8. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

I don't really know, I can only see that the recollection of seafood and small-scale fishing is not controlled at all and I believe that around 30 families within this zone are helped to survive by this kind of business (main species collected: *Asparagus albus*).

**9. What kind of other economic activities is generating income in this region? Are there any synergisms between them?**

Tourism which is quite important within the region of the five municipalities has not touched the park area so far even though it could be a possible resource in near future. One is already talking about this kind of "resource" (originating from tourism) but as far as I am concerned first of all there has to take place a proper management in order to achieve a possible synergism between the park area, its activities (such as aquaculture) and tourism.

**10. What is the most important one (including the culturing/harvesting activities)?**

The service sector and to a less extend, naval industry (the last one losing importance).

**11. How important are any traditional aspects concerning the culturing methods or species groups?**

It is so important that I am even working in the recuperation of a traditional salt pan. The abandonment of the traditional salt ponds was the beginning of the deterioration of the environment of the current park area. It seems that in the time before, the different forms of usage were much more compatible.

**12. How would you judge the perception of the usage (of the marine bio-resources) by the society?**

I see that they generally don't care a lot about it, only those that are making use of it or those who are performing some kind of activity. Children over here learn that the recollection of things is nothing bad (e.g. recollection of bivalves or shells on the beach), so when getting older they don't consider it as something negative, it is something natural to them.

**13. Do you think that the actual form of usage of the marine resources is a sustainable one?**

As far as I am concerned, the resources are sustainable if the activity of culturing organisms will be performed according to the traditional way of manner that is with a carrying capacity that is adjusted to the environment. Therefore, this kind of activity has to be complemented with other activities, a diversification of the species has to take place, ecotourism should be promoted and also the tourism of bird-watching.

**14. What could be improved?**

See also answer 13. Diversification of activities (other activities), more consensus about activities, to find agreements. In the same zone different things could be performed, promoted, that are sustainable for the environment.

**15. What are the visions/scenarios for the future?**

Concerning the Nature Park Bahía de Cádiz, I am quite pessimistic. I think sooner or later the park will disappear since the different interests such as aquaculture (intensive form) or infrastructure within this area are too strong. So far the population does not recognize the values of this area. Thus, I am quite pessimistic regarding this topic.

**16. How could they be transferred (management options)?**

To be honest, I really don't know. Since 1983 I have been following planning options for the Nature Park Bahía de Cádiz and even though a lot has been said, investigated and decided, not even 20% of the desired changes towards the better have been performed in order to improve the situation during the last 20 years. Thus, also the existing document about the integrated ordination, planning and management of the humid zones of the Bay of Cádiz (reference towards the book of Barragan-Muñoz, 1996) is not complete at all.

**FEDERICO FERNANDEZ, Head of the Service for the Management of the Environment; Delegation of the Environment ("Delegación del Medio Ambiente")**

**1. What kind of species that are naturally occurring in this area are thought about to be used or could potentially being used in near future times?**

There is a high potential of different species in the Nature Park Bahía de Cádiz and there surely are species that could be used commercially. However, this kind of activity depends on private initiatives. There is, for example, an enterprise that is trying to extract a certain substance out of a tunica species.

**2. What is limiting this so far?**

Institutions like the universities should investigate more into the usage of our bio-resources, since there is certainly a potential for their use. This would also imply investigations concerning modifications of techniques etc. However, local initiative is missing.

**3. What are the biggest problems the exploitation of the bio-resources (aquaculture, harvesting etc.) that is facing at the moment and what is their effect upon the marine resources?**

Most probably within the Nature Park area the kind of cultivation that is taking place at the moment has already got some kind of intensive character. On the one hand this is necessary for the economic benefit but on the other hand there is a negative impact upon the environment due to the release of large loads organic material into the surrounding water body.

There is also a big problem concerning furtive fishing and collecting since there is missing a lot of control and organization.

**4. Are there any problems related to over-exploitation of the stocks and how is this manifested?**

I believe that due to the above mentioned activity of furtive fishing and collecting there is a negative effect upon species which feed on these resources. Thus, it could even result in the endangerment of certain species or species groups.

**5. Are there any problems related to competitive usages in the respective area and how do they look like?**

In general there is no real competitive use on the area of the Nature Park. It would be better if there was some since this would imply a diversification of activities within the area. The Nature Park is not a closed park (apart from the reserves) and there are still intentions to refill parts of the area to gain more land for construction purposes. However, then this could not be considered any more as a competitive activity but rather as an exclusive one.

**6. How important is this kind of business for the local population (economic efficiency)?**

Cultural values are indispensable. If they were not existent, that is if there was no aquaculture performed the Nature Park Bahía de Cádiz would enter into complete degeneration.

**7. How many people are employed in this business?**

I am unaware about the number of people employed in this sector but I believe it is not many.

**8. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

I do not know the relevance of the enterprise "Cupimar" but I believe that the percentage of people employed here in relation to overall people employed in the area is not very big. About the rest of the people that are collecting and fishing illegally (as a contribution) we can talk about a kind of submerged economy.

**9. What are the most relevant legislations of the country/of the region related to this topic?**

There is a sectorial legislation about fishing ("Legislación sectorial de Pesca"). The "Ley de Costas", among others, has complementary importance.

**10. What kind of other economic activities is generating income in this region? Are there any synergisms between them?**

The surrounding municipalities of the park have different prevailing economic activities. In Chiclana, beach tourism and some industry is prevailing. In Puerto Real industrial activities are prevailing and in San Fernando a lot of economic activities are depending on the military.

Ecotourism has not entered the area of the Nature Park so far but first steps are being performed into this direction. There is a lot of population living around the park so at one stage it should be possible to find and create synergisms in between aquaculture and tourism and also between salt ponds and the associated bird fauna.

**11. How important are any traditional aspects concerning the culturing methods or species groups?**

I don't know about that.

**12. Do you think that the actual form of usage of the marine resources is a sustainable one?**

I don't think so. I think in order to achieve a sustainable form of exploitation, there are needed more instruments of ordination (plans etc.) as a mechanism for control. The present instruments are very insufficient.

**13. What could be improved?**

First of all the organization (see above). Secondly the measures of control, thirdly the promotion of our products (e.g. the implementation of an eco-label). However, the promotion is not only a question of publicity but also of a fiscal exception. There has to be an economic incentive in order to produce high quality products: "If you give me money I will do a good work".

**14. What are the visions/scenarios for the future?**

This is a difficult question but personally I think that the future is hopeful. In general there is a rising degree of sensibility in the population which finally will lead to a higher conservation of the surrounding area (Nature Park Bahía de Cádiz). Nevertheless, there are other initiatives which want to construct more beaches and infrastructure. Things like this are also required.

**15. How could they be transferred (management options)?**

As far as I am concerned, private initiative is indispensable. But, at the same time, the new policy about the public domain prevents/complicates that the manager invests into his own installations. Thus, there exists a policy of subsidy. The tourism of Chiclana could make up for this. However, a program for the recovering of the Public Domain has to take place. Otherwise all those areas will enter into complete abandonment.

**JUAN MANUEL ABARCA MOLINA, Demarcation of the Coast (“Demarcación de Costas de Andalucía-Atlántico, Ministerio de Medio Ambiente”)**

→ Director of the section of the service for the management of the Public Domain; responsible for the delimitation processes

**1. What is the surface [ha, km<sup>2</sup>] actually being occupied for cultivation (infrastructure: dams, channels, waster-water basins etc.)?**

For the five municipalities there are around 406 ha (intensive), 406 ha (semi-intensive), 907 ha (extensive) which are used and much more extensive which is not used actually. There exist five to six cultivation parks (“Parques de cultivo”) for bivalves in the intertidal zone: *Ruditapes decussatus* (Almeja fina) and *Tapes philippinarum* (Almeja japonesa), each of them with two to three ha, that is altogether around 19 ha.

**2. What kind of problems is facing the exploitation of the bio-resources (aquaculture, harvesting etc.) at the moment and what is their effect upon the marine resources?**

In the first place there is something that we can consider as “contamination of life”. The Bay of Cádiz is semi-closed concerning the flux of water and the salt marshes are surrounded by large urbanization (altogether around 400.000 inhabitants). Thus, waste water originating from urbanization is a major problem, particularly if one is to consider that until recently the waste water was entering the bay without any kind of purification. Contamination originating from naval industry and other smaller industrial areas can be neglected. The concentration of heavy metals within the sediments has shown to be low. This is in contrast to the intertidal zone around San Fernando and the channel Santi Petri where the load with contaminants in the sediment is much bigger. However, quality of water is fundamental for the aquaculture business; it seems that this is starting to improve a little bit due to the sewage-works.

Secondly, there is a high pressure of ichthiophage birds that are not only taking away large amounts of fish out of the culturing basins but are also causing damage to the fish if the fish is not captured properly and released back into the tanks.

Thirdly, there is the problem with stealing of fish out of the basins. In particular this is a problem for the intensive and semi-intensive cultures since here there is a high density of fish, thus it is easier to capture fish out of the basins. This stealing in turn is a consequence of a re-conversion of the naval industry: before there were around 15 to 20.000 working places created by this branch of industry, today there are only a few people employed in that business. Also a lot of juveniles are fished out of the channels which is a problem concerning the recruitment rate of different species.

Furthermore, a lot of former salt ponds have been abandoned because profitability was very low. However, people working in aquaculture say that we are guilty about the neglected state of the salt ponds because before the “Ley de Costas” became effective the private owners were maintaining their property. However, after the reclamation of the salt ponds as public domain the administration would have had to pay for any further maintenance of the salt ponds. This was not carried out properly and this is part of the problem we can see today. Some aspects of that accusation might be true but not in every aspect. At the beginning of the 90s, for example, “Cupimar” took out a mortgage on 15-20 salt ponds for the exploitation in form of aquaculture and thus invested in their use. Today “Cupimar” is the biggest enterprise for aquaculture in the Bay of Cádiz.

However, the fundamental problem for aquaculture of our region is the high cost that is associated to the cultivation within the traditional salt ponds compared to open sea cages. Costs of investments are much higher and the yield per m<sup>3</sup> is less than in the open sea. It is also more difficult to maintain surveillance since due to the vegetation cover in between the salt ponds and the extended area visibility is not so easy.

**3. Are there any problems for the environment originating from culturing activity (“by products”)?**

There is a certain amount of organic material released from the salt ponds but this is not very much. However, this kind of contamination is appreciable when talking about the semi-intensive and intensive form of cultivation where there exists a dense biomass of organisms in the ponds and where there is a contribution of artificial food. There exist only few depuration systems for the water and there are taking place a lot of studies about systems of bio-filtration.

**4. Are there any problems related to competitive usages in the respective area and how do they look like?**

This will take place up to a certain point but it has not been happening up to now. The problem of the Nature Park Bahía de Cádiz is its abandoned state which makes the area somehow unattractive. Up to now there is no major competition concerning a multiple use, this is not a problem.

**5. How important is this kind of business for the local population (economic efficiency)?**

The business of aquaculture has been declined during the last decade. Some 7-8 years ago the annual production was around 2500 tons, now it is much less. The reason for that can be found in the high costs that are associated to production (e.g. seeds, general costs, manpower). Thus, less expensive products from other countries (Greece, Italy) have been entered the local market, a fact that is beating down the prices. If at the end of the 80s, the price for a certain fish species was around 8 €/kg it has now gone down to around 3.5-4 €/kg. There is an explicit problem with supply and demand. In order to be able to sell the local fish at higher prices again it is necessary to distinguish our fish from the one produced in open cages that is to promote the quality. The number of species has to be diversified as well, above all towards bottom-species that can not be cultured in open cages such as *Solea senegalensis* (Lenguado). However, this will only be possible when the whole life cycle of this species can be controlled, a fact that has not been achieved so far.

**6. How many people are employed in this business?**

There are only three to four enterprises with a fixed structure that is “Cupimar”, Santi Petri and further one or two. The rest of them are small family enterprises. Altogether, the total volume of people employed in this sector in the Bay of Cádiz will be not more than around 300. Furthermore, there are people collecting in the intertidal zone and fishing in the channel during their leisure time with some of them selling their products to the local restaurants. Sometimes there can be counted around 2000 to 2500 small boats per day in the whole Bay of Cádiz

**7. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

Aquaculture in the old salt ponds is beneficial if it is of extensive character (growth of fish in natural circumstances) but the yield is very low. This has to be compensated with products that can be sold any better. The idea is to implement “ecological etiquettes” which promote the high quality products that have been produced in extensive cultures in the salt ponds. However, there is a problem of “distortion” related to these etiquettes since a final product which does not fulfill certain criteria might even be embraced by such a designation.

Considering the exercise of extracting marine resources during leisure time or on the weekend and selling the products to the local restaurants (200 to 300 people) it can definitely be regarded as some form of covered unemployment because this kind of activity is usually only possible if no other kind of work is performed. Moreover, it is an activity that causes a lot of damages to the Nature Park as a whole.

**8. What are the license requirements for the culturing of marine organisms and who is in charge of their control?**

All those who are performing any kind of culturing activity have to have a license for that. Licenses are given by the Council for Agriculture and Fishing (“Consejería de Agricultura y Pesca”) which is also the body of control. Usually the given licenses have an indefinite character. However, many of those authorizations are not used and the respective area can be found in a much neglected condition.

**9. What are the most relevant legislations of the country/of the region related to this topic?**

There exists a law concerning the cultivation of marine organisms (in force since 2002), the “Ley 2/89 de Espacios Naturales Protegidos”, the “Ley 22/88 de Costas” and many more regulations and international conventions such as Ramsar and Zepa which are valid for the region. Furthermore there exists a “Plan Estratégico Español para la Conservación y Uso Racional de Humedales” (see: [http://www.mma.es/conserv\\_nat/planes/plan\\_humed/plan\\_humed.htm](http://www.mma.es/conserv_nat/planes/plan_humed/plan_humed.htm)) with a validity of ten years.

**10. What kind of other economic activities is generating income in this region? Are there any synergisms between them?**

Beach tourism is a very different concept that is generating income but that is not to be related to the Nature Park Bahía de Cádiz. So far tourism has not been developed within the Nature Park area. Here, concepts are thought in which there is the idea to diversify activities that can take place next to each other or in combination (extraction of salt and aquaculture in combination with ecotourism). It could be possible to think about a tourism related to such activities that could have a positive effect for the park. However, local people have not been educated sufficiently for that kind of tourism. In general, within the region (local) the park is still somehow “unknown” with a difficult and very special landscape, something quite hostile.

The Park was “constructed” by private individuals for the activity of salt extraction which was very profitable in former times. However, with the disappearance of this business many former salt ponds got abandoned and went into a stage of deterioration. Now, every “new” activity will never be so

profitable as salt extraction used to be and there will always be necessary some form of financing of the administration (for the improvement of the environment of the salt ponds and maintenance works).

**11. How important are any traditional aspects concerning the culturing methods or species groups?**

The traditional exploitation was that of salt extraction, however, this kind of business disappeared around 40 to 50 years ago due to a low profitability. Fish in the estuaries was always something like a secondary product that was used to give tips to the workers in the Salinas and with which celebration of the salt took place at the end of summer time.

**12. Do you think that the actual form of usage of the marine resources is a sustainable one?**

At the moment, concerning aquaculture in the salt ponds, yes. More than 70% of the surface is abandoned, thus, the extraction of fish does not reach the carrying capacity at all. Dangerous concerning sustainability of the resources is the activity of furtive and sport fishing in the interior part of the Bahía de Cádiz and in the channels.

**13. What could be improved?**

The control of the furtive fishing, the setting of cultivation in the abandoned areas, the diversification of the supply of species and activities (day-tourism, ecotourism).

**14. What are the visions/scenarios for the future?**

It is desired to reach equilibrium between the Nature Park on the one hand and the aspect of the economy on the other. It has to be kept in mind that the wetlands are covering only 6 % of the earth's surface. Thus, they are now among the most endangered and at the same time most protected ecosystems in the world. During the last 30 years much legislation has been created and has come into force. These conventions are pressurizing the administration to protect the wetlands any more. In the near future, the administration has to implement these conventions, somehow there has to be found equilibrium between private and public usage.

Concerning the Nature Park Bahía de Cádiz I personally think that there will be establish some kind of equilibrium between the natural environment and the economic needs that will be slightly in favor of the protection of the environment. It is necessary to bring together both "systems" but not only based on the criterion of profitability.

**15. How could they be transferred (management options)?**

See script of Juan Manuel Abarca Molina (Un modelo de Gestión en Espacios Protegidos.). There exist some models about the management options for the Bay of Cádiz, e.g. a proposal for a zonation.

**JOSÉ LUIS MOLINERO VACA, General Secretary of ASEMA, and  
JUAN MANUEL GARCÍA DE LOMAS MIER, Biologist, President of ASEMA and in  
"Cupimar" responsible for the section of the fattening up in the field**

ASEMA = Association of Enterprises for Marine Aquaculture in Andalusia (if not stated otherwise, the questions have been answered by Mr. José Luis Molinero Vaca)

**1. Which are the most important species (groups) that are being cultured in "Cupimar" in terms of quantity, how much?**

In "Cupimar" in the semi-intensive form there is mainly cultured *Sparus aurata* (Dorada) ( $\geq 90\%$ ) and there is some small-scale production of *Solea senegalensis* (Lenguado). There is very few culturing of *T. philipinarum* (almeja), *Crassostrea angulata* (Ostión) and *Pnaeus kerathurus* (Langostino).

Concerning the extensive form of culturing production is not very high.

Production of fry (2002):

Dorada: 27.000.000

Lubina: 2.000.000

Lenguado: 500.000

The largest part of the fry produced is sold to other parts within Spain (75%) with another part being sold to Morocco, Portugal, France and Italy (~25). Some is also used for own production of commercial fish (fattening up).

Total Production of commercial fish (2002):

Dorada: 1150 mt (metric tons)

Others (Lubina, Lenguado, Lisas.): 150 mt

Most of the commercial fish is sold within Spain and on the own market (90%) and around 10 % is exported to Portugal.

**2. Which are the most important species (groups) in terms of the economic profit?**

Actually it is *Solea senegalensis* (Lenguado) with around 3000-3500 pesetas/kg (18-20 €/kg) since the production of this species has not been optimized so far and thus there is a far lesser quantity of this species and a higher demand on the market.

**3. What is the surface [ha,km<sup>2</sup>] that is actually being occupied for cultivation (infrastructure: dams, channels, waster-water basins etc.) of “Cupimar” and in the whole area of the Bay of Cádiz?**

“Cupimar” is occupying around 1900 ha, ~300 ha of that is used for the semi-intensive form of aquaculture. Altogether, it will be around 4000 ha within the whole bay which is being used for culturing.

**4. What kind of species that are naturally occurring in this area are thought about to be used or could potentially being used in near future times?**

Concerning “Cupimar”, it is the *Solea senegalensis* (Lenguado) which has still not been optimized. Furthermore, there are investigations about *Pagrus pagrus* (Pargo), *Saparus caeruleostictus* (Urta), *Pagellus bogaraveo* (Besugo de la pinta) and *Plectorhinchus mediterraneus* (Borriquete), however, these investigations are not performed by “Cupimar”.

**5. What is limiting this so far?**

Better and more results from investigations and resulting optimization of the production in semi-intensive form (e.g. the production of fry).

**6. Are there any kind of problems that are related to the exploitation of the bio-resources that are originating from the environment? What kind?**

No.

**7. Are there any kind of problems for the environment that are originating from culturing activity (“by products”)?**

No. The water leaving the culturing basins has even got a higher amount of dissolved oxygen since there is artificial oxygenation of the water body within the tanks taken place. Moreover, before the water is released back to the water of the bay, there is some form of decantation taking place.

**8. Are there any problems related to over-exploitation of the stocks and how is this manifested?**

There is a lot of furtive fishing and robbing taken place which has to be solved by the administration.

**9. Are there any problems related to competitive usages in the respective area and how do they look like?**

Concerning tourism or industry there is none. Problems that exist with the Nature Park can be solved. However, there are a lot of problems with the interpretation/ the incorrect application of the Ley de Costas because they are confiscating the area of the “owners”. In general, more diversification (of activities) should be possible.

Furthermore we have problems with robbing and a larger amount of birds that are also taken away our future “products”. However, the biggest problem is the competition of prices on the market.

**10. Whom is the major conflict with?**

The biggest conflict is due to the interpretation of the Ley de Costas.

**11. How important is this kind of business for the local population (economic efficiency)?**

Very important. The unemployment rate in Cádiz is very high, so the sector of aquaculture can improve this situation any further.

**12. How many people are employed in this business/ are depending on the aquaculture activity of the region?**

At the moment there are around 120 people employed in “Cupimar”. Moreover, within the Bay of Cádiz there will be a further 180 people that are depending on that business, summing up to around 300 altogether. However, apart from “Cupimar” these are very small enterprises (around 30 of them) which more or less 2 people directly involved in the business and further 3 people depending indirectly on the aquaculture activity (transport, selling etc.). The aquaculture activity generates around 3 indirect working places for each direct one.

**13. Are those effects positive or negative and do they contribute to the society as a whole (or is it a form of a covered unemployment)?**

Apart from “Cupimar”, I think that we can talk of a covered unemployment. The lowest wages within our activity will be around 700 €/months.

**14. What is the main form of processing on land (type of enterprises)?**

Actually there is packaging taken place. In Barbate (south of Cádiz) fish filets are produced including the necessary steps for that. A new enterprise “Quality Fish” which is buying the fresh fish from “Cupimar” is elaborating meals which means precooking and selling (<http://www.diariodejerez.com/pg030304/provincia/provincia136529.htm>).

**15. Are there any licenses given for the culturing of these marine organisms?**

Yes, an authorization for any form of cultivation is necessary.

**16. By whom and how much per year?**

The General Direction of Agriculture and Fishery (Dirección General de Acuicultura y Pesca) is giving the authorization. This is given once and afterwards valid for ever but the production/ the activity has to be confirmed.

**17. Are there any problems related to these licencing requirements and regulations?**

No. If no production can be confirmed, then the license can be taken away.

**18. What are the bodies of control?**

General Direction of Agriculture and Fishery

**19. What are the most relevant legislations of the country/of the region related to this topic?**

There is a law about Fishing and Agriculture and also a white book that exists about aquaculture which has been published by the General Secretary of Fishery (Secretario General de Pesca).

**20. What kind of other economic activities are generating income in this region? Are there any synergisms between them?**

There is beach tourism that is quite important and they are trying to create some form of rural tourism with the idea to relate the aquaculture activity in the region to tourism. Furthermore there is the naval industry which is of great economic importance of the region, however, this branch of industry is losing importance any further.

**21. What is the most important one (including the culturing/harvesting activities)?**

First of all naval industry, tourism and aquaculture coming very much after that.

**22. How important are any traditional aspects concerning the culturing methods or species groups?**

Well, the origin of aquaculture can be seen in the activity of salt extraction which has been a very traditional activity for a long time. The root can be found in this activity. The fishes in the estuaries of the salt pans were something like a “by-product” originating during the salt extraction process. Those fishes were then used in the celebration for the “harvesting” of the salt. At the moment the price of fish produced in the salt pans is rising again due to the demand by society.

**23. How would you judge the perception of the usage (of the marine bio-resources) by the society?**

Very well, fish produced in the salt ponds such as *Sparus aurata* (Dorada) is very much appreciated by the society.

**24. Do you think that the actual form of usage of the marine resources is a sustainable one?**

Yes, completely.

**25. What could be improved?**

To convert more the experiences from the past into the actual process by the use of better techniques, to intend to improve the costs for production, to develop elaboration of the primary products on the spot (new enterprises).

**26. Has there anything been learned from the past (natural and socio-cultural developments)?**

Learning is always taking place with the experience that is obtained.

**27. What are the visions/ scenarios for the future?**

I am quite pessimistic with my previsions. Aquaculture within the region has to be firmly established and developed any further. Actually there is only a small growth taking place which is far too small if we are to compete on the market. In general, there is too little support performed by the administration. If we don't take care than the whole aquaculture activity will disappear from the region and shift to other regions of Andalusia or of the country. Consequences will be very bad for our region.

Within the area of the Nature Park Bahía de Cádiz more semi-intensive culturing should take place. This could be concentrated in concrete zones with some kind of extensive aquaculture around it. Thus, the production could be concentrated in smaller areas since by means of the extensive form of aquaculture there is not actual contribution to the sector of aquaculture within our region (it is not profitable; production by means of semi-intensive aquaculture: 30.000 kg/ha; extensive aquaculture: 200kg/ha) (García de Lomas de Mier).

**28. How could they be transferred (management options)?**

More private inversion has to take place in this sector, thus management for the region has to be carried out. Public administration has to protect and guard, norms have to be respected and the quality of the product has to be maintained. There are different models which could be converted into practice in order to combine the needs of the different stakeholders. Therefore, if there is set a limit for the expansion of the semi-intensive form in our area, subsidizing has to take place in order to compensate such measures. It is also possible to combine the extensive form of aquaculture with tourism which generates income which would otherwise be gained by more production in the semi-intensive form. In every aspect, the different parties have to try to understand better the other part and it cannot be said “no” to everything without thinking about the herewith resulting consequences for a certain group (García de Lomas Mier).

Example of the Salina “Santa Margarita”

Area: 45-50 ha

Production: 50 tons/year

final loading (extensive): 1kg/m<sup>3</sup>; (semi-intensive): 3-4 kg/m<sup>3</sup>

all salt ponds of San Fernando

Santa Margarita. ~45 ha: 50 t/yr

Agarrapito. ~15 ha: 10 t/yr

San Fernando. ~42 ha: 70 t/yr

San Judas. ~38 ha: ~60 t/yr

San Pedro. ~25 ha: 8 t/yr

Altogether for this area (~170 ha) there are 12 working people, 1 guardian per day and 3 guardians per 3 time.

Overall production within the area: 200-240 t/yr.

ALFONSO MACÍAS, Technician of ASEMA

(answers to questions concerning the organization of aquaculture enterprises in the PNBC via email)

**Organization of enterprises**

Most of the aquaculture enterprises in the PNBC are small family-scaled enterprises. Some of them are associated to the “Association of Enterprises for Marine Aquaculture in Andalusia (ASEMA)” or to the “Producer Organization of Marine Fishculture in Andalusia (OPPMA)” which acts to improve the commercialization of the products. Recently, there has been constituted the “Association of Small Producers of Fish from the “Esteros” of the Bay of Cádiz” which pretends to group together all of the small producers in order to facilitate the production of their products. There can also be found some mollusk cooperatives within the limits of the park.

It is not necessary to be registered or linked to an association, organization or cooperative in order to perform aquaculture. However, due to the mentioned reasons (advantages) mentioned below, it is very convenient and nearly necessary to count on the support of a body that serves as a speaker in front of the administration, defending the interests of the sector in a joint manner and exercising more influence than if it was practiced by the privates alone.

**Advantages of an association such as ASEMA**

There are various advantages for the members of an association:

- Representation and defence of the interests in front of the public administration (e.g. at present there are various actuaciones concerning the correct interpretation of the Ley 22/88 de Costas)
- Stimulation and promotion of investigations on topics related to aquaculture and the application of their results to the aquaculture exploitations in the Autonomous Region of Andalusia; diffusion of the obtained results
- Establishment of documentation and information services for the benefit of the associates (for more information: <http://www.asemaonline.com>)

**Concerning gathering and harvesting people (“mariscadores”)**

Some of the gathering and harvesting people are grouped in cooperatives but it only concerns those that are collecting mollusks. Of the other “mariscadores” (collecting crabs, worms etc.) there is no proof about the existence of any cooperatives.

JOSÉ MARÍA JIMÉNEZ DERQUI, Businessmen in the field of extensive aquaculture in the Bay of Cádiz**1. What are the principal species that you are culturing and what are the techniques applied?**

I am cultivating fish in the ancient estuaries of the old salt pans according to the traditional manner of the extensive aquaculture which means that I am not using any kind of additional feed or adding additional fry. Thus, typical fish fauna of the Salinas is represented within the catch and harvesting takes place during the natural biological cycle of the species.

**2. What is the area you are actually occupying with your business? Can you live on that?**

I have two properties for the cultivation purpose taken together around 120 ha. However, income is too low in order to survive on this kind of business alone, thus I am depending on an additional subsidy (of the state), around 6000 € per year. In general, there is only a very limited amount of people occupied in this business.

Before, at the beginning of the 70s, I was working as a technical engineer. Afterwards I was occupied with the selling and buying of shellfish. Since the beginning of the 80s I am into the business of the extensive aquaculture but I never started any kind of intensification because I prefer the traditional manner. The terrain that I have the concession for has been used for the extraction of salt in former times. However, the “Ley de Costas” has complicated everything since there are new regulations concerning property rights etc.

**3. What are the main problems you have to face with your business?**

The main problem for us is the competition on the market with the fish raised in intensive manner. Their market prices are too low for us in order to compete with our own products even though our products are of better quality. Furthermore, due to the intensive culturing, there is a total lack of

control in the amount of fish-eating birds. Their abundance has augmented rapidly caused by the intensive fish-farms in the area. Due to the Nature Park regulations we are not allowed to scare away or shoot birds, thus more fish is eaten by the birds and less is left in our cultivation areas.

Urban contamination as well as contamination originating from the intensive fish farming ponds is a further problem since we have to cope with larger amount of algae in the water body and less oxygen levels which can cause the death of our fishes.

**4. Are there any kind of problems related to competitive usages within this area?**

With tourism there are no problems at the moment, they do not cause damage to us. However, contamination resulting from industrial activity (naval industry) can be considered as a form of competition since here any negative effects for the aquaculture business are concealed but substances are transferred into the water body (see answer 3).

**5. Are there any synergisms with other activities of the area?**

Out of my point of view, there is a problem with the "Ley de Costas" since it prevents the compatible usage of a certain area. Thus, no windsurfing or other aquatic activity can take place (is allowed) in areas where, for example, fish is raised. A sectorized way of thinking is still taking place, or this...or that..., but nothing together.

Concerning tourism, there is very little environmental education performed so far, thus any kind of interest in the environment is very small.

**6. How do you judge the effects of your business upon society?**

My activity is a very positive one because it is conserving the natural environment and its original structure, giving living space to a variety of associated organisms. Furthermore, our products are of a very high quality. This is not to be compared at all with the intensive form of culturing which, as far as I am concerned, a cancer for the environment. Many studies have been shown the negative effect of intensive fish-farms, e.g. the alteration of the bird fauna or the sewage originating from those farms. However, it seems that the results and the recommendations of these kind of studies are never converted into practice due to an inadequate administration or because they do not know how to implement the results.

**7. How important are any traditional aspects concerning the culturing methods that you are performing?**

My form of cultivation is based on the traditional form of exploitation of the natural resources, thus is very important for the maintenance of this traditional activity. I like this business very much even though I can not live on that alone. My grandfather owned an area of around 500 ha of salt marshes where he was dedicated to the cultivation of fish. So some roots in my family can be detected.

**8. Do you think that the actual form of exploitation of the resources (like you do it) is a sustainable one?**

Out of the point of view of the living resources it is very sustainable activity the resource is renewable with the cultivated species reproducing themselves. People always could rely on that, they know it since roman times. However, at the moment the main problem is situated in the economicalness of the business which is very much jeopardized by the low market price.

**9. What could be improved?**

Products should be bought according to their *quality* of their sizes. To give an example, restaurants prefer to buy larger fish because by offering larger sizes to the consumer (in the dishes) they earn more money. No one can eat 700 g of fish at one time, but since the size of the fish is so big, people pay for it even though the quality of the fish might not be as good. Very often there is offered a quality that is not real, but nobody really proves it.

The problem can be found in the proper administration and offering of the products. Here, more intervention should take place from above (e.g. the E.U. is insisting on sanitary aspects but not on quality and origin of the species).

**10. What are your scenarios for the future?**

Well, the politics of the Nature Park for us is very bad, so my perspective of the future is quite black. It seems that there is no real aim they want to achieve, so everything will die due to political misfortune.

**SEBASTIAN MORENO, Businessmen in the field of aquaculture production in the Bay of Cádiz**

**1. What kind of species are you cultivating? How is this performed?**

We are buying fry of the species *Sparus aurata* (Dorada) and of *Crassostrea angulata* (Ostión). Furthermore we are cultivating all the species that are entering naturally with the tide. We are feeding artificially and have pumps for the regeneration of water and for oxygenation. It is what we call semi-intensive culture. We have installed tanks for the fry, later on they are released in transformed basins where seawater is entering.

**2. What is the area for the installations?**

Around 100 ha. However, this area is no former salt ponds but the basins have been constructed for the purpose of aquaculture. I think we are the only ones around that are not performing aquaculture in a transformed Salina. We have constructed this terrain close to two channels near the Santi Petri.

**3. How much (kg) due you sell per year?**

Around 250.000 kg. We are mainly selling to restaurants and also to people selling the products directly on the local market. We are also selling to intermediaries who are selling the fish afterwards on larger markets within the region.

**4. Since when are you performing this labour and is this a family tradition?**

I am working in aquaculture since 1980 on the described terrain. My father and grandfather have also performed aquaculture but not on the same spot.

**5. Can you live on the income originating from the aquaculture activity or do you need something additional?**

One has to have an additional work.

**6. How many people are working in your aquaculture business?**

Altogether 18. Two of them have to be guardians during night time.

**7. What are the biggest problems you have to face with regard to your culturing activity?**

Firs of all the selling prices on the market (competition) and the high prices of the prime material (fry, feed). 20 year ago the price Dorada was sold for 1700 pesetas (11 €/kg). Now it has declined to around 700 pesetas (4-5 €/kg) (Oysters are now sold for around 3€/kg.). Secondly, there is the problem of stealing; one has to have guardians all the time who have to be paid

**8. How do you see the “Ley de Costas”? Is it affecting your business?**

Yes, this law certainly has an effect on the business. It is not our own terrain any more but public domain. If you want to take out a mortgage the bank gives you money but not for the ground but on the activity that you perform. This is more difficult to measure. There is the problem that for a bank only private but no state-owned ground has a value ground. Moreover according to our activity we have changed the depth of the surface in some areas (e.g. digging channels for the aquaculture activity). Thus, there is now entering water into areas that have not been subjected to tidal changes before. Now these areas are considered to be public domain because of the tidal influence.

**9. Do you see this kind of traditional activity? Is it important for the local population?**

The culturing activity is something very typical. Fish out of the estuaries has always been consumed, thus is it a traditional activity.

**10. Do you thing that the actual form of the exploitation of the marine resources is a sustainable one?**

This is very difficult; the situation of the market is very difficult. There is a large difference between the qualities of fish coming from other areas towards the fish produced in our area. People do not assess the value of that but buy according to the selling prices. You can only note the difference of the fish when you eat it, but then it has already been bought.

**11. What could be improved and how could it be transferred into practise?**

This is difficult. Maybe the introduction of an eco-label but that would mean that a further person has to be paid for the control and the labelling.

**12. What about the association ASEMA?**

This is an association of producers within Andalusia and I am also an associate. However, every single one is selling according to the own production it is also depends on the species every one is culturing.

**Mr. SALVADOR, Ex-member of a former cooperative devoted to the cultivation of clams****Report**

Around 15 years ago we were involved in a program about bivalve mollusks that was promoted/sponsored by the Council of Andalusia (“Junta de Andalucía”). This was in the time around 1985. The idea was to establish cooperatives that would help to improve the situation of a fairly high unemployment in the region (which was and still is a great problem) by means of creating/using plots of land for the cultivation of clams in which would employ a variety of people. Above all, we wanted to work for the social benefit. La “Junta de Andalucía” gave us land and the program was even subsidized by the E.U. Material and tools were bought by the money that was given to as well as clam-seeds from the already existing private enterprise of aquaculture “Cupimar”. We continued with the idea to establish an own production site of seeds (hatchery) as well as enough sites for fattening up and purifying the clams in order to be less dependent from large enterprises such as “Cupimar” which was selling the seeds to us at higher prices. Moreover, we wanted to commercialize our products. However, this goal was never reached because due to “higher forces” by the private enterprises (e.g.

“Cupimar”) which did not want us to compete on the market. An actual “war of prices” started since products were imported and brought from Italy and France for lesser prices even though our products were of a higher quality so that we could not compete with our own products on the local market any more. Thus, the majority of the cooperatives broke apart because the whole thing was not profitable at all since all of us were depending of the money and other resources that were not made available to us. At the end people did not gain enough salary and there arose internal problems with people working against each other etc. They had been taken away our illusion because politics did not take suitable action. Today there only exist around 4 cooperatives, each of them employing around 5 people. However, it is a craft-industry (artisan) with only a very minor production.

#### **About Problems**

Or the sites that were given to us in the beginning not all of them were adequate for cultivation purposes since there were problems with the height of the tides, the subsoil etc. Furthermore, the seeds originating from the production in “Cupimar” were not of the autochthonous species *T. decussatus* (Almeja fina) but from the introduced species *T. philippinarum* (Almeja japonesa). The production of this kind of seeds was easier but, at the beginning, there were problems with the cultivation in the field. Still, in the few production sites left today there is more produced the Almeja japonesa (faster growth rate etc). However, both species mixed afterwards.

In general, there was not given to us and adequate support concerning administration, adequate personal, adequate resources and infrastructure. Thus, our social “issuance” was a failure since even though the idea of the cooperatives was installed at the beginning most of the above mentioned support was missing during the procedure. Private enterprises such as “Cupimar” itself wanted to commercialize but no competition on the market.

#### **How does the future look like?**

There is not taken enough advantage of our local natural resources. Apart from “Cupimar”, only a few sites of (private) cultivation are left and people hardly survive on that business alone. Other people will keep collecting mussels etc. (illegally) in order be able to sell small amounts (4-5 kg) to local restaurants or in the streets.

#### **Visions for the future**

As far as I am concerned the situation could look much better since there are enough unexploited resources of mussels. There should be invested more, e.g. in the production of seeds. However, this has to be done by the state. The hatcheries should be transformed into cooperatives by means of a proper administration. The administration should organize the “marisqueo” by giving them licenses and looking after its legal uses. In general, illegal activities such as furtive fishing, the fishing of fry and collecting of seafood should be prevented by means of stricter controls and the commercial situation of the cooperatives should be improved as a whole. The form of organization should be re-structured completely such as in Galicia. In Galicia, the image of this kind of labor is much better and the cultivation and collection of seafood is much more organized and better seen by society. We wanted to achieve something similar over here. Over there, for example, is mainly cultivated and captured the native clam species. Thus, quality is much better and on the market one kg can be sold for around 40 €. In contrast, over here the products are of minor quality due to not cultivating the native species, therefore the market price is much less with only around 15 €/ kg.

In general, there are enough (biologic) resources. However, a lot of areas are abandoned which prevents an adequate exploitation of the resources. It is the politics which have to take action by means of a proper administration of the natural resources and a prevention of monopolization on the market. Then, much more people could be employed in this business.

#### FISHERMAN collecting organisms in the intertidal zone of the inner Bay of Cádiz (meeting by pure chance in the interior part (saco interior) of the Nature Park “Bahía de Cádiz” at low tide)

→ Fisherman coming back from collecting marine benthic organisms from the mud flats

#### **How is the fishing going?**

Not very well, there is nothing to be found today. (There are around 7 crabs (*Carcinus maenas*) of a small size (carapax-length ~5 cm) and one Sepia (*Sepia officinalis*) in his bucket).

#### **What are you going to do with it?**

This will be shared with my family for a meal.

#### **Are you only going for crabs and bivalves or are you also fishing? By boat?**

I am also fishing, not by boat but from the borders of the channels where the water rests after the doors have been closed after high tide.

#### **Are these channels former salt pans that have been used for the extraction of salt?**

Yes, these are the channels which have been used for salt extraction and in which we are fishing. Fish gets captured after the closure of the doors at high tide. These former salt pans have been abandoned

for a long time. Over there are the ancient buildings of the former owners which have been working on salt extraction.

**Actually it is not allowed to fish within the limits of the National Park. Are you having any problems with the authorities?**

No, fortunately there are no controls, so after the establishment of the Nature Park we can still go fishing.

**Well, there are not many people around today...**

Yes, that is true, that is a good sign. It means that they are working in other labors and that there is less unemployment around at the moment.

## **RIA FORMOSA, PORTUGAL**

**MANUEL ALFONSO DIAS, Scientist at the University of the Algarve (UALG), Faro**

→ Investigation on artisan fishery

**To 1-3)**

Aquaculture in salt ponds: *Sparus aurata*, experiments with *Sepia officinalis* and, of course, clams (*Ruditapes decussatus*). There have also been experiments with prawns but I don't know if they are being cultured by now. I don't have figures about quantities etc. However, the culturing of clams has a large social impact.

Concerning commercial fishing, *S. officinalis* is being caught and also small Sparidae (mainly *Sparus aurata*). A lot of the captures are directly being sold on the fish market or to restaurants without passing an auction.

There is harvesting/collection taking place for a variety of species for bait such as *Upogebia deltaura* or different polychaete worms. The bivalve species *Ensis* sp. or *Solen* sp. are caught by means of large tapered sticks that are sunk into the sediment into the open mussels which close their shell around the stick and can be taken out.

There are a lot of fishermen who are fishing inside the lagoon Ria Formosa but also go fishing on the outer part of the islands, thus, these small communities exist operate at both sides. A lot of those fishermen have their summer-houses on the dunes, a fact that has a long tradition but which also causes problems since it leads to the destruction of the dunes. Now things have improved a little bit because the access to the houses has been improved by means of small paths that prevent the damage caused by walking through the dunes (also by many tourists during summer time).

**To 5-6)**

Efforts are being done with flatfish-species, *Solea senegalensis*, *S. solea* and other special flatfish species that exist in this area which are and very much appreciated with high marked prices. There are also other species such as prawn and *Sepia officinalis* that could be made better use of. However, concerning for example prawns, people tend to be more interested in larger and fast-growing species that are not naturally occurring in our area, but, out of my point of view, we should make more use of our own species. There is a lack of orientation and national planning. This is not only concerning EU policies but more our national policies. They are also related to the level of education and training in aquaculture practices. Larger enterprises have trained staff but smaller enterprises very often have a lack of qualified personnel. For example, people tend to grab/collect fry from the nature in order to putting them into their culturing ponds.

**To 7)**

As far as I am concerned, the main problem can be related to the quality of water which can cause pollution problems for the aquaculture activity. There are still a lot of places in Ria Formosa where effluents enter from the cities, particularly during summer time. Sometimes water exchange in certain inner parts of the Ria where culturing takes place is low so that water quality becomes a problem. Some years ago there was a political decision to artificially keep open some of the openings into the Ria because due to the natural processes (sedimentation etc.) those openings tend to disappear. In general, a license for fishing is needed. However, fishing is taking place, particularly during summer time (sportive fishing), with gear that is forbidden. There exist an official law/an official regulation for the use of fishing gear and for general fishing in the Ria Formosa. However, collecting of species also needs some kind of regulation since it is, for example, allowed to fish/collect by means of snorkeling but not by means of scuba-diving. The effect of both practices is similar. Some kind of regulation would be needed considering the impact of such activities on the different species.

**To 8)**

I don't believe that there exist any kind of data to support an answer to this question, there can't be given a firm conclusion.

**To 9+10)**

In Ria Formosa there have always been problems with competition for land, e.g. properties for any kind of touristic installations. Furthermore, as already outlined before, in the past the houses of the fishermen constructed on the dunes have not been well-planned. These houses will fall apart one day. However, these communities have a long tradition and the places have a high importance, on the one hand for the fishermen, on the other for the tourists. Because they are part of Ria Formosa tourists want to see the fishermen, their gear and their houses. About this topic there are also contradictory opinions because people living in those houses and holding licenses want to keep the places due to the long tradition in living there.

**To 11)**

It is relatively important for the local economy since aquaculture and fishing has a large effect on local economies. A lot of people are involved in that business even though there are a lot of them who are performing this kind of business only for the own subsistence. Thus, the income is not very high but they live on it which is enough. Some of the fishermen have secondary jobs, e.g. work in construction or, during summer time, in restaurants. I think as a holder of a fishing license you are not allowed to perform an additional job officially. That is different with those holding a license for aquaculture activities. Here, a lot of people are also performing agriculture or horticulture.

**To 13)**

Well, it is their profession and they do it every day like that. They live on the lagoon. It is their way of living.

**To 14)**

Products are mainly sold fresh directly to the restaurants or on the markets. Concerning clam production, those sold to the restaurants have to pass through the process of depuration which exists on the spot. This is regulated by law.

**To 15-18)**

Licenses are given by the DGPA (General Directorate of Fisheries and Aquaculture). Now (with the new government) they are also in charge of the inspection of the licenses which, out of my point of view, can lead to problems later on.

**To 19)**

There are general regulations for aquaculture and fishing, the DGPA can provide better this kind of information.

**To 20+21)**

The most important activity in terms of economy is tourism. The selling of fresh seafood in restaurants to the tourists can be regarded as a certain kind of synergism between the exploitation of marine species and tourism. Nature tourism is being promoted recently as well. The synergism between salt extraction and fish has always been existent. There has also been performed a project about the extraction (and promotion) of the best part of the salt, the "flower of salt". This project has also won some prizes.

**To 22)**

The activity can be considered as very important (see above), even so important that it should be maintained for the sector of tourism as well. In this aspect maybe even the airport which has been constructed right in the middle of Ria Formosa could be considered as relevant for the activity since it is also an attraction to see the Ria from above and thus get the idea to visit this place.

There are some very important fishing communities around the Ria, that of Culatra (resident fishing community) or Fuzeta. This last mentioned community consists of a lot of fishermen that formerly had been employed in large vessels and have been lost their jobs due to the declining capturing rates have been bought a small boat with their paying off. Now they are fishing, harvesting and collecting (without licenses) inside the lagoon and live on that as well. In Tavira there is a specialized market for Octopus.

**To 23)**

I think there is no real perception of the mentioned problems, people are not aware of it.

**To 24+25)**

I don't have a number to support my hypothesis but what I see is that we don't have a proper management plan. But, if you don't have adequate data you can't do such a plan. There only exist studies performed by the university but I believe that this is not enough because the outcome of such investigations is not coming together. The Ria Formosa needs an observatory that collects and controls data, analyzes trends and so on. So far we don't have anything like that. All data are spread out and there are no comprehensive works. Of course, such an observatory should be among the duty of the university. We needed someone who looks into the whole system. It would be something like a synergetic job, putting all together and create a monitoring program. One should not believe, but even inside the institution of the university there is a lack of a platform in order to bring people and their knowledge together.

**To 26)**

Since the first regulation of around 1987 there has improved something. Up from this date, some drastic fishing practices have been banned (high punishment) and the small opportunistic fishing that is taking place illegally can not be considered to cause a serious impact or harm to the system.

**To 27+28)**

I would like to only have a positive idea but there are some problems. There is a need for a platform in order to better manage and develop the area. All stakeholders should be involved in order to discuss figures etc. If this happened, we would have a nice system. If not (like it is the case now) we will always have some kind of one-sided pressure. The EU-water regulations are a step towards the right direction if they will be applied properly, if not, we will stay with the problems that we already have. I think we will need an enforcement of such legislations, including control, monitoring etc. It all depends on these things. Being realistic, I don't have an optimistic vision. However, there are some nice projects going on such as with the Olhão-Council (Nature tourism, promotion of salt-culture etc.).

**RUI SANTOS, Scientist at the University of the Algarve (UALG), Faro**

→ Macrophytes in the Ria Formosa and salt marshes; working on the importance of macrophytes, energy flows and management of the system

**To 5+6)**

There are plenty of seaweeds that could be used for consumption but also for other purposes (bio-remediation etc.). We are involved in a project about the treatment of effluents from a fish farm and coupled seaweed growths. On the one hand, this could be of high economic value in terms of new resources; on the other hand it minimizes the loading of the fish farm effluents. So far we are using an *Asparagopsis* species but this species doesn't have a market yet. In general, the cultivation of seaweeds in the R.F. lagoon would not be of a high profit because the production of seaweeds is performed in countries where there are low production costs. Furthermore, conditions in the Ria are not suitable for seaweed culturing since tidal range is very high and exposure-time would be too long.

**To 7)**

In general, the system is quite good because there is a lot of water renewal during each tide. There is no major industry around that could have an impact on the water quality. However, there are potential problems with agriculture and overall urban pressure. Even though the water from the main cities Faro and Olhão is being treated now there are still nutrient loadings flowing into the lagoon.

**To 8)**

Not concerning macrophytes

**To 9)**

Tourism and related urban pressure can be regarded as one of the major problems. Historically seen societies have always developed close to the coast and people still just like to live there. The use in this region is very intensive, there is a lot of collection and general exploitation activity taking place, there is a lot of boating (leisure etc) and many further activities. In order to keep all these activities alive the main channels have to be kept open which is partly good for the system due to the resulting flushing of the system. But, there are companies that used to extract the sand in areas where the sand was of high quality but also where this activity had a negative impact on the system. However, this situation has changes due to higher restrictions. It has to be kept in mind that we are talking about a very delicate and fragile system.

**To 11)**

I believe the exploitation of the lagoon (collection etc.) is very important since culturally and historically seen it is a very traditional activity. This is not the fact for the fish aquaculture and there is not many of this around. But, concerning clam culturing it is a very big thing in our region and there certainly is an impact of this activity on the lagoon which is not very well known so far. However, there are some impacts such as the fact that the clam fields are developed in the intertidal regime which is negatively affecting stocks of *Zostera noltii*, the key seaweed species in the lagoon. If this species is reduced too much this could result in a major disturbance of the system. People don't know about this possible result and even the responsible managers such as the park authority really don't know about this danger either. In general, the communication between science and management is very little. For example, managers very rarely come to university in order to ask for scientific results. The communication with each other seems to be very difficult.

**To 24)**

This is a difficult question and I don't know whether there will be an actual answer. This is not scientifically based but my feeling is that the exploitation of the resources is increasing. Until now the health of the lagoon is good, but we don't know how close we are to the "turning point". In general, there is a very intensive use and people tend to exploit the given resources any more. There is a steadily rising population and every time more activities are evolving (such as university, other

institutes, airport activities..). It seems that the management departments are not worried about it but I certainly am.

**To 27)**

I don't really know and it certainly relates to the questions raised before. If we are still far away from the turning point, the system will be stable for many years. However, if the ecosystem will qualitatively change very much there will be less production in general and also a decline in the production of a lot of species. This in turn will lead to a decline of a lot of economic activities that depend on the status of this system. As already stated, it all depends on the turning point of the system of which we don't know where it is.

**To 28)**

There has to be invested more in the carrying capacity of the system. Furthermore there is an urgent need for a group that integrates several powers such as scientists, producers, politicians, managers etc. There has to take place some kind of institutional integration of all aspects and knowledge in order to find out at what point we are and what kind of further investigation is needed. We have to find out in what level the system is right now and what the best answers are for it. There is no easy way to communicate with each other, this has to be developed by means of an integration of socio-economics, political power and science (some kind of information highways and links).

**KARIM ERZINI, Fishery scientist at the University of the Algarve (UALG)**

→ Two main areas of research: 1. impact of different fishing gear; 2. population dynamics of commercially important species; during the last 9 years different projects on fishing gear and impacts, during the last 2-3 years more focus on juvenile stages since here the Ria Formosa seems to be extremely important for commercial fish species

**To 1-3)**

In aquaculture (intensive and semi-intensive) there is the focus on two species, *Sparus aurata* and *Dicentrarchus labrax*. They are also trying with *Solea senegalensis*. This species are also commercially fished. Furthermore, traditional salt ponds that have been converted and water basins are used for the extensive form of fish culturing. In general, in this extensive form there is grown a large variety of *Diplodus* species (seabreams) that are of commercial value as well. Here, around 150 kg /ha are produced without any kind of additional feeding (≠ intensive and semi-intensive culturing). With this traditional form of culturing there is the problem juveniles are caught from the natural resources and are put into the ponds; however, this is an illegal activity.

In general, compared to fish raised in aquaculture, sizes of adult fish caught in nature are much larger. For example, *S. aurata* originating out of aquaculture is generally sold with a weight of about 350 grams. However, individuals caught in nature can reach a weight of about 6 kg. The commercial value of such large-sized fish is much higher than the ones raised in aquaculture.

In terms of quantities, there is the sardine that is caught mainly outside but to some extent also inside the Ria. The sardines are followed by *Trachurus trachurus* and there is also important in terms of biomass and also in terms of commercial value *Octopus vulgaris*.

**To 5+6)**

I think there is a high potential of marine resources that is still to be discovered. For example, there is a former student of us who has established a small enterprise that is called NECTON. They are investigating in direction to bioremediation out of certain species and have also started to commercialize the "flower of salt".

I believe there is high economic value for the collection of bait (small crustaceans, annelids and other worms). It is very interesting to know that even from Spain or France they are coming to collect bait to sell it in their country. It happened that I went into a fishery store in Montpellier/France, where they were selling *Marphysa sanguinea* that had been collected in Ria Formosa for 15 €/ individual. I think there is something like a hidden economy. However, it is very difficult to breed the life-cycle of such species, maybe that's the reason why it has not been performed so far.

**To 7+8)**

It seems that there are a lot of concerns about the water quality in the Ria and the therewith related problems. There are, for example, around 82 golf courses in the whole Algarve region. Since for the maintenance of those courses there is used a large amount of pesticides the effluents seem to contribute to the negative water quality.

There are also many problems concerning fishing activities in the Ria with forbidden gear, especially with the beam trawl, a device that is pulled behind boat. The mesh of the net is very fine so besides damaging the seabed a lot of juvenile fish is caught. They usually do it at night time when they can't be seen. Moreover, there is quite a lot scuba-diving activity taking place (its illegal!) for the purpose of collecting raiser shells which is then be sold on the market. For that reason the divers use a liquid

for bleaching that is poured over the sediment floor which leads to the fact that the benthic organisms come out so that they can be collected easily.

**To 9+10)**

In the Ria Formosa there is a lot of urbanization taking place. There are many different towns that are increasing, there is the airport that is constructed just in the middle of the wetlands, something that is and has always been a big issue. Again they are discussing an extension of the airport.

There is also a lot of illegal housing on the barrier islands and with every new government there starts a new discussion about knocking down those 1000 houses. Furthermore, there is a pressure to build more “marinas” and developers are also thinking about the developments of some kind of floating hotels (house boats) such as it can be seen in the Caribbean.

**To 11)**

I think the whole field of aquaculture and fishing is quite important for the local economy. Around 6% of the working population of the whole Algarve is linked to this activity which is a fairly high percentage and 70-80 % of marine aquaculture is performed in the Ria Formosa. However, fish entering the market from Greece, for example, are dumping the prices of the local products (e.g. 6 €/kg for *S. aurata* from Greece).

**To 13)**

It is a way of life for people who have been born on the islands or in the Ria. Their mobility in terms of employment is quite limited, thus, fishing in the Ria is an alternative for being unemployed. Globally, I think it contributes to society and is beneficial since there are a lot of people coming to the beach but also to eat in the local restaurants.

In general, fishermen have an extremely low level of education and that will be the main reason for the mentioned low mobility. I believe this situation will be slightly different with people occupied in aquaculture.

**To 14)**

I have no data but especially in Olhão there is a number of fish-processing enterprises, mainly for sardines but probably also for octopus and clams (also smoking?!). There might be also an enterprise for the production of fish meal for the feed of animal in Olhão.

**To 15+16)**

For aquaculture, I don't really know.

**To 17)**

For fishing, certainly yes. For example there is a certain length of nets on the boats that can be used but very often larger nets are used. In general, there is a big problem with monitoring and surveillance of fishing activities.

**To 18)**

There is the maritime authority “Capitania” and also the Park Authority that are in charge of control. When we perform some kind of investigation in the Ria we have to declare everything before and very often they come and have a look whether everything is all right. However, they do not seem to perform much surveillance during night time where most of the illegal activities take place.

**To 20+21)**

Tourism and the therewith related service sector is the most obvious activity generating income in the area. It can be said there exists some kind of synergism between tourism and the local fish and clam restaurants since products from the Ria are one of the reasons for people to come. Ecotourism is still very small; there are little boats going out, e.g. for bird watching.

Some sand extraction is taking place in the Ria Formosa. Faro has a small port so that they try to keep the main channels open. The sand is then used for other purposes. Clam producers also insist in some kind of dredging activity in order to keep or even improve the water quality around the “viveiros”.

One of the main fish-aquaculture installations, “Timar”, complains a lot about the water quality because they also rely on good water quality for their intensive form of culturing.

**To 22)**

In terms of fishing, I think it is very traditional and I don't see a lot of development. Experiences are passed on from generation to generation and there is a lot of knowledge accumulated that is not written down somewhere but that could not be studied out of books either. It is like a sixth sense, you can't learn it the same way if you not have been involved in it since your childhood.

**To 23)**

This is difficult. Resources are over-exploited, a fact that is also realized by fishermen. They keep saying that 20 years ago there was more and bigger fish. They know that some of their activity is harmful but there is the situation that “if I don't catch the fish, my colleague will catch it, so I'll better do it myself”. Even though there is a lack of fish people go out to catch because with the rising selling prices for fish the incentive is created to catch more. Thus, they don't have to catch a lot in order to have a decent living. (25 €/kg for high quality fish compared to 6 €/kg for fish imported from Greece).

**To 24)**

I don't think so since locally many stocks of fish are heading for collapse. Over-exploitation simply is not sustainable. For Ria Formosa there is another danger. There is taking place a lot of fuel loading on the port. Imagine if there was an accident with fuel in the Ria that would be devastating for the whole region.

**To 25)**

The fishing effort should be reduced. It actually has to be cut dramatically. Better monitoring has to take place and people have to follow the rules. IPIMAR is thinking about the construction of an artificial reef just in front of the barrier islands for the purpose of aggregating fish (creation of refuges) but also to prevent fishing with forbidden gear in the respective area. However, it has not been proven so far that those artificial constructions really serve its purpose and, as far as I am concerned, they could also have a negative effect in that more fishing effort will take place around them leading to more pressure on the stocks.

**To 26)**

see answer 23

**To 27)**

Well, we just started working more in the Ria and our last report revealed that concerning fish the Ria is in a surprisingly good status. Compared to data from the 80s the general biomass may have gone down a little bit but diversity may have actually been increased (which may be due to different sampling devices). It seems that compared to around 20 years ago overall water quality has slightly improved (sewage water treatment plants) and we really have to hope that there will not be allowed more marinas or other things that might negatively effect salt marshes and other biotopes of the Ria.

**To 28)**

I really don't know exactly because there are so many different bodies involved in the management aspects such as the Park authority, the maritime authority ("Capitania"), local town authorities etc. This causes a lot of conflicts. Of course, it would only benefit if some illegal fishing would be cut and if further activities that are having a negative impact such as golf-course tourism would be reduced.

**LUIS CHICHARRO, Scientist at the University of the Algarve (UALG), Faro**

→ Studies on bivalve-larvae and -juveniles of the Ria (analysis of larvae in the plankton and settlement; modeling)

→ Participating in a group funded by the UNESCO about coastal management

**General talk**

The culturing of *Ruditapes decussatus* is mainly taking place in the private culturing plots ("viveiros") but there is no great collection of this species by shellfish gatherers. There are natural banks of *R. decussatus* in the Ria that are exploited for the collection of seeds and seeds are also coming from a state-owned hatchery near Huelva. In contrast, *Cerastoderma edule* is growing naturally in large quantities in the Ria and no seeding of this species is necessary. There are also oysters that are in culture. There is the native species *Crassostrea angulata* that is of a better taste but now there are also seeds of the species *Ostrea edulis* imported from France. For the culturing of oysters there have been problems with water quality in the Ria before, particularly during summer time when there is less dissolved oxygen in the water body and a higher amount of sewage water (pressure from tourism) entering the Ria. Some years ago they opened a further inlet west of the Ilha de Faro in order to improve the water circulation; sewage plants have been constructed around 10 to 15 years ago.

**To 7)**

The work in the ground plots is causing a lot of changes for the environment due to the movement of sand. Sand is put on the "viveiros" in order to improve the quality of the sediment (reduction of the anoxic layer) for the growth of the bivalves. However, at the same time there is less nutrient exchange of the "viveiros" with the surrounding water body taking place which leads to a diminished primary production in the water on the one hand but a general decrease of eutrophication on the other. Such controversial effects are often difficult in terms of any political decisions but in general a lot of people do not understand that certain activities can cause drastic changes in the system. There is a general reduction of the salt marsh area. Changes of the sediment patterns have lead to a decrease of seagrasses (*Zostera* sp.) with resulting higher loads of unfixed sand in the system. However, *Zostera* is very important for the trapping of bivalve-larvae and its disappearance could be of a long term problem for the recruitment of many species.

There has been a steady decrease of the number of *R. decussatus* over the past years which can be related to the gill-damaging parasite *Perkinsus marinus*. After spawning in early summer the clams are stressed and with rising temperatures are getting susceptible to the gill disease. So far, the reason of the occurrence of the parasite is uncertain.

There is also quite a large pressure on the natural banks due to the collection of seeds that are sown on the ground plots. Here it would be better to have an own hatchery for the production of seeds.

Moreover, there is a lot of human pressure on the system; the capacity of the sewage treatment plants is very often insufficient during summer time.

There are large problems with the market organization of the fishing and culturing sector. Our products are of a very good quality and it is ridiculous that you can find products from the Ria Formosa with a Spanish label in the north of Spain for a much higher price. There is no organization of the market, e.g. a label that protects our products.

**To 8)**

Probably there is a problem with the group of the razor shells.

**To 11)**

This kind of activity is very important and has a large social impact even though the general importance has slightly decreased in the last few years. There are entire families depending on culturing/harvesting and fishing activities. Some years ago there have been given some funds in order to improve the education of fishermen and to upgrade their knowledge concerning any ecological aspects related to their business. Thus, there should be enough information about the impacts of the activity.

**To 22)**

The methods are more or less the same like before with slight changes in sand movement. There are still knives and baskets used. However, there are attempts to use a kind of tractor for the work on the ground plots. This would indeed have a much bigger impact.

**To 23)**

I don't think that there exists a lot of awareness about it. People know that the clams are coming from the Ria since you can see the "viveiros" from the land and fishermen also organize special fests in order to inform about the products. But, there is no perception about the ecology or any kind of problems related to the production.

**To 24)**

Concerning bivalves, yes. About finfish I don't really know. In general, there is not so much fishing taking place in the Ria (mainly as a leisure activity) and a lot of fishing gear is forbidden.

**To 25)**

It would be better to have own hatcheries to avoid the use of the natural banks. Furthermore, there has to be taken care for the quality of the water. However, at the moment I don't see a dangerous situation for the Ria.

**To 26)**

Yes, I think so; even fishermen are trying to do so. There are traditional ways of cooking the clams and there are festivals where the people are shown special ways of cooking (e.g. kind of dish with pine-needles and pine seeds).

**To 27+28)**

I don't think that there will take place any big changes in future. Tourism in the area around the Ria Formosa will not increase much more since urbanization is already quite large. Now things are much more cared for than before and there is more education in environmental problems. Most probably natural changes, e.g. in water temperature or the recruitment rate of larvae, will bring about more changes than any kind of touristic activities.

Of course, there is always a risk of political decisions but we have a Coastal Plan (POOC) that determines certain actions. Concerning management, certain decisions, e.g. concerning captures, limitation of activities, are very important. For the purpose of a proper management there is more information is needed how to integrate different aspects. Only then we can fall back on what exists in the coastal zone and what kind of actions should be performed in future.

There exists a fairly new concept called "Hydro-ecology" which could be regarded as a new tool for coastal management. Here, it is tried to improve the system by means of strengthening it against any impact (like strengthening the immune-system by means of stimulating the auto-defence system).

### ESTER SERRAO, Scientist at the University of the Algarve (UALG), Faro

→ Research on seaweeds in the Ria Formosa

**To 5)**

Seaweeds could not be directly exploited but they have a lot of value for the ecosystem of the Ria Formosa. That's why they have to be conserved. Otherwise many other species would disappear as well.

**To 7)**

In general, seaweeds have a very important role for the settlement of bivalves. However, there is a great problem with the disappearance of seaweeds since after dredging activities re-colonization is very difficult.

**To 9)**

As far as I am concerned, the main problem is concerning the destruction of seaweeds for the cultivation of clams. This leads to a destruction of the whole habitat. However, the importance of seaweeds for the cultivation of bivalves should not be overlooked since it keeps clean the system. With declining beds of seaweeds eutrophication problems with a resulting development of algal blooms would increase which in turn would cause more problems for any bivalve cultivation activities. In general, there is a large pressure performed by cultivation activities, but, however, the park has to decide on this.

**To 11)**

Quite important

**To 20)**

This will be tourism that is related to beach activities and golf. Concerning tourism there exists a little bit of bird-watching but I don't know whether this is significant. Concerning synergism with marine organisms it would not be good any kind of activity related to diving (there is a lot of problem with illegal diving activities and the collection of raiser-shellfish) but nature walks and bicycle trips through nature should be promoted any further. There is definitely needed higher control of the activities and the guarding of the whole area to prevent any illegal activities.

**To 22)**

In general people are sticking more to the traditional activities.

**To 27+28)**

The Ria Formosa system is in a very delicate equilibrium which is very easy to imbalance. If it stays like it is at the moment I believe that there will be no problem, but, this situation is very easy to alter. There has to take place a thorough monitoring of the different activities, more surveillance and also more integration of the public. The last mentioned is still missing and there should be more (scientific) information available and exposed in an understandable manner to the public. In general, more activities should be performed that promote the importance of the nature park.

**MARTIN SPRUNG, Scientist at the University of the Algarve (UALG), Faro**

→ Involved in the project "The Biology of the Ria Formosa" from 1988-1991, here working about benthos and to a lesser extent zooplankton and botanic

**To 1)**

Bivalves: *Ruditapes decussatus*, *Cerastoderma edule*, *Pavia aurea* (= *Tapes aureus*), *Ensis* ssp., *Solen marginatus*, oysters (*Crassostrea angulata*, *C. gigas* and *Ostra edulis*). *C. gigas* might be the most frequent one, here development of hybrids between *C. gigas* and *G. angulata*; Gastropods (snails): *Murex trunculus*; Polychaetes: *Diopatra neapolitana*, *Marphysia sanguinea* and the small decapode crab *Upogebia pusilla* as bait; several finfish species such as *Sparus aurata* and *Dicentrarchus labrax* (in aquaculture), furthermore *Octopus vulgaris*. There are also the claws of *Uca tangeri* sold on the market but there is no kind of a cooperative for this species (usually caught by young boys for selling purpose). Very marginal, if captured, there is also made use of *Maya* sp. by fishermen for own consumption

**To 2)**

This will be *R. decussatus* because it is the main species being cultivated in the ground-plots ("viveiros").

**To 3)**

I suppose it will also be *R. decussatus* but I don't know about the economic importance about the fish species in intensive cultures (e.g. "Timar")

**To 5)**

You have to ask Teresa Dinis who works on that. I think considering any traditional aspects about the species being exploited at the moment the natural potential is already being used. (Generally, in Mediterranean (fish-)markets there is a much larger variety of species that is being exploited.) Maybe green algae could indirectly (as feed for animals) or directly being used. It could possibly be exploited the sea grass species *Zostera* sp. that, for example, is used as a plant fertilizer in the north of Portugal. There it is collected and even harvested.

**To 6)**

First there might be the tradition that is limiting the exploitation of further species, at second there has to be a market for that and at third there is important the aspect of the hygiene: the Ria can't be used as a garbage bin and at the same time for food production.

**To 7)**

The people of the "viveiros" say that during the last decades the Ria is silting more and more. This, in turn leads to more anoxic phases and can cause a negative impact on the cultures. Thus, dredging activities are performed to enhance water circulation. In general there is a lot of sewage water input into the Ria which, until a couple of years ago, entered the Ria without any kind of

pretreatment. Thus, there has been a problem of faecal coliforms. There has also been an enterprise that was treating the seeds of the Carob-tree with sulfuric acid and where effluents with a pH of 1 were entering the Ria (local effects). However, this does not happen anymore. In this area there is a lot of agriculture and apparently there is a problem with nitrate-containing groundwater entering the Ria. Probably there are also some problems with heavy metals (local effects). However, the Ria lives on the very intensive exchange of water. It has been measured that around 120 m away from a discharging source there can't hardly be detected traits from the sewage source due to the high dilution. Thus, the self-cleaning of the Ria is very high.

The sediment works performed in the "viveiros" are having some kind of impact on the Ria. Most probably, those impacts on the cultures are even bigger than the ones that are caused by pollution. But, however, the Ria is declared as a Nature Park which means that several activities are allowed to be performed with most of them having a long tradition. Coarse gravels are introduced into the sediment in order to enhance the oxidation zone and thus the clayish part is decreasing. But, I don't know if that has a negative impact or not. Furthermore, the permanent walking across the "viveiros" is leading to a compression of the ground which, on the long run, could lead to the fact that the "viveiro" has to be abandoned some day.

There are also known problems of local eutrophication concerning (intensive) fish cultures and the resulting sewage water that is entering the Ria. Furthermore, there are major concerns about large-scale dredging activities from Barra to Faro that originally were meant to keep the main navigation channel open. However, there is more sand than clay taken out and the respective enterprise is making good money out of it. Moreover, sand is taken out of areas that are not suitable. This activity is well known but actually illegal. The "viveiros" situated near the dredging activities are exposed to dropping down.

Direct touristic activities are generally not a real problem but there is a very large indirect pressure originating from this sector. There are many construction activities around the Ria for any new buildings related to tourism. A new harbor for sport boating was planned to be constructed near Tavira but, fortunately, it was prevented once again. However, the pressure is existent and there is already quite a large activity related to over-size motor boats. In general, wave action caused by those boats is negative for the edges of the salt marshes of the Ria.

#### **To 8)**

So far I believe there are no problems concerning bivalves because they have their own dynamic (one individual releases around one million larvae). There might be one exception which is the group of the raiser shells (*Ensis* sp. and *Solen* sp.). They are exposed to quite a large pressure since apart from being collected in the intertidal area they are also collected by means of scuba-diving making use of concentrated hydrochloride which is poured over the sediment to make the species come out. Thus, they are collected from the wild in very large quantities which might be a problem for the maintenance of the stock.

Concerning worms there are rumors about the possibility of an over-exploitation because of the reproduction cycle being very lethargic (e.g. of *Marphysia sanguinea*). However, no related studies have been performed so far.

In general it can be stated that by nature the Ria is a very disturbed environment (e.g. tidal dynamics). It is considered a "white nose environment", thus, quite a chaotic system. That is probably the reason why the activities that are being performed do not surpass the natural dynamics so far.

#### **To 9+10)**

There are conflicts with dredging activities and also with the sewage water mainly during the periods of high touristic activities in summer time and high temperatures of the water body. At one stage this could be a problem for the "viveiros" with the water quality being too bad in order to cultivate bivalves (a combination between high temperatures, low oxygen concentrations and high concentrations of faecal coliforms). Spontaneously I would say that sewage water and the cultivation of bivalves is compatible but only to a certain degree.

#### **To 11)**

According to a talk of Rui Cachola there will be around 10,000 people employed in this business.

#### **To 12)**

Today around 80 % of the bivalve production takes place in the Ria Formosa and thus it seems to be important locally but definitely will have been even more important in the past. However, with the university in Faro and with Faro being the centre of the legal authorities of the Algarve there will be more people employed in these sectors as well.

#### **To 13)**

I think it is a mixture of everything. There are a lot of "gypsies" performing some kind of collection activity and this will certainly not be their traditional activity but performed out of poverty. However, the yield will be relatively high if the activity is performed in the "right way" in the traditional way of manner in form of the "viveiros", full or half time.

Of course, maybe there are some people performing this activity who have a failure in life.

**To 14)**

I think there is not much. With fish there might have been developed special cooling processes for selling them in the international market but as far as I am concerned there is nothing like conservers for bivalves or anything related to that.

**To 15-19)**

I know that there certainly are some, but, to summarize, this is a Portuguese problem. There is such a large amount of departments that have any kind of influence and that even make contrasting statements. There is missing an overall concept.

**To 20+21)**

Concerning tourism, generally only the individualists are staying but the real the mass tourism is taking place further towards the west of the Algarve. However, tourism is not the only thing that people are working with. There is a lot of agriculture taking place around the Ria (dominant in terms of the surface area occupied). In the surrounding villages there is an intervention with certain nationalities that are constructing their retirement home. Here, usually a lot of municipality taxes have to be paid which is a source of income for the communities as well. As already mentioned, there is the university, there is the administration and the legal authorities in Faro which is attracting people. That is why there is a lot of urbanization taking place as well, not only due to tourism.

As far as I know there are some concepts that are starting ecotourism activities such as nature paths and guiding through parts of the Ria. There is one small company that is offering some kind of a day program in ecotourism for the "Ilha Deserta".

**To 22)**

I think the tradition is part of the culturing activities. The work in the "viveiros" is manual labor that has not changed a lot during the last centuries. Here, the nature park has been victorious against the introduction of heavy machines. It is also a tradition that at the weekends the family goes out for fishing and collecting in the Ria.

**To 23)**

I think, particularly the old and long-established people are having a strong relation towards the Ria. Usually, someone of the family owes or has owed a house somewhere near or in the Ria that is where the Sunday has or is still being spent. But, however, a lot of people are losing the relation towards the Ria and its natural environment, probably more the ones of the second and third generations. That can be seen in the large amount of solid waste thrown away.

**To 24)**

This is very difficult to answer. With my naive understanding I suppose it yes will be sustainable because of the high water exchange with the waters of the Atlantic (...and the Atlantic is big).

**To 25)**

As far as I am concerned the biggest problem is related to the solid sewage that is entering the Ria. There seems to be a complete insensitiveness of people. It is even complicated by the fact that the government seems to promote the use of non-returnable products (bottles etc.). Thus, out of my perspective main problems will not be related to over-exploitation or eutrophication or hygiene since there is the high water exchange. But, what are not diluting are the solid substances.

**To 26)**

Concerning clams, I think it has been learned not only to use the Ria as an exploiter but also as a cultivator.

**To 27+28)**

I don't think that there will take place major structural alterations in the Ria. Maybe there will arise some industry and maybe the cities will expand a bit further even though it seems that this development is stagnating (also stagnation in population growth).

However, in the past the Ria was bigger than today because there has been taken place land reclamation. There is, for example, the airport that has been built in the Ria. I hope, this kind of development will be prevented in future since a large part of the Ria is living on the very important primary production that is taking place in the salt marshes (around 40 %). I think the problem with sewage will stay constant. There is a great pressure originating from tourism which could degenerate the environment any further and become a real problem for the Ria. In general, pressure has to be taken out of the system by means of management options.

**SOFIA GAMITO, Scientist at the University of the Algarve (UALG), Faro**

→ At the moment working with the ecology of water reservoirs and the impact of extensive, semi-intensive and intensive form of aquaculture

**To 1-3)**

Of common interest and cultivated in all three types of aquaculture performed (extensive, semi-intensive and intensive) there is *Sparus aurata* and *Dicentrarchus labrax*. There also tried some *Diplodus* species. In the extensive manner, that is without any kind of additional food added, there is also produced many other species such as *Anguilla anguilla*. However, mullets (Family: Mugilidae) occurring in such poly-culture systems are of no high commercial interest.

Not only salt ponds have been transformed for the purpose of extensive aquaculture but larger water reservoirs of the Ria Formosa are also being used for this purpose.

**To 5-6)**

I don't really know because I have been working more with benthic species.

**To 7-8)**

A problem occurred more in the past but has slightly been improved during the last years is the capturing of wild larvae and fry that has been introduced in the aquaculture ponds afterwards. In general, this kind of activity could be of a problem for the natural resources. However, now fry is produced in hatcheries, e.g. in "Timar", the Norwegian aquaculture company situated near Olhão or it is even bought from hatcheries in Spain.

Concerning pollution originating from aquaculture activities, I believe that there are problems with organic sewage released from the semi-intensive and intensive form of aquaculture (including loads of antibiotics, medicine). However, we don't have thorough information on that.

**To 9+10)**

I don't know but I think there are sometimes conflicts between people cultivating shellfish and the semi- or intensive form of fish-aquaculture since the outflow of the semi-intensive ponds can have a negative impact upon the bivalves. Land use is another problem; there are a lot of restrictions due to the Nature Park legislation. As far as I know there are licenses given for aquaculture and culturing activities. Some of them have already been given but the activity has not been performed so far. Thus the area has been occupied but not used. Most probably the biggest problem is related to bureaucracy and the lack of control.

**To 11+12)**

I think for the local economy culturing and harvesting of shellfish is more important than fish culturing. Around 3-4000 families might be directly employed by activities related to shellfish culturing of collecting. Concerning fish culturing there are three main aquaculture installations in Ria Formosa ("Aquamarin", "Timar" and a third one); in "Timar" there might be employed no more than around 20 people.

**To 13)**

Concerning extensive aquaculture (fish and bivalves) there are a lot of problems related to unemployment: there is a lot of stealing and robbing, most probably mainly performed by unemployed people. However, control is very difficult in this area, especially at night time.

**To 14)**

There is actually only done what they directly do in the fish farms, thus, packing on ice, but as far as I am concerned there is no further processing.

**To 20+21)**

I think, tourism is the most important source of income; there is not much industry around. As far as I know there is little synergism between different the different activities in the Ria Formosa so far but I think they are trying to implement some of it (e.g. ecotourism).

**To 22)**

I think any traditional aspects are very important, particularly the traditional form of bivalve cultivation. However, there are changes in sediment transport due to this cultivation activity which in turn has an effect on the hydrodynamics in the Ria Formosa.

**To 23)**

This is difficult to answer. People think that they can exploit the natural resources in the same way as it was done by the grandfathers, "I can do the same as they could". They don't understand any restriction of activities within the Ria Formosa that is being imposed by the "POPNERF". They are not very happy about this kind of plan. Nevertheless, culturing and harvesting activities are a source of employment and their effect on society can be large.

**To 24)**

This is difficult to answer, actually we don't know. A lot of interventions are needed in order to keep the system sustainable such as dredging of the main channels to improve water circulation. Problems of pollution have slightly been improved after the construction of the sewage treatment plants but there is still a lot of undefined pollution: there are impacts from agriculture and pig breeding and there is an industry related to the carob-tree. The effluents originating from the treatments of the seeds of this tree have a negative impact on the environment. To summarize, I don't think that we can talk about sustainability right now.

Furthermore, it has to be kept in mind that the naturally the system tends to close due to sediment accumulation which prevents water circulation. This can only be performed by dredging activities.

**To 25)**

There are problems related to the intensive form of aquaculture and also to the breeding of stock such as pigs, these things have to be improved. In general it is very difficult to solve the problems, even though by means of the organizing plan which is just being renewed it will be difficult. Fishermen say that there are more problems originating from agriculture effluents entering the Ria and so they don't understand why they should alter or decrease any kind of fishing or digging activities.

**To 26)**

Traditional activities performed within the region such as the capturing of tuna and also the extraction of salt went into a crisis. That's why there has been taken place a development more towards culturing activities of marine organisms. However, ever since bivalve cultivation has always been the important form of culturing.

**To 27+28)**

Even though we cannot eliminate reality, I wish that the activities performed in the Ria Formosa would be sustainable in future. This implies a control of the shellfish production as well as a control of fishing activities. Different activities could be implemented such as some kind of soft tourism but no additional "aggressive" activity. The new organizing plan foresees the stopping of some nautical activities such as motorized vehicles for leisure time; in future they will only be allowed outside the Ria. Pollution is also meant to be controlled any more but I don't think that it will be possible to put it into practice. However, besides the revised ordination plan there is a strong need for higher control, a fact that usually doesn't work because the whole nature park area will be very difficult to control.

**MIGUEL SANTOS, Scientist, Instituto de Investigação das Pescas e do Mar (IPIMAR) (Research Fisheries Institute)**

→ Working on fishery resources

**To 1-4)**

The Ria Formosa is an estuarine lagoon system with an extension of around 60 km, there are with 5-6 openings to the sea. The Barrier Islands in front of the lagoon have a large impact on the resources within the lagoon. Many species are exploited by fishermen and tourists and it is a legal activity as far as it does not exceed 2 kg/species.

Around 80% of the national clam production (*Ruditapes decussates*) takes place within the area; also the collection of juveniles takes place from nature for the restocking of the banks used for aquaculture. Concerning finfish, the Ria Formosa is a nursery for most of the commercial species. There are very few fishing licenses for a variety of fish species such as *Diplodus* sp. (5-6 species), *Sparus aurata*, *Solea senegalensis*, *Dicentrarchus* sp. and the cattle fish *Sepia officinalis*. However, a lot of illegal fishing takes place that is fishing with gear that is forbidden to use (e.g. beam trawl).

Formerly, this area has been used for salt extraction purposes, however, with the crisis of this activity these former salt ponds have been transferred for the purpose of aquaculture, mainly of the finfish species *Sparus aurata*. In general, there exist two types of exploitation systems: extensive culture and semi-intensive culture where fry and feed is supplied. However, the market prices are one of the main problems for the last few years.

**To 5+6)**

Locally there are no other products thought to be exploited. The Portuguese are keen on fish and fish products but not on seaweeds etc. Seahorses could be harvested like it is done, for example, in Asia, but we don't want them to know, otherwise there would be a problem with the exploitation of this species.

**To 7+8)**

There is not much industry around so pollution originating from industry is not a major problem. However, the islands are still depurating directly into the Ria, so there is urban pollution. Concerning fishery, there is a lack of enforcement related to illegal fishing. This can result in a bigger problem because recently they started to collect *Ensis siliqua*. by means of scuba-diving (which is forbidden) and there is the danger that they are also collecting the ones who that are guaranteeing the recruitment of this species. Also the collection of juvenile finfish species takes place, very few of this is allowed but you need a license to do so. (Now, if the owner of a license dies, usually this license is not been given again to someone else, thus the number of licenses given slowly disappears). Concerning aquaculture, it used to be allowed sometimes to catch juveniles from the nature for restocking the banks of *R. decussatus* but I believe it is not allowed anymore.

Pollution originating from aquaculture does not seem to be a problem at the moment unless this activity is not to be intensified any further (which I don't believe because during summer time it gets really very hot).

**To 9+10)**

Tourism and salt industry, however, most of the last has been transformed for aquaculture purposes.

**To 11)**

In terms of bivalve, it is very important since around 80% of the national clam production takes place within the Ria Formosa area.

**To 12)**

I don't know but many fishermen that are fishing during wintertime are working for tourism, particularly in restaurants, during summer time. Licenses that are given to people for fishing inside the Ria are very often used for the outer part (seaside of the Barrier Islands) as well. Thus, numbers changes.

**To 13)**

Some people earn more in working for the restaurants than in fishing but fishing is the traditional activity, so they keep this activity. Thus, I would not consider it to be a form of a covered unemployment.

**To 14)**

There is a new law (last 5 years) that obligates the depuration and packing of the clams, This is quite a recent activity. There is also some canning industry but this is not only for the products coming from the Ria Formosa.

**To 15-19)**

Licenses for fishing activities are given every year but if you once got one it will be renewed every year again. There is also the IPIMAR and the Nature Park authority as well as environmental agencies that are involved in this process. Concerning bivalve, I think it is a different system (e.g. license given for 50 years?). The DGPA is in charge of the giving licenses and the supervising. They have a group that evaluates, for example, if it is possible if you want to swift with your culturing activity from one area to another.

**To 20)**

Ecotourism is starting such as bird watching. It seems that these kinds of activities are coming and rising in terms of the importance.

**To 22)**

In general, activities related to fishing are very traditional. However, the semi-intensive form of culturing is relatively new compared to traditional activities such as salt-extraction, for example. Bivalve harvesting and culturing has always been traditional, formerly this has also been the case for the oyster but there were problems with pollution and diseases related to this. Thus, they are not cultured to such an extent as before.

**To 23)**

The Ria and its resources are like a heritage for many people on which a lot of them depend directly. There is also a strong indirect dependence between the people and the Ria in terms of recreation etc.

**To 24)**

If rules are followed there are compliances, otherwise the exploitation will cause more problems. The system has a very good capacity. For example, once there has been a problem with sewage over a certain clam banks with the result that most of the individuals died. However, some years recovering took place. It is estimated that around 80% of the water is exchanged with each tide within the Ria.

**To 25)**

The most important thing will be to control the activities, the professional fishery and harvesting as well as the recreational fishing.

**To 27)**

Naturally, this system is supposed to collapse because the islands are moving further towards the shore which reduces the circulation of the water. This process will particularly increase with a rising pressure upon the system (more construction activities etc.). Tourism is so important; thus something has to be done in order to keep the islands in the "right" position. In order to keep the system stable, on the medium- or on the long-term, houses have to be destroyed, people have to be compensated with money and water circulation has to be kept or even improved. If you can guarantee a good quality of water the long survival of the Ria will be no problem, if not, the system will collapse. But, if there are too many openings between the islands towards the sea, currents can take too much sand away.

**To 28)**

By reducing all anthropogenic impacts as far as possible.

**RUI CACHOLA, Scientist, Instituto de Investigação das Pescas e do Mar (IPIMAR)**  
**(Research Fisheries Institute)**

→ Responsible for the bacteriologic control of the whole lagoon and for the classification of the B and C-Zones.

**To 1-3)**

Concerning bivalves, mainly *Ruditapes decussatus* (Amêijoá boa) is cultured extensively and on the second place *Crassostrea ssp.* (*Ostra portuguesa* + *Ostra japonesa*; differentiation between the two species is difficult as there have been developed hybrids as well). In terms of the economic profit the most important one is *R. decussatus*. However, all the following species are collected within the Ria: *Ruditapes decussatus*, *Venerupis senegalensis*, *Cerastoderma edule*, *Mytilus ssp.*, *Ensis ssp.*, *Crassostrea angulata*, *Crassostrea gigas* and *Ostrea edulis*.

Concerning fish, there is mainly *Dicentrarchus labrax* and *Sparus aurata* in cultivation.

**To 4)**

Fishculture 460 ha  
Viveiros 456 ha (=1319 viveiros)

These are the new data that we have collected for the new Land Management Plan for Ria Formosa ("Plan de Ordenamento da Parque Natural Ria Formosa") but there are still missing a few viveiros. At the end there will be slightly more than the above given number.

**To 5-6)**

I can't think of other species for being cultured in future times. We talk a lot about aquaculture but in general it is very difficult for bivalves. There is always a problem with the seeds. The price for seeds coming from the hatcheries is very high and there is quite a high mortality. In contrast seeds taken from the natural environment are less expensive. However, there are a lot of people that are collecting seeds; altogether there might be more than 8000 people collecting seeds and bivalve species.

**To 7)**

Yes, there are problems. Even though there are a lot of water treatment plants within the region (about 50 for the whole Algarve-region), particularly during summer time there are problems with sewage water due to the high amount of tourists in the region. Thus, sewage water treatment is not sufficient. Moreover there are problems with the runoff from lands (agriculture). There is a lot of control concerning the water quality near the production area of the cultivation sites. In general, areas are classified with A (<300 faecal coliforms/ 100g), B (300-6000 faecal coliforms/ 100g), C (>6000 faecal coliforms/ 100g). Usually, coastal waters are classified as A-sites whereas estuarine waters as B. In the area around Faro there are a lot of B-sites which is due to the mentioned problems with sewage water, particularly during summer time and runoff from land.

There is no problem with industry in this region (no major industry around).

Since the culturing activity within the region is mainly performed extensively (at least for mollusks) there are no problems for the environment originating from the culturing sites.

**To 8)**

Not concerning bivalves.

**To 9+10)**

Concerning the culturing of mollusks, no! We have an authority (Nature Park Authority of Ria Formosa) which controls the activities in the Ria Formosa. We (including me) don't allow the area that is good for the culturing of mollusks or the extraction of salt to be used for other kind of activities. Thus, we try not to have competition with other activities. At the moment I am working on a new Land Management plan for Ria Formosa that we hope will be concluded at the end of June where all important areas for cultivation will be depicted.

**To 11+12)**

Very important since a lot of people are involved in the culturing activity of mollusks (around 8000 or even up to 10000).

Fish is also quite significant but here there exist a lot of problems concerning the market prices (cheaper products entering the market from foreign countries such as Greece).

**To 13)**

As far as I am concerned, it is not a form of covered unemployment but positive for the society since in the Ria Formosa and adjacent waters around 80% of the whole bivalve production of the country takes place. A lot of fishermen also have "viveiros" (bivalve-culturing sites) as a secondary source of income or activity in times of bad weather when they can't go out for capturing finfish. Some may also be part-time taxi-drivers.

**To 14)**

Besides harvesting activities, the collected species are sent to depuration plants. However, packaging can even take place in other parts of the country.

**To 15+16)**

Yes, licencing is necessary. Since at the moment there are  $\geq 1319$  "viveiros" in Ria Formosa, there exists the same amount of licenses. Licenses for the production in the "viveiros" are given by the DGPA. The process is as follows: There is a commission consisting out of people from the Park Authority, the DGPA and IPIMAR. Our commission analyses the data and the final paper is sent to

the main office of the DGPA in Lisbon who have to sign the paper. Thus, final decision making is taking place in Lisbon but based on our proposal.

**To 17)**

We are currently working on a new ordination plan for the region. Actually, we don't have more licenses for any further "viveiros" but according to the results of the evaluation that is actually taking place we will see if there more licenses for further "viveiros" could be given.

**To 18)**

DGPA

**To 20+21)**

Tourism (golf and beach tourism) is the most important economic activity within the region followed by the aquaculture of bivalves. Tourism will probably more important for the park area in future times but, however, so far there does not exist any kind of synergistic activity between tourism and the aquaculture activity, for example.

**To 22)**

Aquaculture is a very ancient activity within the region, the same as with fish. People always used to catch or collect marine species in the region. Concerning bivalves, tradition has not changed a lot and these organisms are still exploited in a similar manner.

**To 23)**

What we produce here in the Ria Formosa region is more or less produced for the national consumption, thus, I think there is a high perception of the society concerning this activity. The lagoon is very important for that reason, above all related to the culturing activity of mollusks. The market price is good enough in order to keep this activity.

**To 24+25)**

Yes, I think the production within this region is very good so it will stay sustainable. The main problem that I see is related to sewage as pointed towards before even though water exchange is high and there is large amount of phytoplankton. I have just been to a meeting where we talked about the problem of viruses which is the main problem at the moment. Depuration of the mollusks (24 hrs. <at around 15° C) concerning *E. coli* is no problem, but the virus stays. For that a depuration would be needed that works at a higher temperature and for a longer period of time.

**To 27)**

People within the region are very difficult to work with. Now, the situation is slightly improving. People start to pay more attention to our advices. Some 35 years this situation was very different and people did not understand that we wanted to help them. They did not want to accept, for example, that the best sites for the collection of seeds can change with time and that it would be better to go to another area and leave the former areas alone for a while.

**To 28)**

There is a big problem concerning aspects related to the culture of the people. Now, people understand what I want to tell them and they learn after they have been seen that I am also able to work in the field with them. However, there is a very strong feeling/relation of people towards this area. I have made the experience that the relationship towards them in the field works very well. I hope that this situation improves any further in future times.

**PEDRO POUSAO, Scientist, Instituto de Investigação das Pescas e do Mar (IPIMAR) (Research Fisheries Institute)**

→ Director of the fish-culture research within the boundaries of the Nature Park Ria Formosa visitor area

**Talk about the research centre**

This is a very new plant (since January 2003) and we are mainly concerned with the production and reproduction aspects of fish species such as *Sparus aurata*, some *Diplodus* species, *Pagrus pagrus* and –above all- *Solea senegalensis*. We observe growth patterns and perform research in the nutrition in larvae. When the new plant will be finished completely (hopefully next year) we will also start to study the environmental impact of intensive fish production. There is the idea to make experiments with treating the effluents in different ways. For that purpose we have huge tanks (basins in the earth) that are very similar to the ones that are used in Ria Formosa for the semi- and intensive form of fish culturing. Around 90 % of the fish aquaculture takes place in such ponds. Here in the research centre we try to do what the private people can't do which is the performance of research and experiments in order to improve production and find out about new species.

We are also producing fish for the purpose of restocking. Along the coast there exist around 32 km<sup>2</sup> of artificial reefs and we try to "restock" the sea with fish. The Ria Formosa functions as a nursery for fish but then they need a place to grow. We are hoping that by means of these reefs abundance and diversification of fish species enhances again (protection, possibility to retreat). The reefs can also be

attractive for divers (diving clubs) and tourist fishing since if there is no fish it is not attractive for people to go diving.

**What would be the biggest problem for fish farms in Ria Formosa at the moment?**

The price of the fish on the market and the way of production. That is why we want to test equipment and other species in our research centre. You have to find out about different amounts and quality of food needed, about the quality of the effluents, the water quality. In general we have to improve the management of the whole procedure so that private producers are able to compete on the market without polluting the environment. This is very difficult but very important. With the new plant being finished we will offer workshops that are concerned with fish production.

**Do you think it is a profitable business?**

Yes, I think so. It all depends on the management. "Timar", for example, has about 8 different fish farms in different regions of the country and also in different countries, one of them in Ria Formosa. Prices of fish depend very much on the actual market situation.

**Do people who are involved in fish culturing live on this business in Ria Formosa?**

If they perform the semi-intensive form of culturing they usually live on that. However, if the extensive form of culturing is conducted, any other kind of occupation is necessary in order to guarantee a sufficient income.

**How will this business develop in Ria Formosa?**

We hope to have more fish farms in future, that's why we are performing the research (treatment of effluents, impact on bird-fauna, to know what kind of animals grow in the ponds etc.). There are some projects to put around 3-4 additional semi-intensive fish farms in the Ria. We call it semi-intensive because for me intensive means concrete constructions and much "artificial" treatment such as pumping of water for 24 hrs. per day. But, however, it all depends in the investment because people want to put more money in hotels but not in fish farms.

We are also starting to look for alternative and ecological ways of production by means of open sea cages.

In contrast to Cadiz, for example, the properties for fish culturing in Ria Formosa are much smaller (around 12-15 ha).

**LOIS FONSECA, Ex-director of the Natural Park Ria Formosa (PNRF) (1997-2000)**

→ Concerning the park actually involved in a research project about creating a model of the use of coastal lagoons together with a fishery institute (IPIMAR), the university of Porto and the Nature Park Ria Formosa. Later on this model should be used for management purposes (turned towards the end-user, the Park authority)

**To 1-3)**

Concerning bivalves, mainly clams (*R. decussates*) are cultivated and, to a lesser extent, oysters. In terms of cultivation the species with the highest economic profit is certainly the clam. However, a lot of other species are collected or harvested for bait such as polychaete worms (e.g. *Nereis* sp.) but there is also collected by hand clams, oysters and cockles. Outside the Ria Formosa lagoon (on the beaches) and close to the inlets there is the *Donax*-species that is collected as well.

Concerning fish, in the lagoon there are several species of commercial interest. In culture there is mainly *Sparus aurata* and *Dicentrarchus labrax*. The commercial fish farm "Timar" (a Norwegian company) is cultivating fish in intensive manner; they are specialized in the production of fry (hatchery) which is then sold to other aquaculture installations within Portugal but also for the export (e.g. Spain).

**To 5+6)**

It depends. There are a lot of fish species that could be exploited in near future such as *S. senegalensis*. At present, there are investigations taking place in IPIMAR and at the university (PhD-thesis) concerning culturing methods for this species. There are also other species such as polychaete worms of which could be made more use of. For example, there are small scale tests and already tests on a larger scale for *Nereis diversicolor*. In general there is a need for more investigation, also concerning the exploitation of actinia species, anthozoa or alga (e.g. for medical purpose).

The main problem related to this question is the space of the Natural Park area. In general, the intertidal zone is very important for many different "users" and activities performed: birds (feeding area), cultivation (mussels), collection/harvesting of different species, fish feeding grounds etc. The influences of one "activity" upon the others have not been studied very well so far but we believe that due to the different activities there are changes occurring, e.g. concerning the abundance and biomass of certain species. To put an example: if more area that is used for cultivation purpose (this includes activities that alter the sediment structure since you have to work on the ground), there will be less space available for the feeding of fish. Most probably, a higher occupation of the intertidal area within

the Ria for the cultivation of bivalves compared to the past is a one of the reasons for a declining number of certain fish species.

**To 7)**

Out of my point of view –since we are talking about a Natural Park with legislation and different international conventions (Ramsar site, special bird-protection zone)– the occupation of land and the therewith related loss of habitats is the major problem. For the purpose of construction, mainly for tourism, a lot of land has been reclaimed that had been part of the wetlands before.

In this sense, aquaculture can cause some problems, for example, when channels or intertidal areas are deepened for culturing purpose and as a result certain bird species (waders) will not be able to find food any more.

Culturing of bivalve in the extensive traditional manner probably doesn't cause major problems even though working on the terrain in order to maintain this activity leads to release of nutrients and thus to local eutrophication. This can have a positive effect on some species but a negative on others (alteration of species composition and abundance).

For the purpose of fish production in intensive or semi-intensive manner there is usually performed a strong alteration of the habitat. A change of the habitat leads to an alteration of the abundance of species which can be positive on the one hand but negative on the other: a decrease of certain species on the one hand but an increase of others on the other hand.

There is also coming pollution into the Ria. The built sewage plants are quite recent but as far as I am concerned, they have not been planned and monitored very well. There have also been problems with an industry in Faro that has been treating "Carob" (a product of *Siliquonia siliquae* with sulphuric acid. There have been effluents entering the Ria.

**To 8)**

I don't know. Probably there is an over-exploitation of some bivalve stocks such as *Donax* which is collected outside the lagoon. With cockles there won't be a problem because it is a very opportunistic species. About polychaets, we don't know. Concerning clams there might be problems since the seeds for this species are usually not produced in hatcheries but taken from the nature. I suppose we don't know the effect of the seed collection from the natural banks. Most certainly there are zones of natural settlement of the juveniles and most probably there is a pressure on that because these natural areas are exposed to a lot of changes. This species is gaining terrain on the one hand but probably there is an over-exploitation of seeds on the other hand.

There is also taking place an invasion of the foreign species *Tapes philippinarum* because the seed of this species can be bought from hatcheries and they are becoming more and more abundant. So far we don't know about a possible occupation of this species in areas where *R. decussatus* occurs naturally and the therewith related effect on *R. decussatus*.

**To 9+10)**

Yes, above all there is tourism (mass-tourism) but there are others as well. This can be considered as a very aggressive occupation which is not very compatible with the concept of nature conservation.

There is a lot of physical occupation of land and water, such as aqua sports.

**To 11+12)**

It can be considered as very important. Around six years ago around 5000 people were occupied in the activity of catching/harvesting in the county of Faro (not including Olhão and others!). However, this is the number of the associates of VIVMAR (Faro) six years ago. In Olhão there existed four associations at that time. In general, there are a lot of people that depend on the Ria and its resources. I don't know about the total number of people employed in aquaculture and harvesting activities. It might be an additional 3-4000 people. The Regional Direction of Economy should provide with data about this.

**To 13)**

It depends. It can be negative, it can be positive. It can also be a form of a covered unemployment. If someone is unemployed, he goes to the Ria and collects something. There are a lot of people living on the living resources of the Ria in wintertime but in summertime they live on tourism.

**To 14)**

There is depuration taking place on the spot and sometimes the clams are put on ice for a longer-lasting conservation. There is also some canning-industry in the region which is the main industry for fish products that are coming from the waters outside of the Ria (Algarve Region). Previously, cockles –most probably the only product coming directly from the Ria– have been packed as well.

**To 15+16)**

Yes, there are licenses given. The DGPA is giving the licenses for the business of cultivation but before the Park Authority has to authorize the use of the land. A concession of the area is needed and a license of activity is required.

Out of my point of view, this is a very bad system. If you got a concession once you can usually keep it forever, e.g. you start with a concession for 10 years and go on afterwards. Personally I think that a concession should be given for only 2 years and afterwards the activity should be revised and the concession be renewed.

**To 17)**

There are lots of problems. The main problem is related to the previous law. People were applying a license for 1 ha but when you got there to revise it they already had enhanced the area by moving the sticks from one place to another. There were no points of fixation so we started using GPS systems to measure the coordinates and fix everything on a paper that had to be signed by the respective person. Due to moving the frontiers a lot of competition started between the neighboring areas which lead to conflicts of land use. It was also very difficult for us to decide what kind of area is necessary for the use or conservation of the different species such as cockles, seaweeds etc. By means of the project that I am currently involved in we try to solve this problem of conflicting land use. However, I am not sure whether we will be able to do so.

**To 18)**

Above all, the Nature Park Authority, municipalities, local management and environmental agencies, port industry (institute of south port), water institutes.

**To 19)**

There are lots of them and that is one main problem of Portugal. There exist a variety of legislations and documents so that the application is very difficult. There is the Park legislation that is dealing with the park and land use, and there are legislations that are dealing with the activity. It is a very complex system and it is not really clear to me either. However, in the legislation from 1971 there exists a paragraph about the public domain. This states that if you can prove that you have been the private owner of a piece of land that nowadays belongs to the public domain before or at 1864 there exists that status of a "public-private-domain". As such an owner you can propose an activity to the DGPA and they send the question to the main office in Lisbon. However, at the end there is always needed the authorization of the park.

**To 20)**

Above all, there is tourism. There is also some industry that is related to fish and fish products, there is some kind of agriculture in the region. Sand-extraction is taking place. There are some shipping activities since there is a commercial port in Faro.

There are no official synergisms between e.g. tourism and aquaculture/harvesting activities even though there are ideas and probably there are already taking place activities on a small scale already. As far as I am concerned, there is a great possibility to expand the tourism to the park area in the respect that economic activities such as culturing of organism could be visited by small groups.

**To 21)**

Tourism could be considered as the principal source of income of the region also if one is talking about the Nature Park area (beaches on the islands, airport etc.). Other stakeholders might have a different opinion, probably considering their farming activity as the major important one in terms of the economy. However, synergisms certainly exist between the airport, boat activities, restaurants, beach activity and tourism. Tourists also come to eat the local products so there is also some kind of synergism between tourism and the production of seafood.

**To 22)**

It is a traditional but a conflicting area. Some people perform their activity in a traditional manner. Others do not, so it is an area of conflict. However, the conservative (traditional) manner is supposed to be less aggressive and if we can prove this, then we should restore the traditional method in all places.

**To 23)**

Concerning marine bio-resources and its exploitation, I think there is a good perception but, concerning the park area in general, it is a trouble. The official perception is that of tourism and if you have areas reserved for other things then it causes great trouble. For me, the existence of the park implies the existence of other activities apart from tourism. However, people speculate on tourism as a source of income and there is no law that regulates any kind of compensation if terrain for construction purposes is reclaimed from the park area.

**To 24)**

This is a very difficult answer; it depends on what implies the word sustainable. It means, for example, that there is something that you can make use of but that will still be there for your children and grandchildren.

The natural process of the lagoon is that of a disappearance since there are a lot of climatic and environmental changes. The actual human activity is enhancing this process and thus out of my point of view the actual activity is not sustainable. In order to keep the system alive there has to be performed some kind of maintaining activity such as dredging of the channels. The area has to be

managed since we have no natural hydraulic force to do so. Thus, some kind of management must be performed in order to keep the culturing activity sustainable. However, this kind of management is very money-consuming and I am afraid that people dependent on the culturing activities can not afford this on their own (unless the selling prices of their products rises sharply). Thus, all the other activities performed in the environment, above all tourism, have to contribute to this maintenance and management. Otherwise the activity of culturing (and also others) will not be sustainable.

My perception of sustainability: “You can only keep the activity with a management of the environment and you have to keep the environment with the income from the environment (= the activities performed in the environment)”.

**To 25)**

There has to be created more synergisms, the activities have to be put together. The actors have to work in the same way, there is needed a higher conscience for the environment.

**To 26)**

I don't suppose. History is very important and we know that this place has been an area of interest ever since (settlement, land use). So, there has taken place some kind of human intervention and there must have taken place a certain kind of management of the area before as well. I believe it is very important to look at the past in order to understand the situation of the present. Actually, it is important to maintain the interest of the area because of its long history. However, people often forget to look at the past when management of the present is performed. Out of my point of view there exists a traditional idea of the nature (also be found implicitly in the literature) that has an influence on the present idea.

**To 27)**

Out of my perspective of the previous park director, the vision for this area and its activities is very chaotic, that is if no changes in law and, above all, in the mentality of people take place.

**To 28)**

You have to have goals and objectives in order to maintain the PNRF sustainable. All people must be put together in this subject since the conservation of nature supports tourism, supports the general quality of life, supports the sector of science and technology, supports any future economic activities, and also any exploitation activities.

**LUISA RAMOS, Direcção Regional do Ambiente e do Ordenamento do Território do Algarve (D.R.A.O.T. Algarve), Regional Direction of Environment and Land Management of Algarve)**

→ Worked in the ICN for 13 years, almost 10 years in Quimbra and four years in the Ria Formosa Nature Park; in general principally concerned with problems related to the coast; changed to the DRAOT about two years ago because of differences about a dredging project with a former official

**To 7-9)**

In general, there are a lot of problems in the Ria Formosa. The most essential one will be related to human pressure in different ways, tourism is just one of them. There are big problems with the houses on the barrier islands that have been constructed illegally. With the new ordination plan (POOC) they expect to put them down even though I only believe it when I see it. It really depends on the political courage because this topic is like a bee-nest. Some of the houses are there more than 20 years and people just don't believe and don't see the necessity to put them down. The negative effect of those houses are related to the islands that are getting smaller every time (partly due to geomorphologic processes) and there is put a lot of pressure on the system due to the different activities that are taking place on the islands, the sewage water etc. (there is no connection towards the land). There is an urgent need to remove the constructions and try to rebuilt what it was like around 40 years ago, that is the stabilization of the dunes (e.g. *Ammophila* sp.). However, nearly every day there appears a new and illegal construction.

Here, to a large extend tourism is related to the “inside” tourism that is it is not necessary foreigners that are coming to the Ria. They go usually further west in the Algarve or stay in the tourist resorts like “Quinta do Lago”.

Another pressure can be related to the clam fields and to the fish tanks with the last releasing large amounts of nutrients into the environment. With the clam fields the situation is slightly different in that they have been existent for a long time already and are thus more related to the lagoon and the nature as a whole. Of course, there has also taken place some “development” in technology that is removing and returning of sand. Sometimes there are also put some tires in order to mark the limits of a culture plot but these marks “migrate” with the limits as well.

There is some pollution near the Ria but the sources are generally identified. There are problems with intensive pig raising and nearly every year between July and August there is a high mortality of the clams between Faro and Olhão because at this level the sewage water originating from the cleaning of

the pig-cages is directly pouring into the Ria and there seems to be an accumulating effect with high temperatures and less dissolved oxygen in the water body. In Olhão there are a few smaller industries that are also releasing their sewage water into the lagoon.

Concerning clam fields there is another problem which consists in putting new sand on the culture plots for a better growing of the organisms. This sand has been taken out of the system somewhere else and there is taking place a change of the natural sedimentation patterns. In many areas there is getting too much sand into the channels. Thus, in 1998/99 we dredged nearly all of the channels– the main shipping channels but also the smaller channels –in order to improve the water circulation.

Afterwards we had some problems with more ships passing through the smaller channels but after a few months you could see a higher quantity of clams and oysters and even in terms of the number of fish there could be detected an improvement.

I have a strong connection to the Ria because I have spent most of my life in this area and what I see is that there are a lot of people going to the Ria on the weekends in order to pick clams, oysters and other organisms. They remove nearly everything they find and some of the collected organisms are still very small.

**To 10)**

As far as I am concerned, one thing goes to the other. I believe that at the moment most of the problems are coming from the large amount of boats in the Ria. No one has performed a study on the capacity of the system in terms of what and how many activities the system actually supports. For the clam culture there will be problems with small waves that are originating from boating activities and erosion processes on the edges which in turn demands further artificial support for the edges. I believe it is important to study the whole system in order to get more knowledge about the whole system. So far studies are directed only to a very specific topic.

**To 11+13)**

In terms of the economy, yes. There are around 2000 clam fields that very often stay within the family and are given from the father to the son. It can be considered as a very traditional activity but not so much as it was around 20 years ago. In general, people need something else to live on.

For the restaurants this kind of business is essential. There you can pay around 15 € for a plate of clams. In summer time tourism is related to the lagoon and its activities which certainly includes the exploitation of seafood.

**To 12)**

There will be a lot of people depending on this business.

**To 14)**

In Olhão there are a lot of small business that are related to the direct selling of clams and other shellfish, there are a lot of small restaurants that directly sell the products. I think there is one industry that is freezing clams and other shellfish for the exportation.

**To 20+21)**

Tourism with all its adjacent fields (hotels, bars etc.) can be considered as the main activity. There are a lot of jobs during summer time that are related to tourism such as tour-guides, waiter etc. Faro is also the capital of administration in the Algarve. All things coming from Lisbon are done here and being send back again.

**To 23)**

I judge the perception of society as something very bad. No one seems to have an ecologic way of thinking in that the resources that we have will still be needed in the future. The only thing that counts is the profit that can be taken out at this moment and nobody thinks about whether the grandson or the granddaughter will also be able to use the resources.

We always tried to change this way of thinking and I am quite sad about it. Almost every day we say the same things but even the majors don't care, they only see more beds for tourists, more concrete construction etc.

**To 24-26)**

Not at all. The words sustainable development are two words which I always heard during my time at university which is already some time ago but it seem that only a few actually understand what it means. It is very difficult to explain but most of them only see more houses, more industry, and more concrete building in different ways. To put an example, we are now implementing the new plan (POOC) and have to re-qualify the restaurants on the beaches. They have to perform certain changes in order to find a better way of integrating them into the landscape and to make the buildings more environmental friendly (e.g. more wooden constructions). Everyone complains about it and some of them do the changes but others won't. Then, when it is too late and when they see that we are serious about it with all the consequences they come and start to argue. However, it is very difficult to argue with them.

First of all there is missing some kind of environmental education. We talk a lot about it but people don't have the conscience put it into action. In general, children are teaching their parents more about but it seem that older people don't change any more. At second there is a problem with the administration of the Algarve that exists already for a long time. We have a problem to deal with the majors because they don't have an ecological mind at all. They don't think about the quality of the environment that supports the whole system of activities that is related to it.

But there are also good examples such as the visitor card of the resort "Quinta do Lago" which shows that the coexistence of tourism and the nature park is possible. Here, a lot of activities are related to the natural environment and it is somehow ridiculous that the bird species *Porphyrio porphyrio* which is the symbol of the park has its largest breeding colony around the lakes that have been artificially created in the golf course of "Quinta do Lago". However, this is a good promotion for their concept.

**To 27+28)**

There has certainly something to be done because otherwise a lot of things from the Ria will disappear. Thus, if we want to keep it action has to be performed. I believe that for the conservation of an area some human help has to be performed but in accord with the natural evolution. However, we have to preserve the area because it is the living source for a lot of people that depend on it.

First of all there has to be performed some kind of a "global" study of the system. The Ria has to be studied as a unit in order to find out about the capacity of support for all the activities that are performed at present (clam fields, fishing, recreational boating etc.). Based on those results there has to be decided upon the right orientation about what we have to do in order to keep the system functioning. Secondly, illegal constructions have to be removed because it represents and is related to a very high human pressure (waste, sewage water, removal of everything etc.). There should be created certain areas where people are allowed to perform some activities but only there and nowhere else. In general there are needed more rules for any kind of use and activities.

**ALEXANDRA SENA, Direccção Regional do Ambiente e do Ordenamento do Território do Algarve (D.R.A.O.T. Algarve), Regional Direction of Environment and Land Management of Algarve)**

→ Land Management in the Coastal Zone

**To 7-10)**

There is not much industry and now around most of the cities have their sewage treatment plants but I believe that there are some problems concerning pollution and chemical stuff that is originating from the paintings of the leisure boats and also from old vessels that are abandoned and stay where they are (harbors of Olhão and Faro).

Naturally, there is a lot of sedimentation occurring in the Ria Formosa that is a problem for any kind of activity that relies on constant water exchanges and open channels. However, for us the most important problem is related to human pressure due to activities that are related to construction activities in Ria Formosa. Even though in some parts like on the islands there are partly concessions given for construction purposes people tend to build on more ground that they are allowed to.

The form of tourism that is taking place in our area, the tourism of "second residences" of mainly Portuguese and to a lesser extend foreign tourism can also be considered as a problem since it implies more occupation of land. there are also problems with agriculture in this area with nutrients released into the Ria.

**To 11)**

I think so, Spanish people are even selling their bivalve products here, so it must have a special importance for the region.

**To 13)**

I believe it is important activity for the region, people can gain their money with these activities and they can live on that. The capacity of the Ria Formosa is very high.

**To 14)**

I think in Olhão there is canning industry.

**To 20)**

Tourism will certainly be the most important economic activity, there are boats going to the islands, house renting. There is only very little industry around and only a little bit of ecotourism so far. But, in better tourist resort such as the "Quinta do Lago" on the Eastern part of the Ria Formosa (usually for the English upper class people) they are offering some kind of ecotourism that such as bird-watching opportunities and circuits for nature walks.

**To 23)**

I think say consider it to be a good thing in general.

**To 24+25)**

It is not too bad since the Ria Formosa has a high capacity for renewal but it could even be better. However, people are thinking more in the environment now, so most probably it will be more sustainable in future (maybe, I don't know).

**To 27+28)**

Generally my visions are quite good but the pressure imposed by human beings has to be decreased, essentially in the areas such as dunes and beaches. The accession to the beaches and the therewith related parking problems have to be organized. On land there have to be imposed more restrictions on construction.

There exist so-called "special" plans in Portugal, such as the Plano de Ordenamento do Parque Natural da Ria Formosa (POPNRFF). One of those special plans, the Plan de Ordenamento da Orla Costeira (POOC; Plan of Land Management of the Coastal Zone) was approved yesterday for another region of the Algarve. This plan concerns the 500 m wide stripe of land that is bordering the sea and sea and seaward up to the 30 m bathymetric line. The objectives of this plan can be summarized in the organization of different activities and issues in the coastal zone, the regulation and better putting together of activities, the qualification of beaches for a strategic environmental-friendly tourism, the protection and preservation of nature and of cultural patrimony. These special plans are very important but usually their application is quite difficult.

**PAULA NORONHA, Direction of the Natural Park Ria Formosa (PNRF)**

→ Works on everything in the park but as a landscape architect more related to beach management and questions concerning public domain

**To 1-3)**

*R. decussates* (clams) is the most important species for Ria Formosa and to a lesser extend oysters. There is real commercial fishing activity taking place in Ria Formosa but more outside.

Concerning extensive fish farms (for Olhão, Faro and Tavira) there can be counted 12 that are active and 9 that are inactive. Of two of them we are not sure whether they are active or inactive.

Furthermore, there is one intensive fishfarm ("Timar", Tavira) and two semi-intensive fishfarm in the Ria ("Sousa & Sousa" and "Aquamar", Olhão) (Ana Luisa Quaresma, marine biologist, pers. comm.).

**To 4)**

There are around 1300 viveiros occupying around 500 ha or even a little bit more; not of all of them have been counted the surface so far.

**To 5)**

I don't think so but I don't know. Sometimes they are introducing other species but in general I don't think that they are changing the species that are already being used.

**To 7)**

The main pressure is concerning the construction activities in the dry part of the Ria that is related to tourism. Of course this implies consequences for the whole lagoon. There is a lot of illegal housing that is staying in a natural system. House-building already started before the park was founded but afterwards it still got enhanced. We try to stop it but since this kind of activity has always been performed people don't actually believe that measurements can take place. Around 1988 the government started to put down some houses and only afterwards construction stopped for a while because people recognized that finally something was happening.

There are also problems with the use of the lagoon in terms of recreational and leisure activities. Boats are becoming an increasing problem because everyone wants to go everywhere. In general, every year there are around ten new activities taking place such as the organization of breakfast on the beach for VIP persons including putting tents etc. These things are not really harmful but such activities accumulate, particularly in the high season.

Something that has not been studied so far is the impact of the boats (gas, oil) on the culturing activities. There are a lot of boats in summer time which could probably be related to the clam dying which sometimes happens in the summer. No one knows it exactly and there is a need for further studies.

I think that there is also impact on the lagoon that is originating from the culturing activities. The IPIMAR should analyze such things but apparently they are not doing it very well. There are a lot of things that are not good for the Ria such as the sand-movement for the "viveiros" and putting tires for the breaking of waves on the edges of the "viveiros". It seems that there is also used some kind of antibiotics in the fish cultures.

**To 8)**

The problem of the "viveiros" is that they want to have the maximal production in the shortest time possible. They don't let the bivalves grow to their maximal size because they want to sell them as early as possible. Thus, there is most probably a decline.

The sand movement is putting away the *Zostera* pasture. In future this can become a big problem, so far it is not but we don't know what will happen. I think they need more rules for their activities in the "viveiros". Before they even used to take dogs with them that were destroying the sediments as well, and they even used to put old batteries against wave action. There seems to be the idea that "if my grandfather did it this way I can do it the same way", even though they know that it is not the same any more.

**To 9+10)**

Boat activity within the park area is increasing drastically. There seems to be an increase of agencies who are offering trips for bird watching but we can control them and they are not the problem. The problem exists more with the private boats since there are a lot of people who don't know about the rules or any other kind of restrictions. It is not very easy to drive in the Ria due to a lot of shallow areas. However, with their private boats they go everywhere. Particularly on the islands there is a lot of breeding birds at the moment but people just go there with their boats and don't care. There is actually a big problem with supervision and control of the activities. The controlling bodies in the Ria are us and the "Capitania".

As already mentioned, there is a great problem with land use, thus, construction. Everyone wants to get as close as possible to the Ria. Sometimes they even want to have their restaurants or bars directly on the beach with the service only for private clients. However, that is not possible because this is public domain that can be used by everyone.

There are also some problems with runoffs from agriculture and also with sewage water during high season. Some years ago the EU gave funds for the planting of orange trees that needed a high amount of fertilization. Now they changed the policy for the region and are funding glasshouses for the cultivation of tomatoes, strawberries and cabbage. In general these activities in the hinterland can have a big impact on the Ria.

Industry is not of such an importance in terms of pollution problems for the Ria since there is no great industry around. However, it would sometimes be easier if there was because now we have a lot of diffuse sources from smaller enterprises where the detection of the origin is very difficult.

**To 11)**

Yes, it can be considered to be important because our region is the second or third area of Portugal with the least unemployment. The culturing and harvesting activity can partly be responsible for this. In the past, the Algarve was somehow divided into two parts, the western part where tourism started first and our eastern area. Now it seems to be important that we have a fairly large area that belongs to the park because we put a break to the mass tourism and now people come to see and enjoy the park.

**To 13)**

Good question, a lot of people work in the park with collecting and harvesting activities but some of them have other jobs. Concerning the contribution to society, they have to pay taxes but sometimes they don't declare all their products but only pay taxes for half of the amount that they collect of harvest. Many of them are employed and pay with taxes but I don't know whether they pay like social security. At least the younger ones will be paying more regularly.

**To 14)**

Most of the product is directly sold. Bigger clams are usually sold to Spain or France, there might be related some industry to the bivalve-sector but this is only a minor one. There is some canning industry for sardines but this species is mainly coming from the outside.

**To 15+16)**

We, the Park Authority are giving the licenses for the use of the public domain/ for the use of the land. This year will be the first year where a renewal of all licenses takes place, thus, up from now everyone who is using a piece of land has a license and has to pay for the use of the land.

Furthermore, there is needed a license from the DGPA for the production in the "viveiros" (production license). This license is always given for a period of 5 years. For getting the production license there is always needed the user license first. However, the new POOC is going to say that the user license (the one that is given by us for the use of the land) will be valid for either seven or ten years. Why is that?! When the plan is published there will be imposed several restrictions and alterations concerning the use of the public domain. For example concerning beach bars we will tell them what kind of changes are needed in order to get the user license (e.g. maintenance, material changes etc). If the time they'll need for these changes will be just one year, they'll get a user license of ten years, but, if it takes two years or only for a period of seven years. During these one or two years everyone will have to make certain changes. For this time, our license will be only a provisional one.

Changes will also have to be performed for the "viveiros" but they won't take such a long time as for other constructions like beach bars or restaurants.

**To 17+19)**

There have been problems while discussing the new plan. As the DGPA always gives their production licenses for a period of 5 years, they did not want to give their license with our provisional license. So,

during the discussion we agreed in the point that there will still only this kind of provisional license given for the land use during the first and second year of change but with the guarantee that it will be extended for a period of seven to ten years afterwards.

There also exist licenses for the collection activity. There are around 4000 licenses given for the collection of organism but there will be altogether 8000 people collecting in the Ria. That kind of collection needs more rules and there will be more licenses given for this kind of activity. However, there is big problem with illegal diving and therewith related collection activities. In general, there are a lot of licenses or laws, e.g. a law about the public domain.

**To 18)**

For the land use, the Park Authority has to perform the control, for the activity it is the DGPA. The "Capitania" is also involved in supervising if everything is o.k.

**To 20+21)**

Tourism will be the one that is bringing us the money but also the one that is causing a lot of problems. The main problem is that tourism is steadily increasing. It was always believed that the creation of golf courses was a gold mine but now one was thinking in the pollution problems related to this activity. Now there are also erosion processes taking place on the scarps.

They are trying to increase the traditional salt production again. We have two of those traditional Salinas running again. There are some more of them but much smaller that are run by very old people who sell the production directly to the neighbors. However, there are certificates given for this natural promotion of the salt (high quality salt out of traditional Salinas) and we are also thinking to do something similar for the clam production.

**To 22)**

The only changes that have been taken place are related to sand movement and rocks that are sometimes placed in the ground plots, but in general it is very traditional activity and has stayed the same. Fishing activities are taking place mainly outside the Ria.

**To 23)**

As far as I am concerned many people who live here don't really have a perception of the problems of and the effects on the Ria. I think that is changing a little bit due to the large amount of scientific research performed in University during the last 12-15 years. People have more perception of the boats and motorbikes but no perception about the tires and other foreign bodies in the system. The only thing that matters is if they can eat good clams or not. To summarize, most of the people don't know about it, they see the boats and the garbage but don't know about the clams.

**To 24)**

Like they do it now it could be sustainable but with all the activity that is involved with the culturing (e.g. sand movement) it will not. We have to perform more control on the art of the activity. There is a lot of sedimentation taking place in the Ria and I believe that the main channels towards the sea have to keep their natural flow patterns. However, maybe some kind of human intervention is needed even though natural dynamics of the system should not be changed.

**To 25)**

Definitely there is need for more control. Producers have to go back to produce larger clams again with a higher profit and with a better quality. We are not going to give licenses for any more "viveiros". Everybody should also start to increase nature tourism such as boat trips, sailing and canoeing in the small channels. We want to give special licenses to people who do these kinds of things (e.g. beach bars with solar panels). In general, people have to be given some direction to do activities that are related to ecotourism (e.g. salt production); their concepts need to be changed.

**To 26)**

I don't know but I believe they are slowly learning, but more from the mistakes. They still think they do the same or even produce more than their grandfathers but they also see the problems related to their activity. This kind of awareness is the first step.

**To 27+28)**

We are currently in a time of changes and decisions. When the park was created there was more like a love-hate reaction towards us. Then, slowly, our popularity increases because we did some useful things such as putting information panels for the people. They realized that we could do something good such as stopping negative activities. However, we would like to do much more things and we are still performing a lot of changes but we need more people and more money to do something. There, the government has to decide.

Concerning the future, if everything stays controlled and if we introduce some changes than future will be positive. In general, we are limited and there is no more space for any further touristic activities or construction. Now, we have to have a management not for new things but we have to deal what we already have. The general aim of the new "Plano de Ordenamento e Regularmento do Parque Natural Ria Formosa (POPNERF) which is currently in elaboration is to update the information of the old POPNERF and to promote better management tools for the park direction. The former

management plan of the Ria was more directed to the dry part of the Ria. With the new plan we want more emphasize on the wetlands of the Ria. Major changes concerning “viveiros” and fishery will be the restriction of the use of the natural resources only to the actual users and also to apply a more effective supervision. We will also have more and better rules for the quality of the water. This will be very difficult to control but is very necessary since otherwise in 30 years we won't have what we have at the moment. There are already so many activities people in the park and if we don't pay attention now, tourism might even be of a more aggressive character in future. The Ria is a unique system, a rare kind of a lagoon and it is very difficult to find equilibrium between economic activities and nature conservation. We certainly have to control the activities and stop the aggressive kind of tourism.

**ISABEL ARROBAS, Direcção Regional das Pescas e Aquicultura do Sul (DGPA),  
General Directorate of Fisheries and Aquaculture of the South), Olhão**

→ Responsible for Aquaculture Sector

**To 7-10)**

Being honest, I think that the biggest problem is that many people don't have any environmental education which allows them to exploit the resources without the necessary concern of maintaining them. There is needed more surveillance, something that is not taking place and the laws have to be kept. In general, the laws are acceptable but they have to be fulfilled.

The Ria Formosa-ecosystem is a very “rich” one and a lot of people depend on it (fishery, aquaculture, tourism etc.). Thus, it has to be conserved and defended against any kind of pollution. There are many problems related to pollution and there is a necessity for a better and more efficient treatment of the sewage water. The concentration of fecal coliforms is quite high in some zones of the Ria, particularly in summer time. There is needed a higher conscience concerning this phenomenon. As far as I am concerned, it would be nice to be able to consume the bivalves directly after harvesting since any kind of further treatment (such as the depuration process) lowers the quality of the final product. But, however, this is not possible because inside the Ria there are only B-zones.

Tourism has some negative influence on the water quality of the Ria as well. Particularly concerning boating activities there are problems with the painting (PCB's) but also with an increasing amount of fuel. The activities of the Marines within the lagoon (in Olhão, Tavira and Faro) have probably a small impact, too.

**To 8)**

Concerning bivalves there are some problems with over-exploitation of razor shells. They are part of a traditional plate and also the Spanish people have a lot of interest in buying this species for selling them on their market. That is why there is a lot of pressure on this species group since a lot of people go and collect them.

**To 11+12)**

It is quite important. We have the indication (figures) for people employed from the “Capitania”. Altogether there are around 3000 licenses for the collection of bivalves in the Public Domain. The owners of the “viveiros” also need this license because they collect seeds from the natural banks (which are Public Domain) in order to put them on their ground-plots. This kind of procedure is not always necessary but sometimes the culture plots have to be restocked. There are around 1300 officially licensed “viveiros” and some still have to be regulated. However, it has to be taken into account that we are talking about a family business where there is usually involved husband, wife and children. So we can put a further 1000-2000 people to the mentioned 3000. Furthermore, there are people who are working in the whole sector of commercialization (depuration, conservation, dispatching etc.) so that there would altogether be employed around 6000-7000 people related to the bivalves. There could even be more people since there are many people that are capturing without any license.

Concerning fishery, the number of people is not so significant since a lot of fishermen are also holding a license for the collection or culturing of bivalves (they do both).

*(about production data:* In the south zone there are two coastal lagoons, there is Ria Formosa and Ria de Alvor. However, Ria Formosa represents around 98 % of the total bivalve production in the South of Portugal. Production of Ria de Alvor will be around 5000 tons (which would be 2 % of the production of the south).

**To 13)**

The President of the Council of Olhão said it like this: “The area of the Ria Formosa is like a pillow of support when there is no employment”. There is a manner to collect clams and cockles (around 5 kg/day) and to sell them directly to the market. In general, there is a lack of human labor for the work in the “viveiros” and usually the owners of a “viveiro” are trying to contract people. However, if people go to collect on their own they gain around 50 € for the 5 kg collected during the day. This is not a bad income taking into account the living standard in Portugal. For the same amount of kg

collected in the “viveiros” the earnings would only be around 40 €. Thus they prefer doing it the other way round.

In general there is a lot of work in the Ria (e.g. in the fishing sector, tourism). There could be less unemployment. There are not only bivalves that could be exploited but also squid.

**To 14)**

There is depuration and a sort of conservation (deep-freezing) but no other transformation.

**To 15-18)**

The fundamental licenses are those: The park authority has to give the license for land use of the Public-Maritime-Domain. Afterwards, a further license is needed according to the activity that will be performed. For fishing and aquaculture activities this license is given by the DGPA.

**To 20)**

There are a lot of economic activities related to tourism. Furthermore, there is the university that is employing quite a huge amount of people. Then, there are a lot of services related to the fishing sector.

**To 21)**

Talking about the cultivation of bivalves I think it could be the most important sector in Ria Formosa, next to the sector of tourism. Tourism is more related to getting money out of recreation, but, besides the economic importance the culturing of bivalves fulfils a very important ecologic aspect in terms of the maintenance of the environment (high filtration capacity). If the bivalves disappeared it would be very bad for the Ria since the system lives on that.

**To 22)**

I think it has not changed a lot. On the one hand, for improving the production it would be better to introduce some more sophisticated techniques. On the other hand, it is good to practice the traditional techniques in order to defend and protect the natural environment. In the offshore area there is certainly needed an improvement of the techniques used but inside the lagoon I think the traditional methods are more in line with the environment, even though at the expense of the production.

**To 24)**

I think so but it is very necessary to increase any kind of surveillance, particularly related to pollution. There have been high mortalities of bivalves within the last few years which is most probably related to water quality. Thus, the quality of water is the most important thing to maintain the resources and related activities.

**To 25)**

There is needed more control and the regulations have to be obeyed. There is also needed a better treatment of the sewage water entering the lagoon.

**To 26)**

Yes, because most of the people which are performing this kind of activity have not learned it in school how to do it but the knowledge has passed on from one generation to the other. This kind of maintenance seems to be positive in terms of the conservation of the environment.

**To 27+28)**

As far as I am concerned, if there will be achieved to maintain the water quality of the Ria, the production of bivalves will go on in a positive way. However, everything depends on water quality and also of the control of the touristic activities in the Ria. I am not able to think so much into what the future will look like because everything will depend on the political decisions of the country that will take place in a certain time. However, the lagoon has to be maintained and therefore it is most important to counteract the factor of pollution.

**JOHN ICELY, Shellfish merchant**

→ Involved in scientific research about the Ria Formosa; uses the Ria as a supplier for his own business in Sagres (most western point of the Algarve)

→ Business (since 1995): importation and exportation of seafood, supply of seafood, mainly crustaceans and mollusks rather than fish, to the local area; provision of services of repairing and maintaining of aquaculture installations; services to universities and research institutes

**1. What are the main products that you are buying from the Ria?**

From the Ria there is mainly *Ruditapes decussates*, *Tapes aureus* and *Venerupis pullastra* that I am dealing with. I am also trying to sell *Cerastoderma edule*. I am also selling *Ostrea edulis* (mainly to France) but this species is coming more from the area around Sagres. Many products from the Ria go up to Lisbon.

**2. What is the purchase price and what the selling price of the main products?**

<i>R. decussatus</i> (big sizes)	buy: 15 €/ kg	sell: 18 €/ kg
(small)	buy: 13 €/ kg	sell: 16 €/ kg
<i>V. pullastra</i>	buy: 10-11 €/ kg	sell: ~13 €/ kg

*T. aureus* buy: 6-7 €/ kg sell: 10 €/ kg

That is what I can sell best and I set the margins on the prices. However, *Tapes phillipinarum* which comes mainly from Spain can be bought at 10-11 €/ kg and thus effects the prices on the market of the other species as well.

### 3. What about your clients?

I have 5-6 regular clients where I know what they want to buy, but I am always looking for new clients as well.

### 4. Are you thinking about merchandizing other species apart from the ones you have mentioned?

I would like to have a wider range of products but all depends on the request of the clients. I mainly have Spanish and Portuguese clients and they want to have clams.

#### To 7+8)

There are a lot of problems with the EU-legislation. In general, the condition of the final product is not the one they would like it to have. As far as I am concerned, it would be better to get the products directly from the area where they are produced, that is without all the intermediate steps (harvesting here, depuration there...). This, of course, depends on the water quality and it would also be a disadvantage for the smaller producers. But, at the moment, there are definitely too many restrictions and legislations that can't be fulfilled completely, thus, a lot of non-legal activity is taking place.

I also know that there are some problems that are related to the alteration of the sediments in the Ria. However, I don't know about any long-term effects. An obvious problem is related to the water exchange and pollution from non-specific sources (golf-course activity, airport sewage that is treated but getting out somewhere where there is only very little exchange of water). In some places there is a high residence time of the water and I have the feeling that it doesn't exchange with every tide. If too many nutrients enter the Ria there might arise some eutrophication problems. However, resulting effects are to be searched more in the sediments and not only in the water samples.

#### To 9+10)

Obviously there is a big problem related to urbanization and building pressure around the Ria. There is not much industry as a competitive activity but more the recreational use such as water boats, jet-ski etc. There are also a lot of people that are digging around for collection purpose but I am not sure whether this activity causes a great problem. There is dredging of the main channels taking place for the purpose of sand extraction or keeping open the channel which might have an effect on the system as well.

#### To 11)

Yes, it is important in terms of the clams but there is also a lot of recreational use. It should not be forgotten that the Ria Formosa is a site of European protection importance such as Ramsar-site and a Natura2000-site.

#### To 12)

This is very difficult to tell but there are ways of getting it, e.g. multiplying the number of associates of "Vivmar" by two or three (500×2-3).

#### To 13)

For society as well as a whole it is possible. Also in the artisan fishery and gathering activity there is coherence, at least those people are trying to do something and are not sitting around.

#### To 14)

"Timar", the intensive aquaculture business is growing and packing on the spot. There is also taking place the production of high quality salt in the Ria Formosa.

#### To 20)

There certainly exists a synergism between the culturing activity and the selling of the products to the restaurants where the people come especially for the consumption of seafood out of Ria Formosa.

Raiser shells (e.g. *Ensis* spp.), for example, are a big thing here, it is a specialty.

#### To 21)

I suppose it is tourism and the airport at Faro is supplying the whole Algarve.

#### To 22)

I think the culturing of clams is a very traditional activity. In contrast, the form of cultivation taking place at "Timar" is a very modern thing. Concerning oysters, there has most probably taken place an adaptation from France. With *Ostrea edulis* there is still quite a high mortality compared to *O. gigas* but I believe it would work as well.

#### To 23)

I think it is fundamental to their whole way of thinking and they like very much their food. But, however, it seems not to be apparent the relation between exploitation and over-exploitation.

#### To 24)

I think it is one the edge and some serious constraints have to be put on it. For example, seaweeds are very vulnerable, there are problems with the male stocks and it seems that the reproduction of a certain species is in danger.

**To 25)**

I think there is needed some kind of integrated plan that people can look on.

**To 26)**

No, I think it is coming hard and fast, I believe little has learned from the past and there certainly are serious problems. There have been put groynes further down the coast, for example, which could change the patterns of sand supply for the Ria Formosa. However, the natural geomorphologic processes are essential for the whole process, people apparently are not aware of that.

**To 27+28)**

To be realistic, it has to be tried to follow up the things that are going on, to get the perception of people and try to work more with the concepts of ICZM. Some kind of sustainable development is possible and people might have a some sort of a concept, but the problem is how to put it into practice.

**FRANCISCO MANJUA, Director of the bivalve-purification and dispatching centre “Cara Pura” at Olhão**

**1. What is your relation to the Ria Formosa?**

I live with the shellfish, I even talk to them, it is my professional career to work with them, its just like this.

**2. How many people are employed in your business?**

Altogether, eight.

**3. What are the main species that are being depurated in your factory? How much per year?**

One has to distinguish between purification and “expedition” that is dispatch. There exists a classification of bivalve mollusk production zones (Europe wide, EU-law) subsequently designated as A, B or C zones depending on the requirements for depuration. In our plant we are only accepting and treating products that are coming from the so-called A-sites ( $\leq 300$  faecal coliformes/100ml) and the B-sites (300-6000 faecal coliforms/100ml). Species collected or harvested in an A-site only have to pass the expedition (auction), that is: entering, grading, labeling and packing. Those from a B-site have to be depurated: entering, grading, depuration tank (at least 24 hrs. in flow-through basins with water that has been pre-treated by ultraviolet radiation), labeling, and packing. It is very important to note that within the plant products from both sides are never allowed to mix.

A-sites can only be found outside the Ria or near the inlets. Species originating from these sites –thus only pass the expedition – are: *Spisula solida*, *Donax sp.*, *Pharus legumen* and *Venus gallina*. Species passing the depuration process (B-site species) are: *Ruditapes decussatus*, *Tapes aureus*, *Venerupis pullastra*, *Cerastoderma edule*, *Mytilus sp.*, *Crassostrea app.* and *Venus verrucosa*.

There are around 1200-1500 tons passing our plant per year. However, the monthly mean varies during the course of the year. During Christmas time largest amounts can be found.

**4. Are there only local products (=from the Ria Formosa) treated?**

These are mainly products that are coming from the Ria but there are also some from the area outside.

**5. How important would you consider your business for the local economy?**

Very important! For the region this business is vital since –theoretically– otherwise it would not be possible to sell bivalves due to the EU-legislation. For consumption (supermarket, market) people are getting more and more aware of the labels that are stuck on the bivalves because they know about diseases related to shellfish that are not depurated properly.

**6. What is the main problem that you are facing at the moment?**

There are no problems

**7. Do you have tourist groups or other people visiting your factory?**

Every now and then there are student groups (university, high school, primary school) coming for a visit. Of these there are more coming from Lisbon or Porto than from the Algarve-region. There is also taking place some training exchange with people from France, Spain, Ireland or Portugal.

**8. Are there any entities that have to control your business?**

There are heaps of them, there is the fishery institute IPIMAR (weekly water control of the ingoing and outgoing water, control of bivalves in terms of bacteriologic examination), the DGPA (2-3 times per year for the controlling of the whole process). There is also the general veterinary inspection, the general inspection of fisheries, the communal inspection, the inspection of finances...

**9. Are there more depuration plants in this region and is there any competition?**

There are three more but much smaller than ours. They are usually just for the products originating out of the own production. Only one of those three is directly connected to seawater, the other two have tanks with water installed on land.

**10. How do you see the future concerning your business?**

This type of activity will always be necessary, even though if the general water quality will improve (due to the sewage water treatment). This is related to the higher restrictions and legislations concerning food hygiene but also to a higher awareness of the end-consumers.

**11. What should be improved out of your perspective?**

We should have a logistic system for the process (e.g. internet-sales). However, it is very hard to control such a system since around 70-80 % of the produced bivalve pass illegally to the market for sale that is without any kind of depuration before. Furthermore, there is a lot of time-consuming bureaucracy that should be improved somehow (only one or two controlling entities).

**FRANCISCO MANJUA, Bivalve- producer in Ria Formosa****1. What are you producing and how much per year?**

I am extensively cultivating in poly-culture *Ruditapes decussatus* (Almeijoa boa), *Cerastoderma edule* (Berbigão), *Crassostrea* ssp. (*Ostra* portuguesa, *O.* japonesa) and *Mytilus* sp. (Mexilhão). Production for 2002 was 26400 kg for *R. decussates*, 15023 kg for *C. edule*, 25.727 kg for *Crassostrea* app. and 12386 kg *Mytilus* sp.

**2. How much is produced in the whole Ria?**

Concerning clams, the most important bivalve species cultured in the “viveiros”, the production in the whole Ria can be estimated to 3000 to 4000 tons/yr at the moment. However, around 15 years ago around 10000 tons/yr were produced. No one really knows real figures because it can be estimated that around 50-70% of bivalves are sold on the market without either passing the expedition or the depuration (which means they are not part of the actual statistics). Thus, official figures from the DGPA can be amounted by 50-70 %.

**3. What is the most important species in terms of quantity and in terms of the economic profit for you?**

*R. decussates*.

**4. How large is your business and how many people are employed there? What is the surface of all “viveiros” in the Ria and how many people would work in culturing and collecting activities altogether?**

I am cultivating 4 ha and there are employed altogether 11 people (depending on the amount of work to do). In the whole area there exist altogether 1023 ha of licensed farms and there would be around 3000-4000 people who are licensed for seed collection and farming activities.

**To 5+6)**

There are possibilities with *Murex trunculus* or *M. brandaris* and I think there is also a high potential with raiser shells. However, there is still a lot of research missing.

**To 7)**

There are big problems with stealing and sometimes high seasonal mortalities caused by a toxic phytoplankton blooms and low oxygen concentrations during dead tides (little water exchange). Sometimes there are pollution problems (probably effluents from agriculture, golf-course) with lead to mortality as well.

Concerning problems originating from the farming activity, there should not be any since we are trying to do it as naturally as possible (e.g. culturing different species together, positioning of the farming area in harmony with the natural currents etc.). Sometimes farmers alter the natural ground by putting too much sand on it in order to elevate the surface. That could have an impact on the surrounding environment. However, we are not performing such a practice.

**To 8)**

Talking about the cultured species, I believe there is no one. It is even good for restocking of the natural population in terms of the genetic variety because small individuals are taken out from nature and a seeded on the cultivation areas.

**To 9+10)**

Actually not because there exists a regulation for the different uses of the Ria for many years and thus farming places (for bivalves) are regulated by the park legislation. Before there used to be more industry, that is not the fact any more, with tourists collecting or stealing there is no major problem.

**To 11)**

In this area fish-canning industry was quite important in former times for the fish being caught in the outer waters of the Algarve. However, with declining capturing rates a lot of people lost their jobs and came back for working in the Ria. Now business related to fishing, cultivating, harvesting is very important and it can be estimated that the work of around 70 % of the population of Olhão is directly related to and depend on the Ria.

**To 12)**

see question 4

**To 13)**

A lot of people get a grant from the government because of being unemployed. However, they still work in the Ria but they don't declare their products. This is negative for the farmers who officially hold their licenses and have their legal business running (paying of taxes etc.).

**To 14)**

For bivalves, there only exists depuration industry but no canning etc.

**To 15-16)**

DGPA

**To 17)**

It is hard to give any answer

**To 18)**

This control is supposed to be performed by the DGPA but it is not done properly.

**To 19)**

To summarize, in general the DGPA together with the IPIMAR (fishery institute) are collecting information about stocks etc. and make proposal for the Ria and send the information to Lisbon where the final decision is made. There have also been adopted quite a few rules and recommendations for Portugal from new EU-legislations.

**To 20+21)**

Tourism is the principal source of income for this region, altogether it is the service sector related to this. However, for the Ria it is very important the culturing of shellfish, particularly for the communities of Olhão and Fuseta.

**To 22)**

People are usually performing the traditional methods and it has always been like this, they don't believe in results of new investigations or in any new ideas. The best example can be seen in the cultivation of oyster which we are already performing for some year. Everyone kept saying that it won't be possible to culture oyster in the Ria but it works and only now people start changing their mind. However, in general productivity of bivalves in the Ria could still be higher.

**To 24+25)**

No, there has to be improved a lot in order to keep this business sustainable. For example there is a need for hatcheries on the spot so that seeds are not only collected from the natural stocks. Many species that are fished/collected in the field are exposed to over-exploitation (declining stocks) and thus there should take place more artificial restocking.

**To 26)**

Concerning techniques, yes (e.g. sand movement). Before, we didn't do anything concerning maintenance or protection of the edges of the "viveiros". However, when dredging started in order to improve the water circulation within the channels we had to start performing some kind sand movement because apart from a better circulation system currency of the water got stronger and we had to put some kind of barriers and had to observe more the flow or the currency. Thus, we see and learn and try to put it into practice.

**To 27)**

Productivity should be improved in order to increase the production in general. I believe we have the possibility to do so because the natural circumstances of the Ria are favorable for production, so we should make use of it. Our products are very important and of good quality.

Furthermore, the official statistics of the DGPA are not reflecting the actual (production) capacity of the system (due to the large amount of products from the Ria that are not announced and consequently not part of the actual statistics). Therefore, there is less money invested in research matters.

**To 28)**

In general there is too much bureaucracy. Much different legislation exists but nobody really converts them into practice.

**ANA MANJUA, Scientist, bivalve-producer****Talk about the organization of people involved in bivalve culturing in the Ria Formosa**

At Ria Formosa there are two cooperatives and two associations for bivalve producers. The cooperatives are CARA and FORMOSA. CARA established the depurator "Cara Pura" and concentrates the products for selling. FORMOSA doesn't have any infrastructures to producers to use. They have some projects for education in aquaculture.

The Associations are APAA, the one my father founded 20 years ago, and VIVMAR who exists for about 8 years.

**What is the role (how important are) of the cooperatives/ associations for the "viveiristas" in the Ria (e.g. Formosa cooperative, association VIVMAR)?**

Every organization should have more importance than it has in fact. The problem

is that with the first one, APAA, many things changed. There were a lot of pressures at the central government together with fishing, and fishfarm associations. What we feel and we know is that others were created to stop all these procedures...and not only in our field. So they have political support. As a result, it is not productive for no one. At this moment we make two steps and we go back 1,2 or 3 steps.

Another problem is the difficulties to producers to be organized: For example a cooperative needs to play with the prices and the quantities to plan and create the market. Since the prices fluctuate a lot the producers, when the price is even slightly higher, sell their products to someone else and only the product they can't sell or when the price of the cooperative (normally stable) is higher they give it to the cooperative. This brings a huge problem to the cooperative because they can not plan or even invest in marketing plans and other things. So, in this moment I would say that the role of the cooperatives (for her main goal) is not achieved totally. At least exists the depurator of CARA, otherwise the producers wouldn't have a place to depurate, to tag, and to certify their products. It's not legal to sell it without the package and the tag.

The associations still do some work defending the resources but its decreasing since the government doesn't give any opportunities to discuss.

**Are you and your father also part of one of those organizations? Are you obliged to be part?**

My father is the president of APAA (association) and CARA (cooperative). We are not obligated to be part. It should be like this in order to be able to use the depurator since it belongs to the cooperative.

But this would create a big problem for both producers and for the cooperative. For the first ones, they don't have any other place to depurate, and for CARA, if they don't open the doors to others they can't plan the work and the expenses for the motive I said before.

**Do the members have advantages and what kind?**

*Cooperative*

This is an organization with profits where every co-operator should participate with the work and give his product to the cooperative to sell. That means that the cooperative manages all the production, builds infrastructures for everyone's use, has marketing planning and so on. But the most important: it can control the market prices!

*Association*

An association generally doesn't have any profitable activities and it can make hundreds of things like helping with EU projects, giving some juridical support, defending what's best for the region and much more.

**If there are any problems in your work (e.g. with dredging, pollution, administration..) how can they express/articulate themselves to the responsible bodies?**

It can be the cooperative or the association to express their opinion. Normally a single person is not invited to discussion groups or meetings but you can write a letter to the responsible body that you need to address your problem. But they are very partial (biased).

**ANTÓNIO LABOIA, Actual president of the association VIVMAR and fishermen (shellfish culture).**

(Translation of a Portuguese student into English)

**To 1-3)**

In Ria Formosa naturally occurring species that are exploited are *Ruditapes decussatus*, *Tapes aureus*, *Venerupis rhomboides*, *V. pullastra*, *Ostrea edulis*, *Mytilus* sp., *Solen marginatus*, *Cerastoderma edule* and *Upogebia pusilla*. There also are fishes from the Sparidae-family and there are some crabs that are used such as the endemic crab called "Caranguejo de boca" (*Uca tangeri*).

From my point of view and concerning my job with the mollusks, *R. decussatus*, *Ostrea* sp. and *Solen marginatus* are the most important species in terms of quantity and they are captured from special sites in the lagoon where they feed and grow ("vivieros"). These species are also the most important in terms of an economic profit. The oysters are usually sold to Spain but the other two species have a nice price in Portugal. For instance, the price of *R. decussatus* is about 14 €/kg and *S. marginatus* may cost 5 € (normal) and 10 €/kg (without the shell).

**To 4)**

The total area of "viveiros" is difficult to calculate because this is not a specific area but many scattered places from Faro, Tavira Olhão and Fuseta. The areas are like 2000 -12000 m<sup>2</sup> large or even larger.

**To 5+6)**

I think that all species that are used in the present will be used in the future since Ria Formosa is a nursery place for many different species.

**To 7)**

The problems that are affecting marine bio-resources are, at first, the pollution and, at second, the removal of sand from the Ria for civil construction. The illegal captures of mollusks and fishing by means of beam trawling can also present a problem.

**To 8)**

There is no problem related to over-exploitation, except for *Solen marginatus*. This species is could be over-exploited by scuba-diving but the port authorities (who are the bodies of control) are trying to look at this kind of divers. In order to avoid over-exploitation of marine resources there is a restriction on building any more “viveiros”.

**To 9+10)**

There are some conflicts with a multinational industry called “IDAL” in Faro because sometimes it seems that they send industrial sewage into the lagoon. Particularly in summer time when most of the tourists come to the Algarve pollution problems are increasing. There is another problem related to tourism that is the capturing of larger quantities of bivalves by fishermen for the selling on the market. If the tourist by itself came to catch some organisms for self-eating that would not be of a problem at all.

**To 11)**

Concerning the economic efficiency and the business for the local people, the “viveiristas” sell *C. edule* every day and for *R. decussates* they receive around 1000 €/year. They are also responsible for the exportation to France, Italy, Spain and Germany.

The business of VIVMAR is also responsible for the local economy because it is an association that helps those who are able or not able to sell the bivalve on their own. This association has 500 associated people and it has a direction. I am the actual president and have been retired from a public job. (The other person who was in the room is married with the lady that is the secretary of VIVMAR. Both of them are partly responsible for Laboia’s presidency.).

**To 13+14)**

As an independent society we say what should change or not without any problems. However, this association also contributes to the legal employment of the people who capture marine bio-resources. This association is more related to legal and bureaucratic questions than with processing of the organisms.

**To 15)**

VIVMAR gives licenses to the fishermen that apply for being an associate. If someone asks for a subscription at the office for being associated, the direction analyses the life of the person and decides if he can or cannot be an associate.

**To 20-21)**

For me the most important activity is the one that is directly related to my business because it is something that is performed the whole time of the year. Tourism is also important out of the economic point of view but it doesn’t occur all year round.

The main objective of the association is to create a solid relation between tourists and “viveiristas” to ensure that the Ria will be more protected. Nowadays we take students and sometimes tourists to visit the “viveiros” and we try to do a kind of an environmental sensitization. Personally I think that tourism could be important for this aim.

Conflicts are with sand extraction.

**To 22)**

It will be interesting to reuse some traditional arts to capture species like “Xalavar” (a special type of a fish trap) and “Faça”. Some other fisheries’ arts like dredging by hand will probably disappear because they are less selective.

**To 23)**

As far as I am concerned, the perception of the use of the marine bio-resources by the society is very well since in Portugal a lot of people live along the coast where they are exposed to a very strong marine influence.

**To 24)**

As far as I am concerned, in general the actual usage of marine bio-resources in the Ria is a sustainable one. To avoid that it gets unsustainable one day they should not permit any more “viveiros” and just the people who are holding a license should be able to capture because they know or at least should know the minimal sizes that they can capture. By legislation no capturing of juveniles is allowed.

**To 27+28)**

My vision about future is a realistic one but I believe control has to be reinforced. As far as I am concerned, the extraction of sand should completely be shut down as well as with the enterprise “IDAL”.

***Annex of the Portuguese-English translator:***

“During the whole interview he repeated some points which I think might be interesting such as the importance of ensuring quality of the products (e.g. *R. decussate* and *S. marginatus*). Weekly they go to the laboratory of IPIMAR for being analyzed. The other thing that he was enthusiastic about and what he repeated several times with severity in his words was- that no matter how hard it would be- they should protect the meeting place/the pub of VIVMAR with all its peculiarities and characteristics.”

**JOÃO NAVALHO, Enterprise “Necton” – Companhia de Culturas Marinhas, S.A. (Company of Marine Cultures)**

→ Administrator of the enterprise “Necton” where the traditional production of salt as well as the extraction of the high-quality “Flor de sal” takes place. Moreover, microalgae are produced for cosmetics and fish feed

**General explanation about “Necton”**

Our company was founded in 1997 but we before we had already started with the research. Originally we started the company for the production of microalgae (favorable circumstances → high solar radiation). Thus we were looking for the algae in the Salinas that were abandoned and then we started to re-establish the traditional way of salt production since it is a very valuable resource that can be exploited in the Ria Formosa. This salt is very different from the one that is produced in the transformed commercial Salinas since it is harvested by hand and still contains almost all of the minerals of the seawater. It is sold on the “ecological” market and the “Flor de sal” is used by gourmets.

**How large is your business and how many people are employed here?**

We have an area of around 12 ha and there are altogether 12 people employed (salt and microalgae-production).

**What about your production?**

Concerning salt we have an approximate production of 150 tons/year of the traditional salt and around 16 tons/year of the “Flor de sal”. We are also buying the salt from some neighboring Salinas and packing it in our plant. The price of the traditional salt is about four times higher than the one that can normally be bought in the supermarket. The price of the “Flor de sal” is around 20 times higher. However, the production of the microalgae is more profitable than that of the salt.

**Explain about the production of microalgae?**

So far we are producing two different species: *Nanocloropsis oculata* that is sold to the hatcheries for sea bream production and other species and *Phayodactylum tricometum* that is used for cosmetics. Every day we can harvest around 25 % of the microalgae produced, using a centrifugation system, and 75 % rest in the culturing facilities.

**Talk about the involvement in a European project**

We are involved in a special program that is called “Animação local para desenvolvimento e criação de emprego na Ria Formosa” (Local animation for the development and foundation of employment in Ria Formosa) that is part of the European program called EQUAL. In this program, we teach about the traditional method of salt production like it was performed some 1000 years ago. The idea is to produce again and bring something out of the Salinas because it doesn’t make sense to leave this area abandoned. Thus, we try to gather all the information that is available in order to keep the knowledge so that it won’t be lost. Imagine that the last book we found that was written about salt production was from 1940 but there it is explained how to transform an ancient Salina into a commercial one. We want to do it the other way round because the salt that is extracted in the traditional way is much purer and whiter than the one produced in the commercial Salinas. Around 80 different minerals are conserved in this salt.

**To 1-4) particularly asking for fish culturing**

There is “Timar” as an intensive producer and two bigger ones, “Aquamarin” and “Piscicultura Fareense”, which produce in a semi-intensive way. Apart from that there are a couple of few small producers (semi-intensive). Fish is not so big here. This kind of aquaculture was very famous in 1990/95 and a lot of people put a lot of effort to that business. There were EU funds to invest in aquaculture but the problem was that most of the people were not good enough to get the business run, they didn’t know about the technique which is necessary in this business. That is why now people don’t invest any more in the aquaculture business.

In general, in our country there is too much bureaucracy. If you don’t know how to move you don’t move at all.

With our own business we don't do ordinary things. At first, people were thinking that we are crazy when we tell them that we are cultivating microalgae and extracting salt in the traditional way. And we have good relations with the people and the concept of the park. We take care of the environment and promote the traditional way of doing it, furthermore there is no pollution originating from our activity. The park wants this resource to be work, thus, there is a coincidence. And there is no kind of pollution originating from our business. We are even helping to conserve the natural bird fauna that stays near the salt ponds.

**To 5+6)**

Before we tried the culturing of oysters but we didn't find it so profitable. No we are already performing some pilot projects with the university of the Algarve about the production of *Sepia officinalis*. Concerning algae we are testing several species in culture.

**To 7)**

For our business water quality is vital, thus, we are very much afraid about a pollution of the water body. So far everything seems to be o.k. even though it can be detected a slight deterioration from the increasing boating activities in the Ria. There is more investment taking place in the sector of tourism and not so much in industry. However, we are concerned about the possibility of an accident of the large ships that are going to Faro in order to unload the fuel. There would be a big problem if something happened here.

**To 9+10)**

Concerning the exploitation of marine bio-resources I believe that the biggest problems are related to construction activities in the Ria but also to the increasing sporting and leisure boat activities that are taking place. People from the clam cultures also say that the salt production destroys their culture fields but I don't know why they say it.

**To 11)**

I think they are very important.

**To 13)**

I believe the effects are more positive than negative as long as it stays in a sustainable way.

**To 15-19)**

Apart from the licenses that are necessary from the park authority for the use of the land and from the DGPA for the activity it is needed the general licenses that are necessary to establish a firm.

In order to sell and to promote our high quality salt there is the French certification agency "Nature et Progrès" coming once a year for the controlling of the water quality and the whole production chain. We are also sampling our water since we depend very much on its quality.

**To 23)**

I think they are not aware of our business so far, at least not about the salt production. They think we do crazy things but they will probably be aware of it later on. I hope, there won't evolve a problem but people could start selling a non-qualified product but advertise it as a high-quality product. This would certainly change the image of the quality of the Ria Formosa salt.

**To 24)**

I think so but I am not the right person to ask this question because I am working in a slightly different sector. However, I think that the clam banks are still o.k.

**To 25)**

There is needed a much more order to keep the Ria clean. People still see the Ria as a garbage place and you can see that there is a lot of waste thrown away. The Ria could be much better used for ecotourism. For example, we will start to have visits during the time of harvesting the salt, we want to make a small business out of it, showing the people the traditional way of doing it, explaining everything, and at the end they can sell the product on the spot. In general, the project that we have been talking about earlier tries to integrate more of these things. For example, people can be taken to the "viveiros" to show them the way of culturing. So far, there exist just a few boats that are picking up the people to show them a little bit of the Ria but there could be done much more. So far, the environmental quality is quite good because of the high water exchanges of the system and because of the introduction of the treatment plants (in Olhão, for example, in 1987). But, however, there will be problems if the activities are rising any further. In general, there is only very little control which just exists on the paper (e.g. for sand extraction). I hope that this will change in future.

**To 27+28)**

People with ideas have to start small companies that are related somehow to ecotourism. For that there is needed a lot of organization, some kind of investment and the necessary contacts. It is a hard business but I think it will have future. We need more people that start to put the things.

Concerning our business, we want to expand our influence but not certainly so much in size. Within the above mentioned project we will start to recover a traditional Salina and teach to some people how to extract salt in the traditional way of manner up. This course that will start at the end of August will take one year in order to follow the whole production cycle and will be directed to six people because

we think that for this six people there will be work afterwards. We will start the development of the Salina, teach them the technique and we will we will make a contract with them that we buy their product afterwards so that marketing and distribution will be guaranteed. In the Park there will also start a one-year course about eco-tourism, which will teach to 15 people about all the necessities for this kind of labor.

### ANA AMARAL, Formosa Cooperativa of viveiristas of Ria Formosa

→ Marine biologist and now working as a technician in projects to better implement the commercialization of the products

#### **General talk**

There exist many different ways to commercialize a certain product. Concerning bivalves there is the main problem in the Ria Formosa that there are far too many intermediate steps between producer and consumer. Our objective is to better organize the producers so that a better commercialization of the products can take place. The price of the end products should then reflect its quality.

#### **To 1-3)**

Concerning bivalves in terms of production and exploitation there has to be mentioned *Ruditapes decussatus* (clam), *Cerastoderma edule* (cockle) and the oyster species *Crassostrea angulata*, *C. gigas* and *Ostra edulis*. Our native oyster species is that of *Crassostrea angulata* (Ostra portuguesa).

However, in the 1980s the pacific oyster *Crassostrea gigas* has been introduced and there are now a lot of problems with this species as it is more resistant than our native species *C. angulata* and has gained terrain. There is also genetic interchange between these two species taking place. There are now two natural banks of *Crassostrea gigas* in Portugal, one of them is situated in Ria Formosa. In terms of the economic profit we have to mention *Ensis* sp. (*Ensis ensis* and *Ensis siliqua*) since here the selling price is around ~20 €/kg. However, this species has not been cultivated so far.

#### **To 5+6)**

I believe that *Ensis* sp. could be cultivated but at the moment it is not necessary since there is still a great abundance. However, in a few years the stock will be decreasing because there is a lot of illegal activity (scuba diving) for this species taken place and tones of this species is caught due to the high market price.

#### **To 7+8)**

The main problem that we see is the decrease of stocks in the natural banks because these areas are not protected. Thus there is taking place an over-exploitation of the natural stocks. Some of the natural areas are much degraded and consequently the survival of juveniles is not very high. During my last investigation (data not published). I have found out that the condition-index –that is the physiological condition of the organism– was better in bivalves of the ground-plots (“viveiros”) than of those from the natural areas. This is probably related to the fishing activities that are higher in the natural areas than on the ground plots.

#### **To 11)**

Around 90 % of clam production takes place in the Ria Formosa but the general problem is that the producers are not compensated for the work they do. Here in Ria Formosa it is not a professionalized sector and a lot of people working in clam culturing or harvesting have a second job. Because a lot of producers don't want to pay the taxes they don't declare the total production. This causes a lot of problems in terms of political decisions: If the production numbers are low no kind of further investment takes place since production seems to be of little importance. Furthermore, if there are high mortalities of the stocks such as it happens some years ago we can't help the producers when they complain about the quantity they lost because these data are not official. In general, the official production data have to be multiplied by a certain factor and I believe it is even more.

One of the goals of our project is the construction of an own hatchery so that all the problems that are related to the importation of seeds (high costs, introduction of diseases, transportation etc.) will be improved. Our native species *R. decussates* is quite difficult to produce in hatcheries so that there is a large import of seeds of *Tapes philippinarum* (produced a lot in Spain) which in general is more resistant. We have to stop this introduction because we want to keep our high quality product of *R. decussatus* even though it is less resistant.

#### **To 12)**

There are no realistic data but I believe that in the whole Ria there could easily be directly employed more than 15,000 people.

#### **To 13)**

I believe it is important and it could be positive but there has to be improved the production line. Shellfish merchants (intermediates) –there are around 7-10 of them for our region– would buy the clams at a price of around 15 €/kg but sell it for around 40 €/kg elsewhere. In turn, in our

supermarkets there can be bought clams that are imported from Spain or other countries (see also answer..).

**To 14)**

Concerning bivalves there is only depuration taking place on the spot. But even here it happens that depuration does not take place in the local depurators but that it takes place in other regions or even countries. Then, labeling of the products takes place with the labels of the respective country so that the origin of the species, being a product of Ria Formosa is concealed.

**To 22)**

In terms of clams it is a traditional activity and it has been discovered that already B.C. some kind of clam production was already taking place. The art of cultivation is still the same and has not changed much. The harvesting of the bivalves still takes place by hand with some form of a knife.

**To 24)**

Now it seems that it is sustainable again but some years there was too much exploitation taking place. They used to catch and sell more juveniles than today. For *Ensis* sp. it will not be sustainable on the long term because nowadays too much of this species is collected.

**To 26)**

From my experience, fisherman are aware of the current situation and they really would like to get more scientific information in order to know more about the species they exploit. I am trying to make a link to them in a practical way, e.g. giving little seminars to explain all about the natural reproduction and the biology of the species.

**To 27)**

It is important to invest more in this sector and to make more political decisions in order to protect the environmental conditions of the Ria Formosa. This is particularly important for the summer time because then there is a large increment of tourism in zones that are directly linked to the Ria. In general, the surrounding cities don't have enough capacity for any sewage water treatment.

**To 28)**

It is very important to create protected areas where there is taking place a high natural production. Supervision and control has to be increased. A lot of fishermen don't have licenses and inform themselves if the water police is around. Probably, more concessions should be given for ground plots ("viveiros") so that the production could be increased. The Ria Formosa is a very productive lagoon and bivalves are great organisms in terms of a high filter capacity.

## WADDEN SEA AREA OF LOWER SAXONY, GERMANY

### MANUELA GUBERNATOR, Managing director of the "Niedersächsische Muschelfischer GbR"

→ Worked on a project on socio-economics of coastal fishery in the Wadden Sea National Park; now representing the interests of the coastal fishery on the advisory board of the Wadden Sea National Park of Lower Saxony

#### **About species and fishery in general**

In Lower Saxony only blue mussels and shrimps are economically used. There is also permitted the cockle fishing, however, this business is not practiced any more. In Lower Saxony this fishery was banned for political reasons in 1992 because the exploitation of this species had become a controversial issue and environmental pressure had grown too much. Now it is not performed any more even though it is legally allowed.

On contrast to, for example, Spain or Portugal, there is no aquaculture being performed on the coast. There are some experiments with long-lines performed for the purpose of gaining seed mussels. I believe that other shellfish species such as razor shells, as well as algal species could potentially been exploited, but, however, you need a market for this kind of business. *Spisula*- fishery could also have a potential role in fishery but is only performed by the fleet of the Netherlands.

Concerning blue mussel fishing, there are four companies with altogether five trawlers, one at Greetsiel, two at Norddeich and one at Hooksiel. In Lower Saxony the performance of this activity is not bound to licenses (no system based on licenses) but there is needed an authorization to hold (invest in) a culture plot. The main difficulty has been a drop in the abundance of eulittoral mussel beds at the beginning of the 90s and thus since 1998 a Management Plan ("Bewirtschaftungsplan") for mussel seed fishery is in force which is currently revised.

Shrimp fishing embraces trawlers of the "mixed coastal fishery" that is plat-fish species (e.g. *Solea solea*, *Pleuronectes platessa*) and shrimps (*Crangon* sp.). These types of boats have a length of 16-20 m and can perform both kinds of fishery according to the time of the year and the species available. This mixed coastal fleet is structured fairly simple (in contrast to the more progressive and also more

aggressive fleet in the Netherlands) and is around 35-40 years old. In Lower Saxony there are 120 trawlers sharing 17 harbors and there are altogether 19 customers for this business (in the Netherlands there are 80 companies). Concerning shrimp fishery, there is no management on regional or national level and there is only EU-legislation that regulated this business. In former times, shrimp fishery was exclusively performed for the purpose of getting animal feed. Today it is a local delicacy and very attractive for tourism.

In general, the spiritual aspect within the fishery sector is very important among the fishermen on the coast of Lower Saxony. We can talk about very self-confident people. The maintenance of this sector is regarded to very important since apart from tourism there are not many further things taking place.

#### **About Problems**

The main problems concerning the exploitation of this two main species are user conflicts within the Wadden sea area. The greatest disadvantage that the Lower Saxony part of the Wadden Sea area has to face in comparison to the other areas of the Wadden Sea can be attributed to the fact that there are far more dredging activities taking place. Here, the three main rivers Elbe, Weser and Ems are flowing into the sea and for the purpose of maintaining the depression in the estuaries a lot of maintenance works as well as the dumping in the sea of the debris dug up by the excavator are carried out. Consequently, the stability of the seafloor-sediments that is necessary for the development of mussel beds is lowered and the landsliding of silt is taking place, leading to an overall decline of areas available for the development and existence of natural mussel beds. Furthermore, the use of harbors is quite intensive and the main shipping channels are running alongside the Lower Saxony coast. Apart from being a constant threat for the ecosystem and consequently the health of the fishery sector, these shipping channels are potential fishing areas where it is not allowed to fish. There is a major concern about the deep-water harbor planned in Wilhelmshaven ("Jade-Weser-Port") because further fishing grounds will be lost. The same negative effect will be caused by the planned Offshore-Windparks. With tourism there is quite a good nature since the trawler harbors are very attractive for visitors and there are also offered trips with the typical boats every now and then.

Problems with nature conservation always depend on the actual political situation. The fishery sector has always been exploited as a political issue in order to push through any kind of decisions or changes. I think at the moment the actual situation is quite acceptable. However, there is always friction with nature conservation about points concerning the selectivity of the gear, the general removal of biomass and the change of the flora and fauna of the seafloor caused by fishing.

In general, there are difficulties in terms of the rising bureaucracy caused by the many EU-legislations. These legislations usually don't take into consideration any regional differences.

#### **Employment and socio-economics**

In the mussel fishery sector there are altogether employed 18 people (including me). Most of the production is directly sold to the Netherlands and there is no processing taking place on the spot. In the shrimp fishery there exist around 120 trawlers. Per trawler there can be estimated a further four (direct) working places in the harbors and in whole Lower Saxony a further 12 indirect working places (supplier business, maintenance of the vessel etc.). Even though the fishery sector can be considered as economically stable, there are some problems with young professionals. To around 99 %, recruitment takes place out of the own families. This kind of activity is not very attractive because it implies around 18 working hours daily.

Most of the products fished in Lower Saxony are traded in the Netherlands. The Netherlands are the central point concerning commerce, partly due to the geographical position that is somehow closer to the main sales areas in the North as well as to Belgium, France and Spain. In the Netherlands people are "born dealers". Their principal of auction which is in contrast to our principle of cooperatives has promoted the development of wholesalers who are pushing this sector. Only shrimps are partly being (processed and) commercialized in Lower Saxony, but mussels are exclusively sold to the Netherlands where commercialization takes place.

#### **Legislations and management**

Of major importance for the fishery sector are the new Wadden Sea National Park Law of Lower Saxony, the Küstentischereiverordnung of Lower Saxony (Nds. FÜFischO), the Niedersächsisches Fischereigesetz (Nds. FishG; "Fishery Law") in its actual version since 1978, the Lower Saxony Blue Mussel Management plan and EU-legislations such as the law concerning market structures.

Management of the blue mussel fishing in Lower Saxony is performed as follows: At first the four mussel fishing companies join together every year in order to have a look at the status of the mussel banks in the eu- and sublitoral and tell me if and which of them seems to be interesting for seed mussel fishing (seed mussel fishing is only allowed in spring and autumn until a shell-length of 4 cm). Secondly and on the basis of the communication of the fishermen, I have to formulate a written application to the State Fishery Office in Bremerhaven, the representative of this office has to evaluate the application by means of looking at the mussel beds and then there is made the final decision if and which mussel beds are allowed to be fished by the State Fishery Office. In accordance with the four

companies, the mussel beds opened for fishing are justly divided between the companies (unambiguous division by means of visible devices, black-box surveillance). The management of the culture plots (around 30 in Lower Saxony) is then at the responsibility of the fishermen. Harvesting and selling is allowed up from 5 cm shell-length.

The selling of shrimps is only possible via producer organizations.

**What are the main aims/ visions for the future and how could it be realized?**

The main aim for the future is to maintain the sector of fishery in such terms that there exists a future perspective for the fishermen. For that, direct commercialization would be a desired aim. At the moment, most of the money is realized in commercialization (most of it taking place in The Netherlands) but profit-margin should be distributed much more to the producer, that is the fishermen. However, the kind of marketing structure described has been grown for many years and I am not quite sure how to break it, but it would be desirable for the future of the fishermen. I believe it could be practicable somehow.

Moreover, the guidelines for the measures concerning cultivation and fishing of seed mussels should be more flexible. The Wadden Sea is a very dynamic system and there are a lot of problems with rigid regulations. Very often, the official period for seed mussel fishery fixed by law does not suit at all to actual climate conditions or the state of the mussels. For example, in the Nds. KüFischO it is stated that seed mussel fishing is only permitted up from the beginning of October when the official catching period starts. Then, at first sublittoral and only after that eutlittoral beds should be fished but usually we don't even get to that point due to the early beginning of stormy weather conditions in the autumn. Hence, there is urgently demanded a change of the current legislation that allows a more flexible handling. Fishermen need to fish the seed mussels when they are abundant and have the adequate size and not when it is foreseen by the respective legislations. Principally, the fishermen should be given more flexibility to work within a general framework and they should have more voice in the establishment of such a framework. With the concept of a co-management it could be practicable.

**How do you see future reality?**

I believe that the marketing structures of The Netherlands won't break away and hence the career of fishermen will get even more unattractive than it already is. Furthermore, we will have to cope with increasing bureaucracy and fishing grounds will be ceased to exist due to the many user conflicts in the Wadden Sea. The fishing fleet will decline and only the most competent shipping companies will be able to exist; family structures (boats with 2-3 people) won't exist any more.

In general, the career will be less profitable since the high prices achieved through commercialization of the final products (taking place in The Netherlands) are not reaching the producers.

Direct commercialization is a question of image and would certainly be favorable for the fishery sector in Germany since direct selling attracts more people.

**PETER BRECKLING, Executive manager of the German Fishery Association ("Deutscher Fischerei-Verband"), Hamburg**

**General talk on fishery management**

The fishery policy of the European Union has a large influence on all aspects concerning fishery in the member states, however, not so much on the mussel fishery. Very important for the current management of the fishery sector is, among others, the Council Regulation (EC) No. 104/2000 on the Common Organization of the Markets (COM) in Fishery and Aquaculture Products. One of the main objectives of this regulation is the establishment of Producer Organizations (PO's) which are principally created in order to guarantee that any kind of fishery is carried out rationally and that conditions of the sale of their members' products are improved.

**About the "Pesca"-project**

Concerning shrimp fishery, at the beginning of the 1980's, a trilateral cooperation between the states Germany, The Netherlands, and Denmark was first considered to improve the situation of the market. An EU project was started at the end of the 1990's called "Trilateral Cooperation and Networking of North Sea Shrimp Producer Organizations" of which the Chamber of Agriculture in Weser Ems has the overall responsibility for the project and coordinates measures undertaken by the eight participating PO's of the three member states. One of the main goals of this project was to found a recognized association of producer organizations. Even though the project could not be concluded as planned with the signing of a binding contract due to objections imposed by the Dutch authority and, later, on by the German and cartel office, the voluntary agreement between the eight participating PO's gives an example and a perspective on how a future trans-national cooperation could look like.

**About the capacity limits of the cutter fleet**

The European Union has determined the extent of the fleet of each member state. The general reduction of the European fishery fleet is among the principal aims to reduce overall fishery effort. Until 2002, separate segments of the German fleet (e.g. offshore fleet) still existed, but, however,

since the beginning of 2003 this kind of differentiation between the fleet segments does not exist any more. Now, there is only one “national fleet” and each member state has to decide on his own in which part of the different segments reduction has to take place in order to comply with the demands of the European Community. As a consequence, if the construction of a new cutter is demanded, an old cutter has to be scrapped.

**What are your visions/targets for the future?**

My vision on the fishery sector of the Wadden Sea is not very far away from the status quo. The main aim is to establish a competitive fishery in the long term, that means fleet-size and the amount of companies should persist. Competitiveness is of particular importance with regard to the neighboring countries.

A certain regime of nature protection is needed. This is also supported by the fishery sector, since –similar to the sector of tourism– fishermen are aware of the fact that they need an intact environment for their activity.

I would like to see more emphasize on the country’s cultural identity with the sector of coastal fishery. For example, this could be achieved by more activities/presentations on fishery within the region. There could exist, for example, something like a “Road of North Sea Shrimps” that goes along the coast through the little village. In the village of Dorum, for example, there is a plate with a North Sea shrimp above the sign of the village, reflecting a certain kind of identification. I also wish that the representation of fishery (the lobby) generally showed more presence such as it is performed by Mrs. Gubernator for the mussel fishery. Nature conservation associations already know how to do that. Furthermore, coastal areas should be displayed as a preference area for the “small” fishery. However, for this an actual planning process that guarantees such a determination would be needed.

**How do you see future reality?**

Actually, I think that we are moving into the above described direction. Socially viewed, nature conservation is “retreating” a little bit, that is, it is not overall prevailing any more and other sectors are also gaining more importance. But, however, if the sector of fishery wants to maintain or even strengthen its identity and importance in coastal areas, it has to show more presence and do something for its image.

As far as I am concerned, coastal fishery is not endangered but will stay an important economic factor along the Lower Saxonian coast.

**DETLEV GAUMERT, Head of the fishery division (“Referatsleiter“) in the Lower Saxonian Ministry of Agriculture**

**What are your visions/targets for the future?**

The main aim is to maintain the existing structure like they are, e.g. to maintain the existing companies, unless a company mismanages and is in the red. The connection between tourism and coastal fishery has to persist since otherwise the coastal zone will lose a large part of its attractiveness for the visitors. Coastal fishery is largely contributing to the “maritime flair” of the small villages and can be considered as a touristic highlight. This is also viewed by the representatives of the respective communities and has, for example, been demonstrated by a strong agreement between representatives of the communities and the fishery sector during the amendment of the national park law.

**How do you see future reality?**

For me, both types of fishery, mussel and shrimp fishery are very traditional branches which will persist in the actual frame. Due to EU-legislations we can’t expect any kind of increase in capacity for the actual fleet. Generally, a promotion of the regional fishery sector is very difficult to perform since the EU does not make available financial help for that. For example, a promotion of East-Frisian shrimps is not possible since according to the EU no advertising of regional products is allowed. Thus, shrimps of Greetsiel would not be eligible.

At present, there is actually being performed a study about the coastal fishery in Lower Saxony where future perspectives are outlined (to be finished at the end of the year). Therewith, we expect to strengthen coastal fishery which is particularly important due to the many existing user conflicts within the 12 sm zone.

Particularly concerning mussel fishery, there will not take place any kind of enlargement of the fleet either since at the moment results show that mussel fishery performed in Lower Saxony is sustainable. In comparison to the situation in The Netherlands, where many more mussel vessels are operating in an area of similar size, the relation of vessels towards total size of Lower Saxonian Wadden flats is certainly favorable along our coast.

**WOFLGANG HAGENA, State Fisheries Administration Bremerhaven**  
Director of Fisheries for Lower Saxony

**To 1-6)**

There is only exploited commercially the blue mussel, *Mytilus edulis* and shrimps, *Crangon crangon*. *Crangon crangon* is fished within the whole Wadden Sea area and until two to three years ago more than 50 % of this fishery was performed by the German fleet. Now, it has been surpassed by the Netherlands. Cockle fishery (*Cerastoderma edule*) has been performed until '92 but is forbidden since then. Apparently, this kind of fishery has been destroying the floor of the Wadden Sea and thus nature conservation pushed through the stop of this kind of fishery. In that time there only existed one company anyway. Cockles are very much demanded in Spain and Portugal, thus in terms of the biomass available in the Wadden Sea this kind of fishery would be profitable if there weren't the restrictions. It still is legal in the sublittoral outside the Wadden Sea Park area but, however, this species is occurring more in the eulittoral and thus a fishery under the current conditions is not promising.

*Spisula* fishery and also the fishery of razor shells could be introduced again but in terms of nature conservation it would be a problem. In The Netherlands, *Spisula* fishery is taking place, and if we introduced it again in Germany again, changes in the EU-regulation for capacity ("EU-Kapazitätsregelung") would be necessary. However, stocks in the offshore area are available.

*Buccinum undatum* has been fished until 1974 in Lower Saxony but there was a catastrophe with Tribuzyl-zinc which caused a great collapse of the stocks. However, fishermen never really went into this kind of fishery and it has been forbidden in the Nds. KüFo which only states *Mytilus edulis* and *Cerastoderma edule* as the species that are allowed to be fished. If other shellfish species were to be exploited, the KüFo had to be renewed either including other species in the list or by generally broadening the current legislation.

Concerning oysters, aquaculture of the species *Crassostrea gigas* is performed in The Netherlands and to a small extent on the island of Sylt. However, this species is already occurring in wild stocks in the Wadden Sea area and there is the great threat that it will deprive the blue mussel of their basis for food. *C. gigas* is not so ideal to bring to market since the shell to meat ratio is fairly high. However, during summer time, the time of the year when the main harvesting of the cultured oysters takes place at Sylt, this species is very much favored by the tourist.

**To 7)**

Concerning mussel fishery, the constant recruitment of the larvae is a big problem for the fishery. Only in strong winters a good recruitment can be expected for the following years and can signify the backbone for the yield in the following years. Therefore, the yearly recruitment can be considered as the "bottleneck" in the mussel fishery. Generally, we have no problems concerning diseases or robbery taking place.

Concerning shrimp fishing, there are problems due to the rising competitive use of areas in front of the islands such as the extraction of gravel and sand, cables and pipelines and the planned offshore windparks. All lead to a decreasing availability of areas that potentially could be fished...and this trend is rising.

**To 8)**

There are no problems with over-exploitation concerning the respective two species. Both are relatively short-living species and have a high reproduction potential. Moreover, In the Wadden Sea there do not exist any shrimp-consuming fish species any more so that there is no pressure from this side. Thus, generally there are no problems at the moment but this situation could change very fast due to changing hydrographic conditions. For example, if the autumn is cold, shrimps are migrating towards greater depth earlier than usual. This implies that smaller vessels (around 14 m) can not follow the migration and have to finish the fishing season earlier in the years. In general, shrimps are staying in greater depth in the winter and during summer time also in more shallow depth. However, shrimps of the best quality are caught in the period August/September to April/Mai since during the rest of the year shrimps are occurring in the more shallow depth of the Wadden Sea where due to food availability (microalgae) the quality of the meat is considered to be of less value (pale color).

**To 11)**

The coastal fishery is a very important economic factor for the coastal region since apart from tourism there is no major source of income. There is a strong synergism between tourism and the fishery sector since the villages and harbors on the coast live on the visitors who are coming to see the typical fishing vessels and who want to eat the fished products in the restaurants. That is also the reason why there is support by the municipality authorities.

**To 12)**

At present there are 145 vessels (companies) for shrimp fishing, employing around two people each (captain and one crew) and in the mussel fishery there are four vessels with three people each. Thus, currently there are 302 directly employed in coastal fisheries in Lower Saxony at present. Even though shrimp fishing is part of the so-called mixed fishery of coastal waters (shrimps and flatfish species), the fishing of flatfish is of no significance any more.

Marketing of mussels takes place in The Netherlands to 100 %, thus, there are no further indirect working places. With shrimps, marketing takes place to a large extent in The Netherlands as well but not exclusively, thus, some indirect working places are related to this kind of fishery in Lower Saxony. The hand peeling of shrimps takes mainly place in Poland and Morocco and there is only one cooperative in Neuuharlingesiel that is performing peeling of shrimps on its own by machines. Generally, no hand peeling takes place any more (economically not profitable).

**To 15)**

In general, mussel fishing vessels need an approval. Shrimp vessels are regulated according to a given capacity (e.g. kW; BRT=Brutto-Register-Tonnen) and if, for example, a fisherman wants to enlarge his vessel he has to buy more of the kW capacity but at the same time capacity of the fleet has to be reduced somewhere else (EU capacity regulation). Here, a general license as well as a special one concerning the fishing gear ("Baumkurre") is needed.

Concerning the culturing plots for mussel bottom cultures, the respective areas are opened by a procedure of administrative law once ("Verwaltungsrechtliches Verfahren"). Usually, these plots are opened for a period of five years but usually once having the approval they are actually opened for an unlimited time (extension of the approval is necessary before the old one expires). In total, in Lower Saxony the upper limit for areas that can be used as bottom cultures for mussel seeds is determined at 1300 ha.

In order to organize the market, the producer's organizations have to work out a plan for the catches ("Fangplan") and thereupon get public funds.

**To 18)**

The bodies of control are us but we are only having an insight into the situation in Lower Saxony. The highest authority concerning fishery is thus situated in Hamburg (German Fishery Association).

**To 19)**

Concerning mussels, national legislations are still more relevant than international ones. There is, for example, the blue mussel management plan for Lower Saxony. In general, orders of the European Community (EC) are converted into national law. However, there are a lot of problems with the many EC orders. They are constantly revised and changed and a lot of them actually are missing their target thus, are going into the wrong direction.

**To 20)**

Tourism will most certainly be the most important one but at least in Bremerhaven and Cuxhaven there are situated a lot of fish-processing companies with many people employed even though direct landing of seafood is taking place only to a small extent. Bremerhaven is the largest import harbor for frozen fish.

**To 22)**

Well, concerning the fishing of consumable shrimps there has been observed a rising motorization since the 30s. Thus, for example, until the 1950s the vessels were equipped with a 50 PS motor and now the strength of the motor is at more than 300 PS. In the past they used to fish with only one net, now fishing is performed with two nets. Mussels used to be harvested by hand-forks but since the 1950s dredging and other nets are being used for the harvesting activity. In general, both fishing activities are quite conservative but dimensions of the fishing methods have been growing.

**To 23)**

Shrimp and mussel fishing is tolerated and even considered in a positive way. Awareness has been growing about the importance of seafood as a protein source (mussels are high in protein and low in fat). However, there are a lot of Portuguese people employed in the shrimp fishery because there among Germans this kind of work is not very much appreciated. Thus it can be seen that in countries such as Portugal but also Spain or France the business and labor around seafood generally appreciated to a higher extent.

**To 24)**

Both species are used in a sustainable way and out of the point of view of fisherman sustainability is very important. But, however, competitive use of the Wadden Sea area is putting a threat to the fishery sector.

**To 25)**

Concerning mussels, a steady recruitment is not guaranteed. Hence, techniques have to be developed by means of which the bottleneck can be avoided. We can not expect to have strong winters every now and then but need a high amount of seeds every year in order to keep the mussel fishery sector going. Concerning shrimps, more could be done in terms of selecting and decreasing more the amount of bycatch even though methods have been improved a lot. However, I believe that more protection is possible which in turn would increase the position of fishery in general.

**To 27)**

I believe and I hope that it goes on like this. For me both types of fishery are very important since it is not only a source of food but also very much part of our coastal region. It is just part of it.

**To 28)**

In general, some fishermen are still lacking a certain kind awareness about the quality standards of what they are doing and sometimes they just don't care about certain things. Training for this business is being performed by the Chambers of Agriculture and I believe that at this level certain improvements could still take place.

**About actual prices**

Mussels: ~5 €/kg (in The Netherlands); in Germany, Blue Mussels of lesser quality produced in Denmark are sold on the market because Germans buy according to the prices but not for the quality  
 Shrimp: 3.50 – 4 €/kg (usually steady during the whole year)  
 Shrimp (only meat): 26 €/kg

**DIRK DE BEER, Businessmen, Krabbenhandel GmbH (Shrimp trade business), Greetsiel**

→ holder of the main business for shrimp commercialization (“Hauptvermarkter”) along the Lower Saxonian coast and primary-/ contractual purchaser (“Erstabnehmer, Vertragsabnehmer”) for a variety of fishermen

**About organization of fishermen and commercialization**

Fishermen are usually members of a so-called producer organization (PO's). This is not obligatory but a precondition for getting any kind of grant from the European Union. There are still two PO's in Lower Saxony (“Weser-Ems” and “Elbe-Weser”), but, however, there is the tendency to merge since one big one will have more weight than several smaller ones.

Every fishermen is usually bound to an own contractual purchaser (“Vertragsabnehmer”) who picks up the shrimps after landing. In Lower Saxony there exist around 10-12 altogether. Of them, around 3-4 work as a cooperative society but the others are private companies (like us). But in Lower Saxony we are the principal contractual purchasers and we market/ commercialize shrimps within Germany. Usually, 5-10 cutters are supplying one purchaser, but, however we have around 35 vessels that are fishing for us. We own some of those vessels but most of the vessels are owned by self-employed fishermen.

Since cost-effectiveness is too small, no shelling of shrimps takes place on the spot any more but only sieving and cleaning. Shrimp shelling is a very longsome labor and apart of that sanitary regulations are so strict that they can't be complied with.

Generally, most of the shrimps, that is around 60 to 70 %, are directly transported to The Netherlands, the principal bulk purchaser (“Großabnehmer”) for German shrimps (they satisfy their demand by means of the German shrimp fishery). Before, shrimp is transported to Morocco and Poland for the shelling process. Also the shrimp meat that will be commercialized by us is taken to Morocco by the largest Dutch company. This results more profitable for us.

**What is the relevance of the trilateral agreements between the producer organizations of Denmark, The Netherlands and Germans?**

At the moment it doesn't play a decisive role since the cartel office has raised an objection against the founding of a recognized trilateral association of PO's. The cartel office says that they want to have the best prices for the consumers and that by agreeing about catch-quotas the price of the product would be regulated too much (not be free to competition) even though that was not the case. However, an administrative fine had to be paid. It is somehow ridiculous since Brussels wants us to reduce fishery effort. At any case, there exist trilateral arrangements concerning catch quotas and how much of the catch can be accepted by the purchasers but there are always some Dutch companies that don't stand to the agreement.

**Main problems**

The main problem is the fact that there exist far too many shrimp cutters. According to EU-legislations, the fleet has to be reduced in general. However, the Dutch shrimp fleet is far bigger than ours. For some reason, they have kept their modern vessels but we had to reduce our fleet. Thus, there is a large inequality between the two neighboring states and no fair competition. This can be explained as follows: Since they are a “fishery nation”, they have very large companies and the whole sector of fishery enjoys high political support. Their fishery lobby is much more active than ours. Thus they have achieved that with the abolishment of larger vessels (for offshore fishing) new EU-cutters could be bought (24 m long). In contrast to our shrimp vessels, their vessels are much larger and stronger and can consequently fish in much deeper waters. Thus, where they are fishing nothing is left for ourselves. For some reason, they can fish all year round whereas our shrimp fishing is being restricted to 9-10 months of the year. Thus, the implementation of EU-regulations in the different countries differs from each other which complicates the situation, particularly if fishing grounds are of common interest.

**What are the main aims/ visions for the future?**

The sector of fishery must be maintained in such a form that it is profitable for the fishermen (otherwise it won't stay). We want the fishermen to have a future since we are very much dependent on them. It should be possible to build new vessels without any government aid. I would like to come to the harbor and see fishing vessels because it is a very important image for our village. A negative example can be seen in the coastal village of Ditzum where no more active vessels are visible in the harbor but only a "museum-vessel". This is due to the fact that fishery in the Ems is not profitable. As a consequence, the village is losing its character and, consequently, the tourists.

#### **How do you see future reality?**

Referring to Greetsiel, I believe that during the next two decades everything will stay like it is, but, there is a big problem with young professionals. At present, the youngest fishermen are around 35-40 years old. There are only very few trainees and there is little motivation for learning the trade of a fishermen (irregular work schedule) even though the income is quite good. Generally, for the Elbe-Weser area the situation is quite negative. However, we hope that this situation will change. Around 20 years ago there was a similar situation but then new professionals were trained. It is them who are actually in the middle age.

### Mollusk Fishermen of the Lower Saxonian Wadden Sea

#### **Catchwords on their work**

We like our business very much but we are not happy about the commercialization taking exclusively taking place in The Netherlands. We deliver our catches directly to the main Dutch port(s) where the value of our catch is determined according to a random sampling. Afterwards we get a fixed price but don't see anything of the final value of our product.

#### **About the main problems**

At present, the main problems can be attributed to the losses due to eiderducks and storms. As a protection measure against eiderducks, mussels stick to each other and form clumps. Eiderducks, able to dive, take out whole bunches and separate the mussels from each other. Even if not all of the mussels are eaten by the birds, the bunches are usually lost for us, the fishermen, since currents and strong storms take them away from the original location of the mussel bed.

### FOLKERT DE JONG and GERALD MILLAT, Common Wadden Sea Secretariat (CWSS), Wilhelmshaven

#### **Concerning the Wadden Sea Forum (WSF)**

Within this forum it is possible to perform an open dialogue between the different parties. Fishery are usually represented by representatives of fishery organizations (e.g. by Mrs. Gubernator or Mr. Breckling) but principally discussions of the WSF –apart from the existent thematic groups– are open to everyone. Generally speaking, it is quite difficult to talk about matters concerning fishery and a lot of fishermen or representatives are very individualistic people.

#### **Concerning shrimp fishery and management**

Within the fishery, trilateral cooperation mainly refers to the management of mussels (?). (The agreements that have been made between the different producer organizations of the three states concerning quota regulation of shrimps are pure agreements for an economic purpose and not of our concern.) So far, it has been thought that there are no impacts of shrimp fishery on the ecosystem. This belief has somehow grown historically. In the ministerial declaration of the 7<sup>th</sup> Trilateral Governmental Wadden Sea Conference on the protection of the Wadden Sea 1994 in Leeuwarden there was agreed upon a common research project on the effects of shrimp fishery. However, due to missing funds such a project has never been performed until now. Goals concerning shrimp fishery would be an undisturbed development of subtidal areas, e.g. by means of non-fishery zones (the biggest one exist in Schleswig-Holstein and in Hamburg after the amendment of the National Park Laws (NPLs) but there are none in Lower Saxony). Thus, the goal would be non-use areas for the entire Wadden Sea with the purpose to create reference areas for scientific investigation (Marencic).

#### **Concerning Co-management**

Co-management can be considered as a form of self-management. For example, fishermen and the responsible ministries agree upon certain goals but the conversion of how to reach the goals is then performed by the fishermen themselves. Thus, the frame is mutually agreed upon but the final conversion and control is given to the fishermen. There are different forms of how to perform a co-management.

#### **Concerning other species of forms of exploitation**

Discussions about the exploitation of cockles are always a matter of concern somehow but usually concerning the area outside the national park. However, in political terms it is not a real matter of fact since it is tried not to disturb the actual status quo (see below). *Spisula* fishery could possibly be performed but also outside the park but within the cooperation area. However, consequences for the

bird fauna have to be evaluated. Furthermore, there is the Pacific oyster (*Crassostrea gigas*) which is being cultured in Sylt (Schleswig-Holstein) and which is invading into the Wadden Sea, also coming from The Netherlands. Wild stocks have already been found in other parts of the Wadden Sea and the expansion of this species will certainly have consequences for the mussel beds. A project about the biology etc. is currently being performed by the Senckenberg-Institute in Wilhelmshaven.

Different forms of exploitation of mussels are thought of such as hanging or standing cultures. This will not seriously be performed within the area of the NP but it can also be interesting for the park area if it concerns the culturing of seed mussels in order to get enough supply for the bottom culture plots. However, there is the personal impression that the fishery sector is not so much interested in such new developments.

I have the impression, that fishery and new forms of exploitation are no matter of fact in current political discussions and there are rather elements about tourism, offshore windparks or the extension of harbors. Particularly, in Lower Saxony there are no innovative ideas concerning fishery. In contrast, in Schleswig-Holstein there are clear arrangements: even though costs for administration, management and monitoring have to be supported by the fisheries sector, there is a socio-economic security for fishermen and businesses for the period until 2016. There are defined restrictions concerning the mussel fishery. This concept, a framework agreement between the Ministry and the fisheries sector, seems to meet the targets of sustainable fishery and is planned on a long-term basis. This brings about advantages for both sides (fishery and nature conservation) and was also important for the amendment of the NPL in Schleswig-Holstein. In general, in Schleswig-Holstein there are more oral agreements between the different sectors such as with the shrimp fishermen. Here, they have voluntarily agreed not to fish in a certain area during the molting of a certain bird species (De Jong). Such agreements have resulted to be positive for the general solution finding of problems. In Lower Saxony, the situation is somehow paralyzed. Politicians don't want any kind of problems and it also seems as if in comparison to Kiel where the main decision making for Schleswig-Holstein takes place, the city of Hanover is too far away from the Lower Saxonian coast (Marencic).

#### **About the main problems**

On the part of the fishery, there are conflicts with the restriction of use due to other activities or nature conservation or the influence of harmful substances. However, if it is regarded out of a more objective point of view, e.g. what can be perceived in the discussions in the WSF, the whole procedure concerning the allocation of licenses, the selection of areas, the conditions of what is allowed and what is not, does not seem to be very transparent, even not for the fishermen itself. For them, a lot of things are like a "Black Box". Moreover, I have the impression that influences of the fishery upon the system are very difficult to judge. In the past, the dialogue with fishermen has been very difficult and in generally the opposing fronts have been very entrenched. The WSF seems to be a possible platform for the common finding of new strategies. On the one hand, suggestions for scenarios have to be presented at the end of 2004; on the other hand, the dialogue should go on and be improved any further. I have the impression that the forum is judged positively by the different parties and problems are presented in an open way. On the part of the fishermen, there certainly exists the willingness for a sustainable fishery. But, the historical development has to be kept in mind: first of all, there was the fishery and only afterwards there arose the awareness for nature conservation. Particularly, fishery needs time for this kind of development. Therefore, a certain time for a development in terms of dialogue and new strategies is indispensable and has to be taken into account.

#### **Future Perspectives**

Out of the nature conservation point of view, it is to be striving to declare areas in the Lower Saxonian Wadden Sea which are permanently closed for any kind of use (e.g. exclusion of any kind of fishery). They should serve as reference areas for scientific research. So far, such areas don't exist in the Lower Saxony. There are possibilities for an environmental friendly kind of fishery, and suggestions on the part of nature conservation are existent. For example, it is possible to concentrate the use in certain areas and exclude it in others. Economic aspects should be more taken into account as a form of a mechanism for regulating fisheries (Marencic).

In the Wadden Sea Forum (WSF), there are developed scenarios for the future. The main aim is to come to certain solutions in a mutual agreement between the different stakeholders. The general framework for that is given but, the elaboration is usually much more difficult. As far as I am concerned, fishery for mussels will stay and there are methods to improve management and techniques. There could, for example, be established something a kind of a "fond" for years where recruitment of seed mussels is poor, e.g. in forms of areas which are usually excluded from fishing but which can be used in certain years. Somehow, fishery pertains to the coast and is part of it. However, there is always the question if the overall perspectives for fishery sector are sufficient in the long term (De Jong).

HUBERT FARKE, National Park Authority of the Wadden Sea National Park of Lower Saxony (answering of most of the questions)

→ Project leader of the of the Lower Saxonian Wadden Sea foundation-Project “Accompanying scientific research for the construction phase of the Mussel Management Plan of the Lower Saxonian Wadden Sea”

GERALD MILLAT & MARC HERLYN:

→ Carrying out the scientific research in the above mentioned project with the main aim of evaluating the effects of the measures entailed in the Blue Mussel Management Plan. Data will be included in the TMAP (Trilateral Monitoring and Assessment Program)

**Answers to specific questions concerning mussel beds, area sizes etc.**

Total NP Wadden Sea Lower Saxony area: 2777 km<sup>2</sup> (277700 ha)

Intertidal area (Wadden flats): 1368 km<sup>2</sup> (49 %)

Sublittoral (e.g. channels): 1220 km<sup>2</sup> (44 %)

Land (e.g. islands): 189 km<sup>2</sup> (7 %)

(Data according to Czeck, pers. comm.)

For shrimp fishing, there is actually no restriction concerning fishing grounds, apart from the area east of the Weser (Wurster Küste) and a small area north of Neuwerk called “Alsenbalje”.

Concerning mussels, around 30 % of the potential mussel beds available for seed mussel fishing are excluded from fishing. There are two restrictions concerning seed mussel fishery in the Wadden Sea Lower Saxony national park: According to the NP law, a number of 31 mussel beds which are situated in non-fishery areas are excluded from fishing. However, 24 beds out of this are situated in the area between Weser and Ems (Wurster Küste) which are not interesting for mussel fishermen at all. An additional 17 sites have been excluded from fishery according to the Management Plan (voluntary agreement of fishermen).

In contrast to Schleswig-Holstein where seed mussel fishery only takes place in sublittoral areas (different hydrographical conditions, sometimes gravel grounds), in Lower Saxony it seems that the available sublittoral areas do not suffice to meet the demand of seed mussels, thus also seed mussel fishery from eulittoral beds takes place to a certain extent.

**Concerning licencing requirements**

The State Fisheries Administration is responsible for giving the authorization for the areas opened to seed mussel fishery. They examine the location and the stock. Concerning these areas, we, the NPA, have to be informed and listened and we make a statement but we don't have a veto. The “installation” of culture plots for the seed mussels has to be applied for at the State Fisheries Administration as well. The permit is valid for a period of five years and has to be renewed afterwards. Some areas stay at the same location or close to for many years (traditional cultures). Others are opened in new areas while the former ones have to be abandoned.

**To 5)**

The guiding principle regarding the Wadden Sea is a sustainable protection and development as a nature area. Thus, the exploitation/use of other marine organisms should not take place or only to a very reduced extent. Natural processes should prevail and the human impact should be kept to a minimum. As far as aquaculture is concerned, at the moment I don't see a method that would be in line with the principles of a national park. If that was the case (e.g. closed systems that do not interfere at all with the natural environment) an approval would be conceivable. Concerning blue mussel fishery, it is imaginable that other types of fishery (e.g. by means of longlines) could be introduced in order to perform it in a more environmental compatible manner.

**To 7)**

In the shrimp fishery there are still some problems with the bycatch even though methods have already improved. Concerning mussel fishery, we always have the problem that there is a competition with birds that rely on the mussel beds as feeding grounds.

In general, there is a lot of pressure on the system due to many different uses (dredging in general, the dumping of dredged material etc.).

**To 8)**

Apparently, in the “Ecosystem Research Wadden Sea” there are first signs concerning over-fishing of shrimp stocks (decline of the average egg size, lower average size classes in the population).

However, there are no thorough investigations about population dynamics of shrimps. The same is true for flatfish species which are apparently less abundant than in former times, but, however, here it is the same. Since we don't have reliable data we can not manifest ourselves. There is no basis.

**To 11)**

Concerning the economic profit (gross national production) and working places in general, the percentage is very small. But, the coast is not conceivable without the coastal fishery. For tourism

which is the most important source of income along the Lower Saxonian coast, fishery is very attractive since it is just part of the coastal image.

**To 22)**

Methods for fishery have changed a lot. The use of hand gear for mussel fishery has been replaced by dredging machines and sophisticated gear for the seeding of mussels already a long time ago. This has certainly improved the high mortalities that occurred in former times. In general, the fleet has been modernized and the capability is much higher. This in turn is a problem in terms of the fishing effort which should generally be reduced.

**To 23)**

I believe there is quite a strong identification with the fishery sector...more than with the national park, but both are not considered to be conflicting. The awareness of the fishery sector is quite interesting if one is to consider that the current manner of fishery is only around 100 years old.

**To 24-27)**

It is very difficult to take a firm stand since everything depends on the fishery effort. At present, the old shrimp vessels are replaced by new EU vessels with higher capacities and where more people are employed in comparison to the older wooden family-owned vessels. These cutters can certainly perform fishery during stronger weather conditions than before and at least four people are employed on each vessel. This implies a higher pressure in terms of the catching amount and this in turn raises the fishery effort.

Sustainability implies knowledge on the availability of the stocks and the capacity of the system. At the moment, mussel fishery seems to be sustainable but we don't know about the situation of the standing stock within some years. There has not been taken place a recruitment since 1996 and so far we do not understand the processes that are responsible for a recruitment. We also don't know about the possible impact of climate changes and general warmer periods, if this will occur in future. We don't know about the most sensitive stages of the respective organisms. In The Netherlands, for example, sustainability is linked to the actual stock: there, at least 60 % of the shellfish stocks (mussels and cockles) have to be reserved for the mean average food requirements of birds.

With shrimps, we don't understand population dynamics in general, so it is hard to stay what will be sustainable.

Since 2001 the Blue Mussel Management Plan has been called "rationing plan" ("Bewirtschaftungsplan"). This plan has two functions: on the one hand, stocks should be maintained. On the other hand, the economic viability of the sector has to be guaranteed as well. In the forerun of the new plan, a committee consisting of the different stakeholder groups discusses the results of the scientific results that are still being carried out (inventory of stocks, biomass, density, coverage, dynamics of mussel stocks etc.). Concerning the Management Plan, a lot can still be done. It could be possible to exclude areas from fishing for a variety of years for the purpose of investigating the natural development of such banks without any human impact.

Concerning Lower Saxonian Wadden Sea national park, a sustainable form of the use of fishery resources can be the only aim since otherwise the principles of a national park are failed. Thus, any kind of use has to be directed to the principles of a national park. As far as I am concerned, this statement will also be valid in 30 years.

I hope that until then we will be able to say how sustainability has to look like, also with regard to the users and the economic viability. So far, the number of cutters is supposed to decline, but, however, the fishery effort is still too high.

**HANS-ULRICH RÖSNER, World Wildlife Found (WWF), Husum**

→ WWF-section for ocean and coast

**What are your visions/targets for the future?**

Concerning shrimps, in no case the WWF wants to ban shrimp fishery as it is very often stated by part of the fishery sector. But, there is the need to create areas excluded from fishery, which means we would favor a certain kind of zonation. This is always a hot spot in any discussions and in sharp contrast to the fishermen who don't want such a regulation. Generally, shrimp fishery tends to see nature conservation as the primary antagonist, but, as far as I am concerned, both groups target at maintaining a healthy natural environment. However, for some reason the ways of thinking are very different and so that both parties don't find a proper way to communicate. This could be a task of the integrated coastal zone management (ICZM) approach. Nevertheless, the ICZM approach is too academic which is not desired by the fishermen.

At first, we want to maintain shrimp fishery globally because out of the point of view of the WWF we consider this fishery sector to be sustainable and friendly in the long term. Moreover, it is a local kind of fishery and its preservation is in the interest of the WWF. But, we also have a strong interest in

keeping Wadden flats unaffected by human intervention. Secondly, the amount of discharge has to be reduced. This is a technical question but certainly still has to be optimized.

We hope that the established Wadden Sea Forum (WSF) will achieve its aim to create a common comprehension for a sustainable development of the Wadden Sea region. I don't know if the thematic group "Fishery" will contribute to achieve this aim. We can see that the engagement and readiness to discuss is stronger among the Dutch fishermen. Thus, with The Netherlands there is the situation that on the one hand fishery impact is much more intensive but, on the other hand, fishermen are much more interoperable. Generally, we anticipate that the WSF creates an atmosphere in which more comprehension exists for the interests and concerns of the other party. This in turn makes it easier to find compromises for conflicting points and to strengthen the cooperation amongst each other. Concerning mussels, on the part of the WWF we target at a management that concerns the whole Wadden Sea area. This includes a general prohibition of the seed mussel fishery on eulittoral (intertidal) banks such as it is already the case in Schleswig-Holstein. Hence, fishing for seed mussels should only be allowed in subtidal areas of which certain areas should still be excluded from fishing. It is our tenor that no kind of fishing is maintainable in eulittoral areas in the long term.

#### **How do you see future reality?**

This is very difficult to say since it always depends on social and political developments. I believe we can assume that the social tenor of conserving the Wadden Sea as a whole is stable. Of course, if a certain area has been designated as a protected site, it always needs time to develop and implement the strategy. I think in the long term, the coastal fishery sector will be compatible with this development. Areas under protection only are such if they are conserved and cared for and if the different parties contribute to the protection. However, we don't know about different factors such as the development of the future climate and therewith related changes. These factors can certainly complicate any protection targets but we can't control them.

#### **HEIKE VESPER, World Wildlife Found (WWF), Bremen**

→ Among others, responsible for the fisheries sector in Lower Saxony in the WWF

##### **General talk**

For us the biggest problem for the Wadden Sea National Park is that fishery takes place to a large extent. If a certain area is nominated to be a National Park it has been done for a certain reason (in the case of the Wadden Sea National Park e.g. special ecological features, nursery area, a place for migratory and resting birds) and it is also bound to certain restrictions, otherwise such a nomination does not make sense. As far as I am concerned, rules are not going too far as we would like them to go. There are hardly any places in the Lower Saxonian Wadden Sea where nature can develop in an undisturbed way.

##### **About mussel fishery**

Concerning the blue mussel management plan, we are not satisfied with it even though there are some mussel beds that have been excluded from fishing. But, however, the laying down of these areas in the run-up to the current plan has been performed without the participation of environmental associations and thus I believe that certain criteria have not been applied properly. Besides, we are criticizing that the plan is still based on too little scientific knowledge. Of course, the blue mussel fishery is a very delicate and difficult business which is very much dependent on natural conditions. In contrast to Schleswig-Holstein, in Lower Saxony there are far less littoral mussel beds, generally beds which are highly variable. Therefore, we are aware of the fact that it is not possible to restrict seed mussel fishery exclusively to sublittoral banks but that certain eulittoral beds have to be opened for seed mussel fishery. In general, mussel beds are limited and it can not be rejected that mussel fishery can have a negative impact on the resting mussel beds. We are not able to manage the natural patterns, that is the whole ecosystem, but we can manage our own activities such as the fishery. Fishery can take place but only in a sustainable way and as far as I am concerned, this is not taking place at the moment.

##### **About management solutions**

Concerning a better management, research should concentrate more on the sublittoral areas since here knowledge is still very restricted. I believe that there are more options for culturing of mussels such as culturing by means of longlines or other devices. The core zones of the national park should not be subjected to fishing at all (so far, seed mussel fishing is allowed in areas of the core zones as well). Concepts for trilateral solutions exist but there is a need for more comprehensive solutions between the three countries (The Netherlands, the two Germany states, Denmark). For example concerning the general seed mussel problem in Lower Saxony, it would be a good idea to get seed mussels for stocking from areas in Schleswig-Holstein where seed mussel availability is greater due to the natural circumstances. However, every state is bound to own regulations and licencing requirements and competition is high, all factors that are still inhibiting such an attempt.

**About shrimp fishery**

Shrimps are a non-quoted stock. However, first signs for an over-fishing of shrimps can be noticed because the general size of the caught shrimp is decreasing.

A couple of years ago producer organizations from the three Wadden Sea countries started to establish a recognized association of producer organizations in order to stabilize the prices and improve the effectiveness of their economic situation by means of catch quotas. However, the German cartel office has opened an investigation against this project to find out if the trilateral cooperation violates competition law. As far as I know, this investigation has not been finished. However, such a self-regulation by the producer organizations of the fishermen can be judged as very positive since only in this case management takes place from "below". It can be considered as a form of a co-management between fishery policy and fishermen where agreements about catch quotas are made and where about the most adequate measure on order to reach the goal is commonly decided.

**Concerning management**

In general, the size of the vessels for the shrimp fishery have been enlarged and modernized to such an extent that fishing for shrimp can be and is usually performed outside the Wadden Sea seaward of the 20 m bathymetric line. Hence, fishing within the narrow channels of the Wadden Sea should not be of such an importance anymore. So far, there are no areas in Lower Saxony which are totally excluded from fishery (apart from the area east of the Weser mouth). As far as I am concerned, it would be necessary to establish areas that are completely excluded from fishing and others where fishing is allowed. However, such an exclusion only makes sense if a whole system of channels connected to each other is affected by this exclusion. Agreements between nature conservation and fishermen are possible; this has recently been demonstrated in Schleswig-Holstein: Here, in a voluntary arrangement a certain area where the molting of the shellduck *Tadorna tadorna* takes place has been included from fishery for a certain period of the year. Even though very difficult to perform, principally, such a kind of a voluntary agreement can be considered as the most desired form of an approach between nature conservation and fishery.

**About conflicts and economic importance**

Concerning fishery in the Wadden Sea National Park, biggest conflict exist with nature conservation authorities. Steady disagreements are mainly related to the principles of a national park. Such principles have to be filled with a meaning; otherwise they do not make any sense.

In terms of tourism, fishery can be regarded as a positive factor for the coastal region since it contributes to the flair on the coast and many people enjoy the fishing vessels and the direct selling of shrimps. For the region, the Wadden Sea fishery can be considered as quite important even though the optimum is not being performed. For example, the shelling of shrimps is nearly exclusively performed in Poland and Morocco. At one stage machines for the shelling of shrimps have even been promoted by the EU in order to process the products on the spot, but for some reasons, the producer organizations preferred to send them abroad. Thus, no increase of the value takes place and most of the commercialization takes place in The Netherlands. There is a lot of Dutch pressure and thus, in Lower Saxony, cost-benefit of the shrimp fishery is not very beneficial. This is one reason for the fact that there is no recruitment of new professionals in the fishery sector with the activity itself becoming less and less attractive. However, along the coast esteem and awareness of the coastal fishery sector and its products is quite large in comparison to inland cities such as Berlin where seafood is only known from tinned food.

**Explanation of the fleet capacity**

The European Union has attempted to match fleet capacity and fishing opportunities through decommissioning programs. The vessels for catching shrimp which belong to the classification of the mixed coastal fishery fleet were also affected by this measure and had to reduce the fleet. However, apart from not having the desired effect in terms of reducing the over capacity of the fleet, the German mixed coastal fleet and the whole socio-economic sector behind was negatively affected by this program. According to the new (revised) Common Fisheries Policy (CFP) there now exists an upper limit for the national fleet and Germany itself has to decide about which fleet has to be reduced in order not to overpass the upper limit. If a new vessels of a certain capacity (kW and BRT) is constructed for fishery purpose a certain amount of capacity has to be reduced somewhere else (1.3 times more reduction for every new vessel) and apart from 2005, the construction of new fishing boats will not be subsidized any more.

**Concerning future perspectives**

I can not think of other species that could potentially been exploited in the Wadden Sea since, in general, use of fishery resources should be further restricted. For example, even though fishing measures have been improved, bycatch in the shrimp fishery is still too high. On the long run the system will not support this kind of impact.

I would like to see larger coherent areas that are put under special protection and where there is undisturbed development taking place. In other areas, a sustainable use of the natural resources has to

be guaranteed which means it has to be acted according to the best knowledge and conscience. So far, the transformation of scientific knowledge and ideas is too slow. We need a mechanism by means of which the existing structures are constantly examined and which guarantees a steady development. The community of the stakeholders has to decide commonly. But, however, a common forum only makes sense if the outcome of the discussions are put into action. Talking and interchanging opinions is not enough. Alternatives have to be found for things that are not running well (e.g. other forms of getting seed mussels).

I believe that within 30 years some of the above mentioned desires will have come to practice. In general, the economic pressure is ruling everything such as it is the case in the fishery sector. If the economic basis is withdrawn, a modification of views necessarily takes place. Personally, I believe that we are approaching the concept of sustainability.

### UWE WALTER, Scientist, Research Centre Terramare (Centre for Research on Shallow Seas, Coastal Zones and the Marine Environment)

→ Actually working in a project where long-lines are tested as potential collectors for mussel seeds in the Wadden Sea

#### **General talk**

In comparison to The Netherlands, mussel fishery in Germany was never so significant. The whole fishery is somehow modeled on The Netherlands but to a much smaller extent. In The Netherlands the appreciation of the products is very different and everything concerning mussels is of much larger dimension. For example, nearly all of the mussel landings go to Emmen situated in the Oosterschelde where they are released off sand on special areas ("Aussanden") and where the main auction takes place. In contrast, in Lower Saxony direct commercialization is hardly taking place and there is no processing industry on the spot.

Concerning shrimps, there is not a 100 % the predominance of The Netherlands but commercialization also depends on only a few wholesale merchants that "have" their special fishermen. In the harbor of Neuharlingersiel (Lower Saxony) there exists one example for a cooperative that performs commercialization on its own. Here, the immediate peeling of shrimps takes place and the products are sold directly.

#### **To 5-6)**

I cannot think of other species (bivalves etc.) that could potentially been exploited since in Germany there does not exist a market for such products (German eating culture).

#### **To 7)**

As far as I am concerned, there EC-Legislations are of the biggest problem for the current fishery sector. Thus, decision making takes place in Brussels about the actual well-being and the future of our fishermen. There is a very deficient lobby in Germany for the coastal fishery because significance of this sector is considered to be very small. As an example, there is the aim of shutting down the amount of the vessels that are fishing shrimps (reduction of the fleet). In this case, The Netherlands reached not having to fulfill that demand somehow but in Germany reduction has to take place. This is a good example about the fact that there is no lobby that feels responsible for the interests of the fishermen on the German coast.

In general, there are always problems with recruitment of seed mussels which is exposed to natural changes and can change from year to year.

Concerning conflicts caused by the competitive use of the Wadden Sea there are no major problems so far. However, there are concerns about further losses of fishing grounds due to the planned constructions of windpark installations in the Wadden Sea area and there is always some friction with nature conservation authorities on different topics concerning fishing.

#### **To 11)**

Considered regionally, fishery is important. I don't have actual numbers but there is quite a large amount of vessels performing this kind of business and particularly in the shrimp-fishing sector some supply-companies that are also dependent on the fishery sector.

#### **Concerning mussel culturing plots**

The areas reserved for the culturing of mussels have usually been applied for a long time ago and some of them are in use for 20 to 30 years already. Thus, there exist possession rights for the owner so that such areas cannot be taken away easily if any new regulations are imposed for the Wadden Sea area. However, authorization for the use of the culture plots has to be renewed after five years. The location of such a plot is requested by the fishermen itself according to the own experience about the best sites for the culturing of the seeds. This is also true for the areas that are requested for seed-mussel fishing. Before, a survey of the actual stocks takes place and afterwards the areas that can be used for seed-mussel fishing are authorized.

#### **To 24)**

To me the terms sustainability does not say anything because everyone is talking about it but actually no-one is really concerned about it. To put an example, how can we talk about sustainability concerning shrimp fishery if there does not exist any knowledge about the actual stock of this species in the Wadden Sea and adjacent coastal waters?!

In the mussel sector, the fishermen themselves know best about the stocks. Here, it has always taken place some kind of practicing for inventory stocks (“Vorratsbetreuung”), but, however, there are always economic constraints that the fishermen have to cope with.

#### **To 25-28)**

There exists a management plan for the mussel but, however, as far as I am concerned, a reasonable management could certainly be improved. For the plan, both sides, nature conservation and fishery, have to perform the recording of the stocks and there is a meeting once a year where the figures which are usually differing from each other are discussed. Thus, it could be more reasonable to perform the assessment of the stocks together in order to agree about the actual figures and discuss the situation on the same basis. However, there exist some aversions between different people which complicate the situation.

Concerning future perspectives for the fishery sector in Lower Saxony, I believe that the actual trends will continue. That means that the outlook is not very good. The amount of fishing vessels will continue to be reduced and this will mainly be due to the EU-legislations that are originating in Brussels. Unfortunately, we do not have a strong lobby or a sectoral planning agency (“Fachbehörde”) which is really interested in the Wadden Sea fishery. As far as I am concerned, this is also true for the German Fishery Association in Hamburg. Thus, the outlook for the shrimp and mussel fishery in Lower Saxony is not very good.

#### INGRID KRÖNCKE, Scientist, Senckenberg-Institut (Wilhelmshaven)

→ Fundamental research on the ecology of the benthos along the North Sea coast but also in the Wadden Sea

##### **General talk**

We work on questions such as benthos communities, how is their structure and function, how do they develop, what factors are responsible for their development etc. In the frame of the ecosystem research we also worked on “Platen” where mussel banks exist.

In our institute mainly fundamental research is carried out. Generally, our results show that the Lower Saxonian Wadden Sea functions in a different manner than in front of the coast of Schleswig-Holstein or in The Netherlands. Over here, the Wadden Sea is quite narrow and its character is stamped by deep channels. Consequently, a lot of ex- and import takes place.

##### **What are the visions for the future concerning the exploitation of marine bio-resources?**

Probably, it will be possible to find new ways via different culturing methods as it is for example, elaborated by Uwe Walter from the Terramare. By this means, a future exploitation of desired natural organism could be guaranteed. However, I don't think of any further (new) resources since in Germany there is no consumer demand on other species.

##### **How do you see the future reality?**

Well, our results reveal that changes are taking place. This is, for example, shown by long-term data obtained in front of the island Norderney since 1979. The question is when and what kind of changes will take place. We can expect climate changes which will certainly have an influence on water temperature. We can expect that the Wadden Sea will get smaller, that tidal changes will be larger, that sediments will get coarser. We certainly will have a different fauna which, nevertheless, can already be seen in the introduction of the Pacific oyster species *Crassostrea gigas*. We still don't know about habitat or food competition and displacement between different organisms but we can already see that the Pacific oyster is invading the Wadden Sea. This will consequently have an impact on any fishery activities. So, we definitely will have changes but can only hypothesize since we don't know what and when they will happen.

#### ACHIM WEHRMANN, Scientist (Geologist), Senckenberg-Institut (Wilhelmshaven)

→ Working in a project on the invasion of the Pacific Oyster *Crassostrea gigas* in the Wadden Sea

##### **General talk about the project on the Pacific Oyster**

In the frame of the project we work on the invasion of the Pacific Oyster *Crassostrea gigas* on mussel beds in the Wadden Sea. Stock taking takes place on mussel beds open for scientific research according to the Blue Mussel Management Plan.

First individuals in the Lower Saxonian Wadden Sea were sighted in 1998 and it was our assumption that the larvae had been drifted from the west (The Netherlands) towards our coast. In the Oosterschelde, the Pacific Oyster was established in aquaculture in the 70s. This assumption has been approved by our first surveys that have been taken place in summer 2003: if you go further west, more

individuals of the oyster can be detected (in the west up to 250 individuals/m<sup>2</sup>). Meanwhile, the Pacific Oyster can be found everywhere near coast. In the past it was believed that spawning of this species was not possible, but now spawning takes place regularly and we can see that all age groups are represented. Meanwhile we can even assume that recruitment is taking place out of the own stocks and not only any more by the drift of larvae from the west. In The Netherlands there are already small reefs existing out of oysters. However, these individuals can not be exploited commercially since they don't meet the standards of the consumer demand. They are thick and broad in contrast to the long and thinner-shelled oyster for consumption.

At present and apart from the surveys performed during summer time, we have experiments on filtration of mussels and oysters and work on questions such as: do they filter the same or different algal species, which algal species are favored by the different bivalve sizes, what about the assimilation capacity, can any conclusions be drawn out of investigations on the pseudo-faces?

#### **Future research in the frame of the project**

We have planned to start predation experiments with bird species since we don't know anything about natural predators of the oyster occurring in the Wadden Sea. This is of particular interest since for the first time we have not to deal with an invading species (e.g. *Ensis* sp.) that has found an ecological niche in which it can live without displacing another species or species group but with a species that is occupying already settled habitats (existing mussel beds).

#### **Predictions**

As far as I can judge the situation, the Pacific Oyster will establish itself in the Wadden Sea. Due to experiences we already know that this species even resists very cold winters. Parasites could be the only possibility to prevent a future dispersion of this species. However, so far we do not know about such a parasite. Concerning displacement of the Blue Mussel, I don't really know. But, oysters grow older, their filtration rate is higher and settlement is apparently more effective. Possibly, in future we will have a competition of space between mussels and oysters. Nevertheless, it has been observed that mussels are also able to settle on "sandy" substrate only by means of sticking towards each other. This is not possible for the oysters which definitely need shell or mussel beds to attach. So, maybe we will see a shift of the mussels towards a sandier substrate?! In any case, it can be stated that oyster beds will establish in the Wadden Sea.

#### **What do your results/observations signify for the mussel fishery in the Wadden Sea?**

I don't have an idea to what extent current seed mussel fishery has an effect on the described development. However, fishermen will definitely have to spend more time on sorting out oysters during the harvest of mussels. Possibly, a new form of "fishery" could be established such as putting the Pacific Oyster into aquaculture. However, more promising could be not to develop near shore aquaculture but instead leave the oysters and mussel beds like they are and try to establish a market based on production and commercialization of oysters from the wild. Of course, there is the question whether it is possible to establish a market for these kind of products but there could be a chance to do so. The main purchasers and consumer could also be abroad such as France where seafood is of very large importance. It could be a branch of fishery based on the marketing of exclusively wild oysters. Certainly, a thorough monitoring would be needed in order to observe the stock as well as an adequate management plan regulating harvesting matters (e.g. amount to be harvested, harvesting periods).

#### **TILLMANN HARDER, Scientist, Institute for Chemistry and Biology of the Marine Environment (ICBM)**

→ Research in the field of environmental bio-chemistry

#### **Talk on projects performed on the research of marine natural products**

Generally, there are not so many projects going on for organism in the Wadden Sea region. Near Hooksiel in the "Hooksmeer", a nutrient-rich water body, a pilot project has just started where it is tried to use macroalgae for the recycling of nutrients but also for using them as comestible goods or for ingredients. There used to be an investigation on the use of the worm species *Nereis diversicolor* as a potential organism to recycle/reuse effluent sludge that for the detoxification of the sludge. However, due to missing funds this project never went any further but stayed as a pilot project. In our group, we have just started to investigate on polychaete worms from the mud flats. We want to know why they colonize certain areas and what kind of chemical signals exist. Herewith obtained results are also interesting for the general research on marine natural products.

#### **Visions for the future and actual tendencies**

I believe there is a lot of potential in nature in terms of valuable substances that can be found in/extracted from organisms, but so far only little research and exploitation is taking place. However, as far as I am concerned, there are not many potential sources in the Wadden Sea area itself and areas further offshore are more promising (e.g. where sponges exist).

. At present, there are no major projects going focusing on marine bio-resources but, as stated, possibilities on research exist. The Wadden Sea is very interesting in terms of the genetic pool of bacteria and their metabolites. We are very interested on a bacterial group of the genus *Roseobacter* that is very abundant in the Wadden Sea. In particular, we want to know about the structure and function of metabolites of this group. In this context, research on marine natural products becomes very important. We are currently writing the application for this project.

**THORSTEN BRINKHOFF, Scientist, Institute for Chemistry and Biology of the Marine Environment (ICBM) of the University of Oldenburg**

→ Microbiologist, working on bacteria of the Wadden Sea

**General talk about the research**

We work on bacteria occurring in the Wadden Sea. We are particularly interested in the production of secondary substances. Our principal questions are: what are the bacteria doing and why/by what means? If we obtain good results we can decide whether a group seems to be interesting or not for any deeper research. We are using different screening methods and are sometimes cooperating with the chemists for chemical analysis.

So far, this is can only be considered as fundamental research since first of all we have to know about which groups exist and are interesting in terms of their substances, hence we want to know about the status quo of the Wadden Sea bacteria. Maybe in future, our results can serve for any kind of application in industry etc.

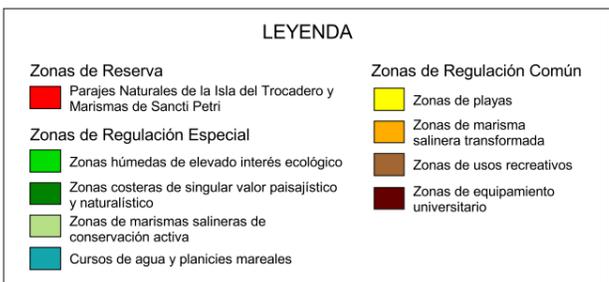
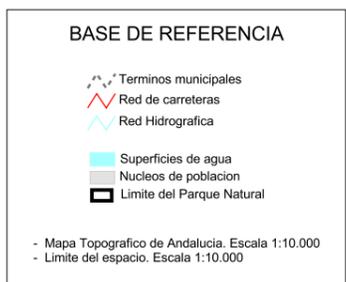
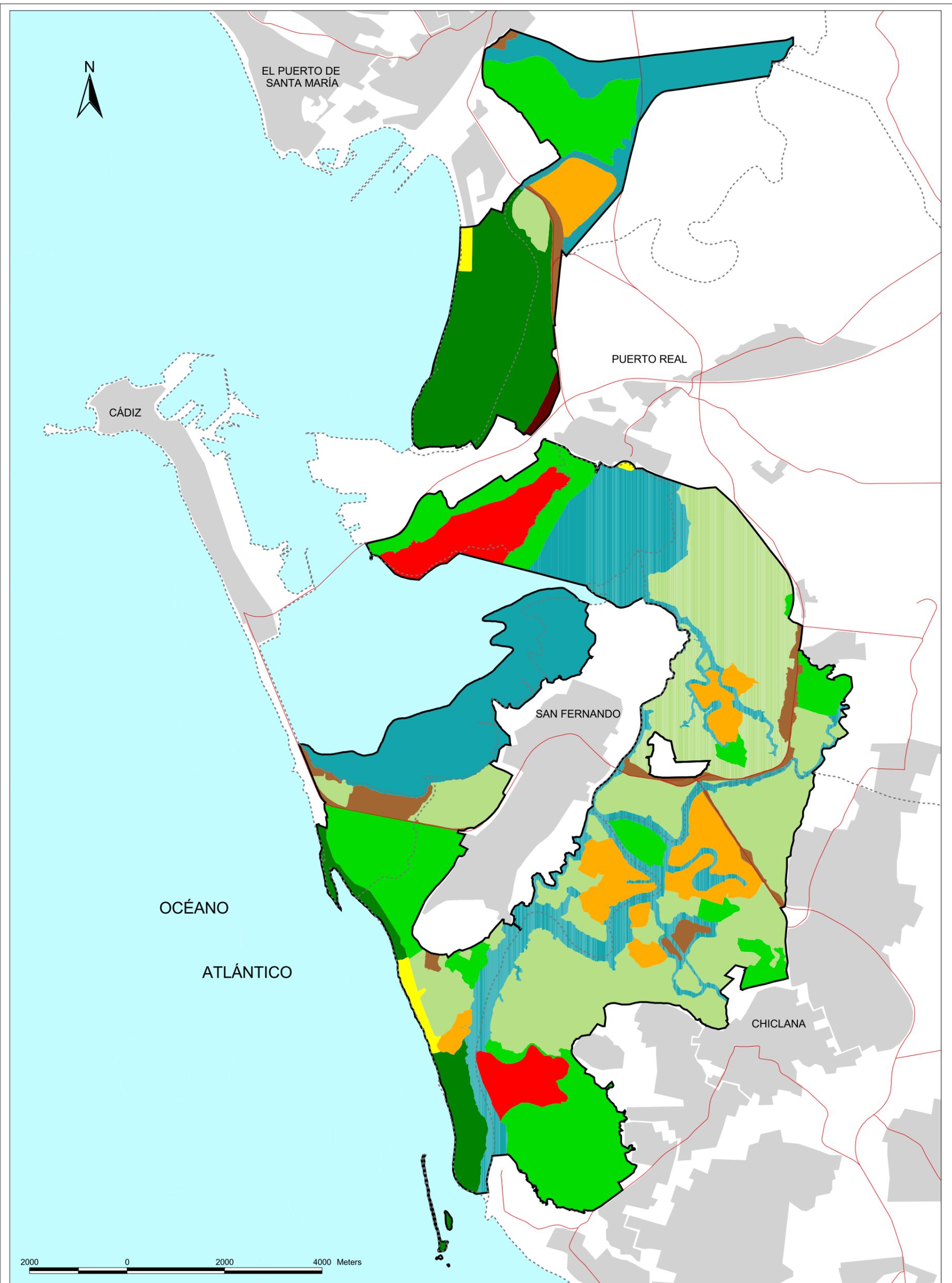
## **Annex IV: Maps and Legends**

### **Pages yyy - zzz:**

- Map of the “Plan de Ordenación de los Recursos Naturales del Parque Natural Bahía de Cádiz” (PORN; Organizing Plan for Natural Resources, Bay of Cádiz) and translation of the legend  
Source: Consejería de Medio Ambiente (2003a)

### **Pages aaaa – bbbb:**

- Map (section) of the “Plano de Ordenamento da Orla Costeira Vilamoura - Vila Real de Santo António” (POOC; Coastal Zone Master Plan, Ria Formosa) and translation of the most important parts of the legend  
Source: ICN (2003)



**PLAN DE ORDENACIÓN DE RECURSOS NATURALES  
PARQUE NATURAL BAHÍA DE CÁDIZ**

**ZONIFICACIÓN**



## Base of Reference

-  Border of the municipalities
-  Road network
-  Hydrographic network
-  Surface of the water
-  Population centers
-  Limit of the Natural Park

## Legend

### Zones of Reserve (Highest Protection Grade A)

-  Natural reserves of the Trocadero-Island and of the Santi-Petri saltmarshes

### Zones of Special Regulation (Protection Grade B)

-  Wetland zones of elevated ecological interest
-  Coastal zones of exceptional landscape and naturalistic value
-  Zones of Salina-saltmarshes actively conserved
-  Flows of water and intertidal plains

### Zones of Common Regulation (Protection Grade C)

-  Zones of beaches
-  Zones of transformed Salina-saltmarshes
-  Zones of recreational use
-  Zones of university equipment



## Legend

 Limit of the intervention zone

 Area of harbour jurisdiction

 Limit of the Ria Formosa Natural Park

 Limit of the municipalities

 Imprecise cartography

 Principal canal

 Secondary canal

### Urban land

 Urban periphery

Urbanized areas

 Consolidated urbanized areas

 Touristic areas

 Existing industrial areas outside the urban periphery

 Areas of planned urbanization

### Rural land

Natural areas

 Protected maritime stripe

 Beaches

 Dunes

 Bluffs, embankments and adjacent zones

Lagoon area

 Restricted use

 Conditioned use

 Sustainable use of resources

 Wetlands and areas endangered by flooding

 Incorporated areas

 Waterlines and margins

 Additional areas of nature conservation

 Protected forest areas

 Agriculture areas

 Areas of aquaculture production

 Constructed areas subject to renaturalization

 Constructed areas subject to restructuring

 Installations, establishments, and infrastructure

## **Declaration**

Herewith I assure that I have written this work on my own and only with the help of the indicated means.

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Tanja Michler

Oldenburg, November 2003