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Kenneth J. Thomson and Lorenzo Venzi

FISHERIES AND AQUACULTURE IN THE LAGOON OF ORBETELLO

S. Martino[1]

Abstract

This paper is an introductory note on the lagoon of Orbetello, defining its environmental peculiarities and productive capacity. The aquaculture firms (both extensive and intensive) and their markets are presented from an economic point of view, focusing on the importance which the area can have as a district, according to the national and regional framework on fisheries. In particular, the unitary strategy adopted in managing the fishery involves the resolution of environmental problems and the coordination of trade to compete with products imported from other Mediterranean countries.

Keywords: fisherireas and aquaculture management, Orbetello lagoon,

Jel classification: Q21, Q22

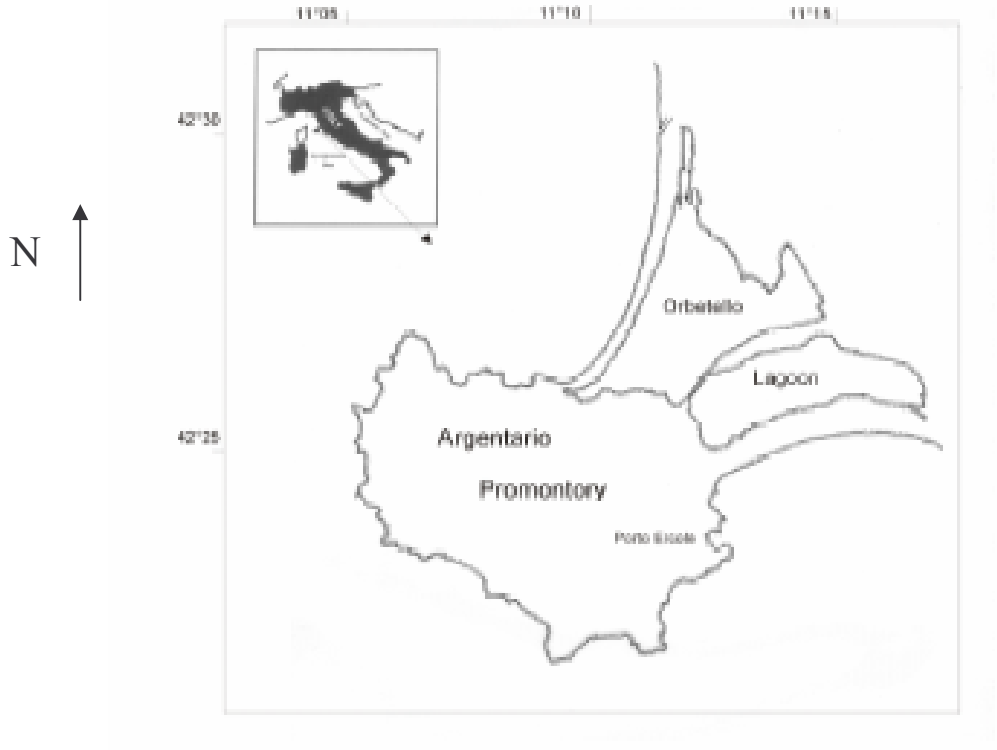
The Orbetello lagoon: geographic context, environmental problems and management strategies

The lagoon of Orbetello, located on the southern coast of Tuscany, is one of the brackish wetlands still preserved in Italy. It has a geographic position between 42°25'28" and 42°28'57" lat. North and between 11°10'6" and 11°16'45" long. East, and covers a total area of 25.25 km^2. The lagoon is made of two communicating basins, known as Ponente (West) and Levante (East) (Figures 1 and 2), measuring respectively 15.25 and 10.00 km^2, with an average depth of about 1m. The tidal range is small, and varies between 0.1m and 0.45m. Precipitation in the area is about 700 mm/year. The lagoon receives freshwater input from the Albegna river, which has 1 m^3/s annual average flow rate, the highest in autumn (Lenzi *et al.*, 2003).

The city of Orbetello is positioned on a tongue of land projecting westward into the eponymous lagoon and is enclosed by two long narrow sandy spits and, on the seaward side, by the peninsula of Monte Argentario (see Figures 1 and 2). A causeway connecting the town with this peninsula was built across the lagoon in 1842 (see Figure 3). On every side, except the landward one, the town is enclosed by an ancient terrace wall. On the north side of the promontory are the remains of a Roman villa, partly below the sea-level.

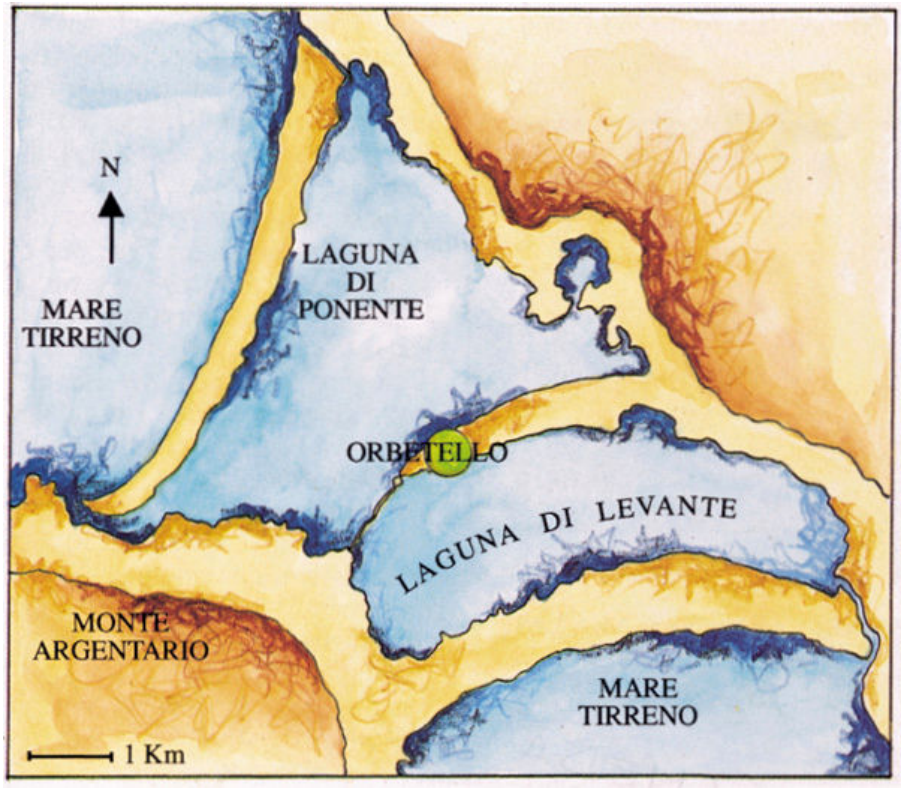
[1] University of Tuscia – DECOS Department, Via San Giovanni Decollato, 1 – 01100-Viterbo, Italy. E-mail: sim.marty@libero.it. This paper is a revised version of a note prepared for the field trip of the Seminar.

Figure 1: Orbetello lagoon



Source: Lenzi et al., 2003

Figure 2: Orbetello lagoon



Source: www.regione.emilia-romagna.it

Figure 3: Orbetello and Monte Argentario

Source: www.monteargentario.it

Over the past thirty years, the Orbetello lagoon, as with many other coastal environments in the world, has developed a considerable seaweed (macroalgae) proliferation, due to the rise of intensive aquaculture and to the density of human population, especially in summer. Moreover, other human impacts place stress on the entire lagoon system. These include two sewage treatment plants that release wastewater into the western lagoon, industrial wastes spread in an area previously occupied by a fertilizer plant, a small harbour located between Monte Argentario and the Giannella sandbar, and several resorts having their waste drainage system along the sand bars (Franchi *et al.*, 2003).

Another factor of stress is the presence of 4 land-based fish farms which discharge into the lagoon 200,000 cubic metre (cm) of water per day, containing 265kg of N and 13Kg of P per day (Porrello *et al.*, 2003a; Tomassetti *et al.*, 2003). All these causes have led to the uncontrolled increase of algal bloom with the consequent death of fish. Furthermore, the exchange of these eutrophic waters with the sea has determined problems for the fisheries and tourism activities in general.

To remedy these problems, seaweed harvest operations have been regularly practised since 1987. These are carried out in winter and spring and generally cease between May and June to avoid bottom sediment movements in warmer periods causing reduction in the chemical oxygen demand. This activity removed just about 300 tonnes of biomass in 1990 (5% of the total algal biomass) at a unit cost of €0.11 per kg of biomass (Lenzi, 1992).

Later, in 1989, a hydraulic model, proposed by ENEA (National Organisation for Alternative Energies), was adopted as a basis for the environmental management activity in

the lagoon. This consisted essentially of pumping water from two canals connecting the *Ponente* lagoon to the sea and allowing water to go out through a third canal, located in the *Levante* lagoon.

In order to coordinate all the lagoon maintenance activities, a watershed authority (the Environmental Reclamation Authority for the Orbetello Lagoon, OLERA) was set up to implement strategies that could solve the dystrophic crisis. The OLERA acts in three main ways:

- removing macroalgal masses from the lagoon;
- increasing the flow of clean sea water in the lagoon;
- reducing nutrients of anthropic origin from the river basin.

After the establishment of OLERA, pumped water was boosted from 8.000 l/s to 20.000 l/s. Moreover, OLERA imposed the cleaning of wastewaters by a constructed wetland (phyto-depuration ponds). To realize these ponds, OLERA required the enclosure of a part of the lagoon, close to the Ansedonia and Nassa canals, to be used as a phyto-treatment pond for the land-based fish farms located nearby. As regards the domestic wastewaters, rather than being directly discharged into the lagoon, they are collected and pumped to a biological treatment plant, and then discharged into a bounded shallow phyto-depuration pond of about 12 hectares. After the phyto-treatment, the effluent is discharged into the main lagoon.

The following sections introduce the idea of a fishery district as it indirectly emerged within European policy, and the criteria to choose and institutionalise it according to the Italian national and regional legislative framework. In order to show the importance of the Orbetello lagoon as a productive district, maritime fisheries and aquacultural activities are presented, as well as the strategies which fish farmers have adopted to face the competition with other European and Mediterranean countries.

Fishery and Aquaculture Districts

Under the Common Fisheries Policy of the European Community, all EC Member States are given the right to fish for all descriptions of sea fish between 12 and 200 miles, subject to quotas and conservation measures. In order to guarantee the sustainable use of resources and contain fishing impacts on marine ecosystems, Regulation EC 2371/2002 Article 17 reserves fishing activities within 12 nautical miles to those fleets that traditionally fish in these waters, unless special rights are possessed by other vessels registered in other maritime district. Moreover, the Common Fisheries Policy contains several principles allowing for a more bottom-up approach that promotes the involvement of representative fishery-related stakeholders, as in the Regional Committees. At a smaller scale participation may be achieved essentially by making fishermen part of the management strategies. This would allow for achieving sustainable measures. In such a co-management regime, fishermen would have more responsibility, and consequently more respect for rules should be attained. Therefore, the 12 nautical mile zone are encouraged to be divided into district fisheries to rationalise space, to integrate uses of the relevant coastal areas and to prevent conflicts.

Fishery districts are common in Britain. Here vessels only enjoy exclusive fishing rights up to 6 miles. Other foreign fishing boats may not enter British fishery limits except for a purpose recognised by international law or convention (in which case they may not fish and must depart as soon as their purpose is fulfilled) (Fishery Limits Act 1976, Section 2).

The government minister with ultimate responsibility for fisheries in England is the Secretary of State for Environment, Food and Rural Affairs. Much of the detailed regulation of fisheries is contained in secondary legislation made by the Secretary of State, or in byelaws made by local sea fisheries committees. There are 12 local sea fisheries committees established around the coast of England and Wales by orders made under the Sea Fisheries Regulation Act 1966. Their membership consists of local councillors, ministerial nominees and representatives of the Environment Agency. Their functions are to make byelaws for the conservation of commercial species of sea fish (now including salmon and migratory trout (under the Salmon Act 1986) and to appoint fishery officers to enforce them.

In Italy, the national Law Decree 226/2001 defines fishery districts as homogenous marine areas from a socio-economic and environmental perspective. These areas must be identified by Ministerial Decree of Agriculture and Forestry on the base of a proposal from the relevant Region. Their aim is to apply subsidiarity principles according to the administrative devolution criteria contained in the Law Decree 112/98. As defined in the most recent National Programme on Fisheries, districts would allow a management board, such as a consortium composed by firms operating in a particular maritime compartment, to manage fishing activities inside the 12 nautical miles. In this way, individual fishermen or firms would have a direct responsibility, by adopting planning measures oriented to sustainability, income opportunity, job creation, and preserving stock from excessive harvesting.

However, fishery districts in Italy are not yet a popular method to manage fishing activity, although industrial districts are very diffused along the Peninsula. The two most important fishery districts are Mazara del Vallo, in Sicily, the most important Italian fishery which accounts for over 300 firms and 5000 employees, and the Adriatic fishery district of Delta del Po. The latter is a consortium of 200 firms, aggregated in cooperatives accounting for more than 200 employees, that coordinates the commercialisation of clams (www.clubdistretti.it). An international district has recently been defined by means of a partnership among those countries surrounding the Upper Adriatic Sea with the aim of implementing, through a three-year programme, measures relating to environment, productive activities, commercialization, research, dissemination and technical assistance (www.clubdistretti.it).

As regards the regional legislative framework, fishery districts have not been yet identified in Tuscany, under the Law Decree 226/2001 just introduced in the new maritime and fisheries Regional Law 66/2005, drawn up in December 2005. According to the Art.10 of the Law, aquaculture and fishery districts are defined by agreement between public and private stakeholders. The partnership can be practised if coastal provinces or internal provinces, in which at least one fish farm is located, make part of the district. The regional government has to define criteria to organize the district and strategic principles to guarantee its development. Art. 11 defines district roles as such favouring and strengthening

interaction among public and private stakeholders; coordinating marketing strategies; promoting environmental and socio-economic knowledge of fish production; promoting the integration of the sectoral policies with those relating to land use, both maritime and territorial; and finally, making agreement with provinces, cooperatives, and fishermen consortia.

According to the legal context above mentioned, a potential district is the coastal zone of Grosseto Province, in particular the strip of land around the Municipality of Orbetello and surrounding the homonym lagoon with relevant aquaculture and fishery activities. This area represents the small nucleus of a productive district and an important sectoral niche capable of generating relevant income and realizing good-quality products (Tudini, 2003). In particular, the whole production of marine species is organised in such a manner that integration between fishermen and breeders is emphasized, both in managing environmental issues and in addressing commercial and distributional strategies. So, notwithstanding the lack of an institution (rule) defining Orbetello lagoon as a district, this productive system may be considered, for some points, in such a manner.

Fisheries at Monte Argentario's ports

The aquaculture-fishery system contributes to the regional GDP in Tuscany, even though it has low influence on the total revenue and value added. However, its importance in terms of social impact for local communities practising these activities, especially in the traditional fishery, is significant (Tudini, 2003). In Tuscany, traditional fishing accounts for 89% of the total, and is practised by small vessels (<11 gross tonnage-grt) within the territorial waters.

The total number of vessels amounted to 871 units in 1998 according to the statistics of the Ministry of Agriculture (Regione Toscana, 2003). Recent statistics (Irepa, 2003) show that in 2002 the number of vessels for the whole regional fishery was 688, and the gross tonnage nearly 5500. The majority of vessels (493), are committed to small and traditional practices, representing 75% of the whole fleet and 24% of the total tonnage. Trawlers were 106, 15% of the total, but represented 55% of the total tonnage (Irepa, 2003).

The number of regional vessels represents just 4.3% of the national fleet, and in terms of grt just 3.2%. In terms of number, vessels have been reduced by 14% since 2000, while grt dropped by 22%, indicating a consistent reduction in catches and revenues. In fact, 2002 production was just 16 thousand tonnes, causing a total revenue decrease of 16 million euros compared to the 2000 income. In 2002 revenue was nearly 58 million euros, compared to 74 million euros was the total revenue in 2000 (Irepa, 2003).

In 2002 nearly 50% of the total revenue was generated by trawlers that landed 30% of the total catch (4700 tonne). The most numerous species were fish (5700 tonnes), valued at 30 million euros, about 36% of the total catches and 54% of the total revenue. The mollusc harvest was 3000 tonne, valued at about 15 million euros and representing 19% of total production and 26% of total revenue. Shellfish represented only 2% of the total catch (330 tonnes) and 10% of the total revenue (6 million euros) (Irepa, 2003).

Regional coast is divided into four maritime compartments or fisheries. The biggest is Viareggio which has the majority capacity in terms of number of vessels and average gross tonnage (17grt); trawlers are dominant in this fishery. Livorno and Portoferraio are smaller, and have the same average tonnage (13grt), while Marina di Carrara has the lowest tonnage (4grt), and is composed essentially of vessels practising traditional coastal fishing.

Livorno fishery, in particular, is split in further units located in the maritime compartments of Marina di Pisa and Monte Argentario. In all ports of the latter compartment (19) 436 vessels were registered in 2000 of which 222, having an average tonnage of 9 grt, were located in Livorno Province. Eleven, with an average tonnage of 4 grt, were anchored in Pisa Province, while the remaining 203 vessels, having a gross tonnage of 14, stationed in the province of Grosseto (Regione Toscana, 2003).

Thus the regional fleet is spread amongst small ports, and is not homogenous both in its structure and dimension. The "atomic peculiarity" of the regional fishery is due to the high number of small centres in which traditional fishery is well eradicated, such as Porto Ercole, Porto Santo Stefano and Isola del Giglio. These are the Monte Argentario ports, representing 90% of the number of vessels anchored in the southern coast of Tuscany. They have a strong tradition in terms of small coastal fishing and trawling, with no presence of vessels operating using power block nets (Regione Toscana, 2003).

Among them, the biggest is Porto Santo Stefano where operated 54 vessels having 26% of the total gross tonnage (grt) in 2000. There were ten trawlers and 14 traditional fishing vessels in 2000 (Regione Toscana, 2003). The annual average production was 700 tonnes for Porto Santo Stefano fishery in 2000, and 1000 tonnes for the entire compartment of Monte Argentario. The average production per vessel was 27 tonnes and the average daily production 142kg, considering 109 fishing days in a year. Sixty per cent of the harvest is represented by fishes, 6% by anchovies, 20% by molluscs and 14% by shellfish. Total revenue in 2000 was nearly 3 million euros (Regione Toscana, Tudini, 2003).

Fishing activity in Orbetello lagoon

Fishing rights in the lagoon are owned by the Orbetello fishermen, who are organised in a co-operative averaging 70 units. Out of these those dedicated to lagoon fishing are 30, while 20 are those involved in extensive and intensive aquacultural production (Lenzi, 1992; Lenzi *et al.*, 2003; Gennaro *et al*., 2003).
Fishing production has considerably increased since the 1960s, following the increase of fish national demand that could not be compensated by traditional fishery. The average productive increase may be partially imputed to the rise of all trophic levels, as a consequence of eutrophication.
In addition, the quality of fishing produce has changed significantly: while mullet has considerably increased, eel appears to have greatly decreased. However, neither tools and methods nor the number of fishermen working in the lagoon have changed much.

As regards produce, from 1960 to 1990 fish harvest rose from 300 tonnes per year to 500 tonnes per year. However, during the 2000s, this production has halved. The composition has also changed, showing a 20% decrease in eel, while mullet rose by about 15%. Overall, critical periods of dystrophy and flourishing moments alternate. This may be explained by the eutrophic character of the basin and on the other hand by remedial activities carried out. The cost of this remediation is rather high (€ 60.000,00 in 1989), and it must be kept in mind that it is footed only by the aquacultural and fishing farms. However, these expenditures offset the occurrence of murrains: the murrain of summer 1986 caused a revenue drop along the period 1986-1989 of 2.5 billion Italian Lire (about 1.30 million euros) (Lenzi, 1992).

Aquaculture production in Tuscany Region: an overview

Apart from the extensive fishery held in Orbetello lagoon, the majority of marine products in Tuscany are reared in land-based fish farms using intensive techniques. In the southern coast of the Region (Livorno and Grosseto Provinces) there is the greatest concentration of these firms. Many of them are located around the Orbetello lagoon and use groundwater because of its high and constant temperature (20°C) (Regazzi, 2005). According to a recent survey, there are 52 aquacultural plants in Tuscany: among them, 13 rear eurialine species and are located in the south of the Region, mainly in the Orbetello District (5 plants). Only three plants are located in Livorno Province (Regazzi, 2005). There is also a maricultural plant producing 30 tonnes of sea bream per year and a mussel plant in the Orbetello lagoon, extending over 5 hectares and producing 27 tonnes per year (Guidi, 2005; Regazzi, 2005).

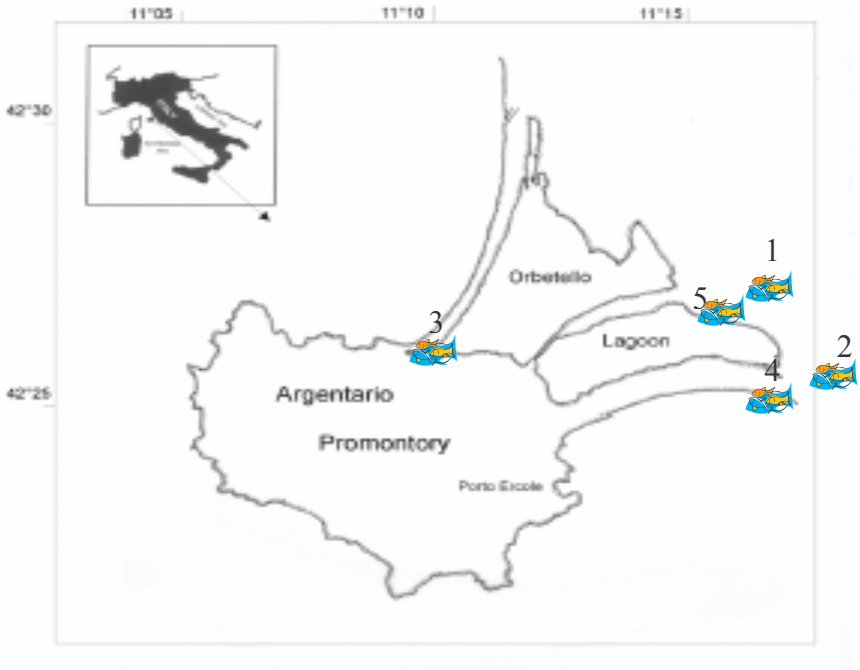
Each of the 13 plants is large, with production exceeding 100 tonnes per year. During the 1990s marine production drifted upwards, while fresh water production dropped. Total aqua cultural production in Tuscany reached nearly 4000 tonnes in 2001. Two thirds of this production is regarded as marine species. Comparing the statistics available for years 1993-1998, a positive trend is evident, doubling production from less than 2000 tonnes in 1994 to more than 4000 tonnes in 1998. However, there has been a decrease of 15% in the new century.

The Orbetello intensive aquaculture began in the middle of 1970s and grew during the 1990s, producing at that time nearly 30% of Italian sea bream and sea bass. Shortly later, this percentage was reduced by the competition of other EU and Mediterranean aqua culturist countries and it now contributes about 10-12% of the total Italian production of eurialine species. The total Italian produce was about 11-12 million euros in 2002 (Regazzi, 2005).

There are 5 intensive land-based fish farms surrounding the lagoon. One is managed by Orbetello Pesca lagunare (OPL), the society which replaced the fishermens' co-operative managing the eutrophication effects before the 1990s. The others are owned by private firms; these are located near the Ansedonia canal, while another is in the opposite position (on the Nassa canal sited at Giannella sandbars), as shown in Figure 4.

1) Il Vigneto
2) Società. Cosa
3) Orbetello Pesca Lagunare
4) Orbetello Pesca Lagunare
5) Ittima società ittica Orbetello

Figure 4: Land-Based Fish Farms around the lagoon of Orbetello.



The Fishing Cooperative: Orbetello Pesca Lagunare srl

Since the early 1990s fishing activities have been managed by Orbetello Pesca Lagunare (OPL), which is run by local fishermen of the former co-operative *Comitato Gestione Peschiere Comunale di Orbetello* CGPCO, and by Orbetello Municipality (*Comune di Orbetello*) that keeps again a small share of the company. The cooperative represents an important business activity in the Orbetello fishery district, from the employment point of view.

Its members are not only oriented to fishing activity, but also to aquaculture, fish processing and marketing, as well as environmental eutrophication management. The latter activity is carried out by a special vessel, which harvests every 30 minutes 0.40-1.20 tonnes of algae. This operation is performed 10/20 times a day for 3 or 4 months per year (Bernacchini, 2005).

Environmental activities integrate the other productive operations that aquaculture requires and the transformation of local and typical products such as *smoked eels*, *bottarga roes* and other fishes less relevant from the commercial point of view. This diversification in the day-to-day operative management adds value to the overall produce and avoids price drops as a consequence of the vast amount of fish imported from other Mediterranean countries (Bernacchini, 2005).

Traditional fishery, extensive and intensive aquaculture managed by OPL

The two main activities Orbetello Pesca Lagunare is involved in are traditional fishing and extensive and intensive aquaculture. Fishing is the historical activity for Orbetello fishermen, and it was profitable until the end of the 1980s. However, after the algal bloom in 1991/1992 it has been necessary to integrate it with both intensive and semi-intensive aquacultural production.

The first fishing system is performed by traditional nets and fishing fixed funnel structures, called "*lavorieri*", located at the end of the three canals connecting the lagoon to the sea. The singling out of fishes trapped by lavorieri is done by hand. Traditional products are eels, mullets, sea basses, sea breams, soles and others (Bernacchini, 2005). Average production in the last four years accounted for 80 tonnes of sea breams, 40 tonnes of sea basses and eels, and 10 tonnes of mullets.

The entire lagoon economy was based on traditional fishing until the 1980s. The belief that the lagoon could sustain greater production led to develop extensive or "integrated" aquaculture. After some empirical attempts, the sea bream was chosen as the leading specie because it grows rapidly and does not have detrimental effects on the environment. So, the number of sea bream sown increased from 33 000 (1994) to 500 000 (2005). Since the end of the 1990s this figure has never dropped below 300 000 units. Other species of commercial interest to be bred are mullet, that has a significant commercial value, and seabass, sown at the rate of 300 000 per year (Bernacchini, 2005).

The extensive aquaculture operates with a low fish density in estuaries or lagoons using least-impact procedures. In the Orbetello lagoon it may be practised because is compatible with wild species, sustainable for the lagoon ecosystem and profitable for fishermen in terms of both quantity and quality.

The areas of the lagoon where extensive aquaculture is implemented are the Nassa canal in the western wing of the lagoon, and the Ansedonia canal, in the eastern lagoon. Both of the eastern and western farms are fenced by nets to protect fish from seagulls and other fish-eating birds which could destroy production. In the eastern basin 30/40 gram of juveniles are sown during spring (March). They are fed artificially until summer, and then they are freed to grow up in the lagoon. This strategy allows the fish to use the algal bed as a natural habitat and feed naturally.

> In the west wing of the lagoon 30-40 grams of juveniles are sown at the end of the spring (May) and are fed artificially until the end of the following winter (March). Finally, they are moved into the lagoon where they can naturally complete the final growing phase. Fishes are then harvested using nets, cages, artificial barriers, called "lavorieri" and illusion instruments. Trapped by these instruments, fish are selected by hand to be marketed, or released, if they are too small, into the lagoon. The selected fishes are sold both to retail markets and to outlets, while the surpluses are stocked in floating cages, in order to constitute a reserve for periods of scarce yield (Bernacchini, 2005).

On average, 3-4 hundred thousand units are reared every year using artificial food for the first six months. The average weight of the final product is 500 grams, and the growing time is 16-18 months. The global quantity of fish produced by the extensive activity ranged from 50 tonnes in 2000 to over 60 tonnes in 2005. The average fish price in the last five years has been maintained around 7 euros per kg. Total revenue of extensive aquaculture ranged from 200.000 to 500.000 euros in the same period (Bernacchini, 2005). In the last five years there has been an increase in the number of sea bream produced, but the price did not drop, owing to a marketing strategy aimed at valorising the quality of the product (see the following section).

The land-based intensive fish farms of OPL have a limited production compared to the other 4 plants located at Ansedonia, with an average harvest of 100 tonnes per year (80 tonnes of sea bass and 20 tonnes of sea bream). The average price in the last 5 years rose from € 6.88 to € 7.83 per kg, but the total revenue dropped from 800.000 euros to 500.000 euros due to the limited yield registered in 2005 (Bernacchini, 2004, 2005).

The total production of the three OPL activities (traditional fishing, extensive aquaculture and intensive farming) was around 400-500 tonnes before the 1990s. However, during the decade 1990-2000, the entire production halved from 514 to 227 tonnes, with a drop in the total revenue from 2.5 to 1.30 million euros. During the last five years, production stayed in the range of 180-290 tonnes, being lowest in 2004. The average price per kg rose from € 5.13 in 2000 to € 6.78, and, in parallel, total revenue ranged from 1.160.000 euros to 1.225.000 euros (Bernacchini 2004; Bernacchini 2005).

Total costs are very close to the total revenue and in particular refer to services (50%), materials (30%), personnel (10%) and others such as social fees and depreciation (10%). The net profit of OPL has been decreasing since 2000, ranging from 50.000 euros in 2001, to 10.000-15.000 euros recorded in the last three years (Bernacchini, 2004, 2005).

Marketing strategy

The sale of OPL products is twofold: to retail markets and to wholesale markets. Penetration into the Italian market is favoured by a strategy based on quality labels, which allows for the clear identification of the area of origin and transformation. These labels are "*Pesce di Orbetello*" (Orbetello Fish) and "*Bottarga di Orbetello*" (Orbetello Bottarga-roes) (Bernacchini, 2004).

The marketing strategy of OPL can be summarised as follows:

1. selling fish to wholesale distribution, especially in the Southern Italian markets (Rome, Naples);
2. selling fish at the retail market by the co-operative itself;
3. adding value to products of low commercial value such as mullet, eel, etc., by adding quality labels;
4. adding value by serving processed and cooked fish at the OPL restaurant.

OPL and intensive aquaculture farms surrounding the lagoon are supported by the local authority in obtaining other labels that certify the origin of products such as DOP (Protected Origin Denomination) and IGP (Protected Geographic Indication) labels (Bernacchini, 2004, 2005). The labelled products have ensured high profits to fishermen in the last 5 years, because of a privileged demand for them on the market. Moreover, OPL is a partner of the international "Slow Food" association in order to increase the interest in those products not well understood by consumers. Fresh fish, in fact, is considered as a feature of the Mediterranean diet and a cultural identity. Slow Food tries to enhance local production, considering small fisheries an added value for sea-dependent regions and aquaculture production as an element of protection and support to the open sea fisheries (Bernacchini, 2004, 2005).

Intensive aquaculture

The land-based fish farms surrounding the lagoon, not managed by OPL, are four. Three of these (see Figure 3) are located in the eastern lagoon and use similar technology, while the fourth is located near the Nassa canal.
From a direct survey on three of the eastern plants emerges as it follows. These plants were built in the middle of the 1970s and traditionally have been producing sea bream, sea bass and shadow fish, even though some of them originally produced eel. By interviews with the owners have emerged similarities among these firms as regards breeding procedures, quantity reared, types of fish produced and characteristics of the commercialised products.

By and large, their produce is made of sea bass (60%), sea bream (30%) and shadowfish (10%). The entire production ranges from 400 to 600 tonnes per year and the final product weighs more than 500 grams, sometimes up to 800 grams, as for shadowfish. Rearing time is 24-32 months. Total revenue per plant is estimated in the range 2.8-4.2 million euros, considering € 7 the average price for a kg of fish. The rearing surface of each plant is about 11-13 hectares and the number of ponds, lined in PVC, is 50. Twelve are dedicated to the first growing phase, until fishes reach 50-80 grams, and the remaining to fattening. The first phase takes about 4-5 months, 1/5th of the entire productive cycle (Guidi, 2005).

Production costs are split between food (40%), personnel (25%), energy (15-20%) and juveniles (10-20%). The recent modernisation (1997) of these plants has caused some additional depreciation costs especially with respect to wastewater treatment (10%) and water filtering. The artificial feed is made of pellets in one case and extruded dry food in the others. The average quantity of feed required for rearing one kg of fish is 2.2 kg for one plant and 2.5 kg for the others. Aeration is achieved by mechanic agitation of water and/or direct inflation of liquid oxygen. Water is pumped from the ground at a constant temperature of 20°C and salinity in the range 17-20 parts per thousand. All plants use a partial recirculation of the water. The hydraulic system is split in two parts, but only few ponds use water partially recycled. The majority of wastewater is discharged seawards through a common canal, as planned by OLERA, while only a small quota is released directly into the lagoon. All these farms have specific system for the treatment of the waters. To reduce solid wastes, water speed is reduced in the canals of the plant to implement a first form of primary (physical) sedimentation (Guidi, 2005).

To enhance the reduction in nutrient concentration phyto-depuration ponds were realised, enclosing part of the eastern lagoon near the Ansedonia canal, as required by OLERA. Notwithstanding the N and P algal assimilation, it emerged that the nutrient reduction was especially driven by the natural sedimentation and chemical denitrification, while the reduction by seaweed accretion was very limited. The difficulty in managing the small fenced phyto-depuration ponds and some political aversion towards managing the seaweed harvesting by mechanical systems, which would have meant the modification of the original enclosure, led to the decision, after three years of life, to remove the fenced ponds in 2003. Talking to fish farm owners revealed that another reason for the phyto-depuration failure was the low release of organic pollution relating to the requirement of the phyto-treatment ponds. To support this idea some research experimented with mussel production in these ponds, though without success (Guidi, 2005; Gennaro *et al*., 2003; Tomassetti *et al*., 2003).

Research on new species breeding

Orbetello aquaculture is essentially based on sea bream and sea bass rearing. However, there is the intention to innovate this sector by investing in breeding other species. Recently, ARSIA, the Regional Agency for the Agro-forestry Development and Innovation, granted 637.000 euros to a project involving 5 Italian universities and several firms and associations of Tuscany dealing with aquaculture. Moreover, Tuscany Region invested 3 million euros in structural investments and an additional 1 million euro is allocated every year. From these

studies, the idea of breeding new species in a recent future was considered plausible, particularly for prawns, mussels and pulps. However, currently shadowfish remains the best opportunity to diversify the production, because problems still exist for octopus and prawns due to the difficulty of these species in surviving during the larval phase (Bernacchini, 2005; Guidi, 2005; Regione Toscana 2003).

Conclusions

This paper has described the characteristics of fishery and aquaculture production in a small area of particular relevance in the Tuscany Region of Italy: the Orbetello lagoon. Since the 1970s the natural evolution of the ecosystem and human intervention have been integrated into a unique management strategy in order to maintain the homeostatic properties of the lagoon, to avoid its impoundment, and to obtain as much produce as possible. Notwithstanding the huge economic and managerial effort in addressing some environmental issues characterising the lagoon, especially since the end of the 1980s, the general idea is that it is possible to manage the relatively small lagoon of Orbetello by using the remedial strategies presented, even though eutrophic conditions prevail, i.e. nutrient sources being at high rate into the lagoon. Therefore, apart from rare dystrophic moments, which reduce overall fishing production, a relatively high nutrient concentration seems to favour good catches. Remedial activities allow rearing in eutrophic basin with the result that some species grow more rapidly and in highly dense populations. In contrast, fishing production appears altered in quality and species distribution. The costs of remedial activities for management are rather high; however, they are more than offset by the prevention of disease.

As regards statistics, the average whole production of the three OPL fishing activities (traditional fishing, extensive aquaculture and intensive farming) remains about 180-290 tonnes, the lowest quantity registered in 2004, and total revenue ranging from 1,160, 000 euros to 1,225,000 euros (Bernacchini 2004; 2005). Total costs are very close to total revenues and in particular refer to services (50%), materials (30%), personnel (10%) and others, such as social fee and depreciation (10%). The net profit of OPL has been decreasing since 2000, ranging from 50,000 euros in 2001, to 10,000-15,000 euros recorded in the last three years (Bernacchini, 2004; 2005).

The intensive fish farms of the district produce sea bass (60%), sea bream (30%) and shadowfish (10%). Total revenue per plant is estimated in the range 2.8-4.2 million euros, considering € 7 as the average price for a kg of fish.

Global district productivity is quite high and represents 10% of the Italian eurialine aquaculture production. Extensive aquaculture accounts for 200-300 tonnes, while total land-based fish farm production is in the range 2,000-3,000 tonnes per year, earning yearly total revenue of 15-20 million euros. Production costs are split between food (40%), personnel (25%), energy (15-20%) and juveniles (10-20%). The recent modernisation (1997) of these plants requires depreciation costs to be considered, with respect to wastewater treatment and water filtering (10%).

The primary motivation amongst the fishermen and aquaculture farmers of Orbetello is to avoid internal competition and maintain high prices, notwithstanding the imports of products from competitive Mediterranean countries. The marketing strategy is based on selling the majority of the produce to the wholesale distribution through a unique distributive channel, a cooperative that transforms and distributes the majority of aquacultural products as fresh and frozen fish. Penetration into the Italian market is also favoured by a scheme based on labels and certification, which allows for the clear identification of the area of origin and transformation. These labels are "*Pesce di Orbetello*" (Orbetello Fish) and "*Bottarga di Orbetello*" (Orbetello Bottarga-roes), while DOP and IGP labels are in the study phase. Another way to stimulate the consumer culture for "fresh fish" is the OPL joining the international organization "Slow Food" with the aim of enhancing local production visibility, and supporting the idea that small fisheries can be an added value component for sea-dependent regions, and aquacultural production an element of protection for and support to the open sea fisheries.

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