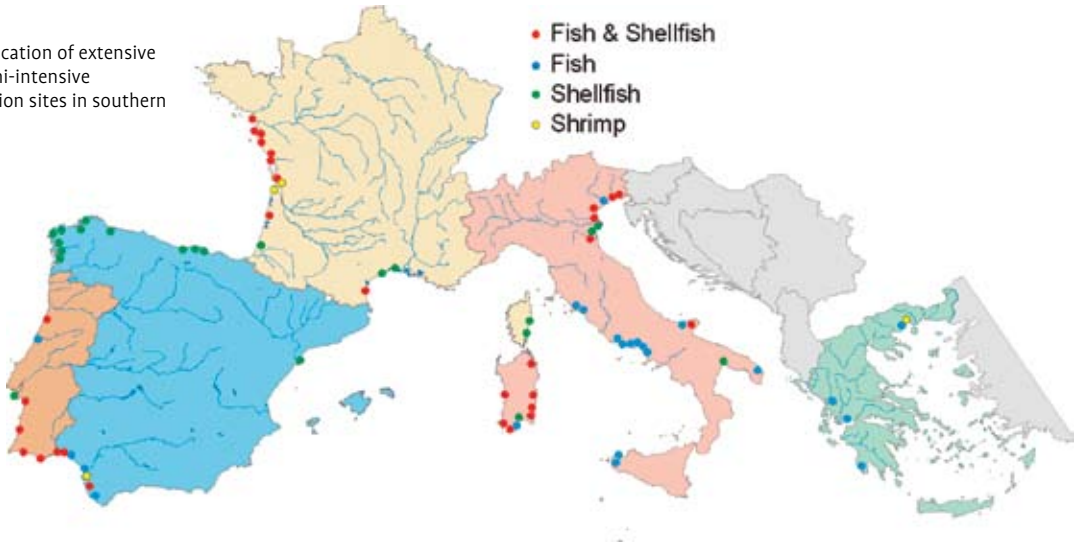

Fig.1 : Location of extensive and semi-intensive production sites in southern Europe.

The current status of extensive and semi-intensive aquaculture practices in Southern Europe

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INTRODUCTION

In less than 30 years, intensive fish farming has become the main provider of marine farmed products. Yet, extensive and semi-intensive systems[1] still represent significant amounts of production and use large places along the southern Europe coastal zones. These include confined areas of coastal lagoons, natural and managed deltas, and semi closed bays and estuaries, encompassing polders with earthen ponds. The farming systems studied are aquaculture *stricto sensu* and capture fisheries of cultivated species.

HISTORIC BACKGROUND, LOCATIONS OF PRODUCTIONS

Total surface of coastal wetlands used nowadays for extensive and semi intensive production seems quite large, At least 92 000 ha have been recorded through the Seacase project (Tab.1). But these values encompass only the used proportion of wetlands (full surface of open water of lagoons plus the amount of marshlands, that are of larger size), so further geographical studies would be necessary to give a more accurate potential of land use for aquaculture.

The list of identified sites and areas of production is given in fig 1. It can be considered as being quite complete.

Productivity is an issue for modern semi-intensive farming, and good values can be obtained. This is very different for extensive systems that display all ranks of values depending on the level of natural constraints, management and technical ability, among other factors. Productivity gain could be achieved in many cases. For the lower values, it often depends on the manager involvement level, and if economic return is reachable or not (eg. non profitable traditional fisheries).

Modern techniques have been integrated by farmers for mass production of shellfish (oysters, clams), as well as semi intensive fish and shrimp rearing. They are quite homogeneous from one country to another. Adversely, traditional practices display more differences regarding technical protocols and water management.

Improvements on commonly farmed species have allowed reliable production, mainly concerning oysters and mussels' monocultures. Shellfish aquaculture provides massive volumes of production in lagoons (>100 000 T), and this is a noticeable contribution to total European

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1 Semi-intensive fish farming was defined as a farming practice where fish feeding is carried out at least two times per week and fertilizing once per week (FAO).

Tab. 1 : Surface, production and number of farms devoted to each system in Southern Europe countries.

System		Portugal	Spain	France	Italy	Greece
Molluscs (ext)	*Surface (Ha)*	n/a	n/a	3860	n/a	n/a
	Production (T)	4 230	3000	> 16 800	87630	n/a
	Nb farms	1 381	n/a	n/a	244	n/a
Fish (ext)	*Surface (Ha)*	n/a	n/a	>4500	74442	n/a
	Production (T)	505	250	n/a	2200	500
	Nb farms	49	n/a	n/a	147	n/a
Fish (semi-int)	*Surface (Ha)*	n/a	n/a	n/a	n/a	n/a
	Production (T)	2 020	3250	N/A	4700	n/a
	Nb farms	65	12	2	12	n/a
Shrimp	*Surface (Ha)*	n/a	n/a	300	n/a	n/a
	Production (T)	n/a	112	50	n/a	n/a
	Nb farms	n/a	3	15	n/a	n/a
	Tot surf (Ha)	**1 633**	**7500**	**8660**	**74442**	**n/a**
	Tot prod (T)	**6 755**	**6612**	**16815**	**94 530**	**500**
	Tot nb farms	**1 495**	**>15**	**>15**	**>403**	**n/a**

shellfish production (including offshore productions). Lagoon use is optimized (over 100 000 ha), but expansion in many other lagoons is limited by the threats of pollution and eutrophication processes. In many cases, the abandonment of marshlands with earth ponds may be critical (France, Spain, Portugal), although they could still provide room for extra refining productions (small amounts), as is the case in France.

The ancient practices of extensive fish aquaculture still continue because of the traditional background of local populations. Apart from in Italy (eg. Valli's and artificialized lagoons), these activities benefit from only partial improvements. They produce small amounts of high quality product, but suffer from a lack of traceability and public recognition. Only Italy with their different types of lagoons displays an optimized use of their potential for extensive fish production, with probably a large production volume despite lack of statistics.

Semi-intensive productions of fish are a further development based on these traditional practices. Several successful trials during the 15 last years have since been converted into reliable farming systems (notably in Spain and in Portugal). Fish production statistics are not complete, but reach a minimum of 4200 T (total in countries studied). Real production is probably higher, but non-official trade practices and barter still persist and prevent from getting more reliable numbers.

REARED SPECIES

The reared species have been inventoried by country in the following table (Tab. 2).

Tab. 2 : Species grown in coastal wetlands in southern Europe..

System	Portugal	Spain	France	Italy	Greece
Intertidal	Clams, oyster	Clams, oyster	Oyster		
Saline reservoir	Seabream, eel, mullet, sole, seabass	Clams, shrimp, seabream, eel, mullet, sole, seabass	Seabream, eel, mullet, sole, seabass		
Earthpond	Seabream, eel, mullet, sole, seabass	Shrimp, seabream, eel, mullet, sole, seabass	Oyster, shrimp, seabream, eel, mullet, sole, seabass	Seabass, eel, seabream	Seabream, sole, mullet, seabass
Lagoon, pond			Oyster	Clams, oyster, mussels, seabass, seabream, eel, mullet	Shrimp, seabream, eel, mullet, seabass
Closed estuary					Seabream, eel, mullet, sole, seabass

The various systems that were inventoried display similarities, according to the physiognomy of the coast and tidal regime, with strong similarities between practices in the Atlantic, and the same in the Mediterranean.

ADVANTAGES AND WEAKNESS OF EXTENSIVE AND SEMI INTENSIVE SYSTEMS

PORTUGAL:

Several constrains have contributed to an extremely low development in Portuguese aquaculture. Both traditional extensive systems and newer semi-intensive systems are settled in wetland areas, several within the natural parks and under conservation protection. This legal condition is a huge constraint for the sector, in particular for semi-intensive farms, as it restricts the implementation of new coastal farms and the expansion of existing ones. With poor possibilities to grow, the majority of farms are micro-enterprises (family based), producing small quantities, sold to local buyers (restaurants). Also, due to insufficient coastal management plans, their fragility to untreated anthropogenic wastes, from urban and agriculture sources, has been responsible for some important economical losses, particularly on mollusc production in lagoon systems.

Extensive fish farming in earth ponds faces difficulties and is gradually disappearing, leading to abandonment of large areas along the Portuguese coast. Due to their low profitability and decline in farmers' interest, present research is more dedicated to solve semi-intensive and intensive production problems. Because of the increasing density levels in production, efforts have been made to detect and prevent the first signs of disease. Farmers have also developed solutions to prevent losses (which can reach 30% of the production) due to predators, such as otters and birds.

Fig.2 : Extensive fish farming in the Bay of Cádiz (Spain).Source FMA

Aquaculture practices in intertidal areas remain extremely dependent upon environmental constraints and surrounding activities (agriculture, factories, aquatic sports, or even other fish farms). The productivity decrease in clam production is mainly explained by a parasite (*Perkinsus marinus*) which causes high mortalities and massive production losses, but also due to difficulties in managing predators and the excess of organic matter accumulation in the rearing sediments. For example, in Ria Formosa the productivity of clams declined by a magnitude of 6 to 8 between1980 and 2005). Aquaculture on long lines has partially solved these problems.

To develop the aquaculture sector, efforts are required in several areas: production and management, marketing, research and training. Diversification would be an issue, instead of focusing on the same common species. Research and experimentation is crucial in this area for innovation, as well a wider connection among industry and other stakeholders. Improved farmers training needs to be accomplished – for example through farmers' associations.

SPAIN:

The use of 'old' salt ponds in transformed marshlands for aquaculture still continues despite several kind of difficulties: incomprehension of administration and other sectors of the society and the competition with other economical activities. These coastal marshes and lagoons are of high environmental value and most of them have been declared natural parks or protected areas. Such status is preventing other uses that are incompatible with the maintenance of the wetlands, although it does not guaranty the maintenance and health of some of these ecosystems. Without the huge and continuous efforts of farmers to manage the water and ditches, the ponds tend to fill with mud or be destroyed by the sea. Many examples of these consequences may be observed in abandoned salt works in the Bay of Cádiz.

However, those zones contain considerable potential available space for coastal aquaculture (e.g. Andalusia). There is a growing interest (measured by the number of new license requests) to make or use new earthen ponds, and this is higher than the number of new requests for sea cages. This fact would reflect some optimistic expectations for the near future of marine fish production in earthen ponds. The effort of the producers associations for the differentiation of high quality products produced in the "esteros" and the combination of extensive and semi-intensives systems adapted to the specific characteristics of wetlands seems to be a good way to advance aquaculture development in coastal earthen ponds. About 4000 ha belonging to former abandoned salt works would be available for extensive and intensive aquaculture production. But in many cases the investments required are depending on an approval of the administration, and/or depending of the resolution of conflicts for land property.

FRANCE:

The large French extensive and semi-intensive aquaculture sector is currently facing several problems. Shellfish production, and oysters in peculiar, has suffered from severe diseases in 2008 and 2009, and were subject to low natural reproduction success for the last few years (*idem* for mussels). Climatic events are supposed to be involved in these unbalanced coastal conditions that help toxic microalgae, bacteria and viruses to cause lethal outbreaks. The urban pressure and continental runoff are also possible causes of higher susceptibility of cultivated species to poorer water quality. Large programs for water treatment at river catchment scale are now starting to give results, and will hopefully compensate human population increase on the coast. Farmers and scientists have developed engineering solutions to respond to

technical challenges, such as water supply, water quality, optimisation of farming process and sanitary insurance.

The use of marshlands remains stable, despite increasing consumer demand. A lot of space is available for oyster storage and finishing in coastal marshes. But the extra production cost is hardly compensated by reselling price, except in Marennes-Oleron with its labels based on the use of earthen ponds for oyster 'finishing'. Productions in lagoons are also of prime interest. But their development has reached a maximum level regarding the required environmental conditions. Water quality remains the main limiting factor, until drastic, large scale, improvements could be obtained from regional water management. Shrimp production is submitted to micro-market conditions, but which are still in good health due to its up-market position. However, production costs could eventually rise with higher environment quality constraints, or a decrease in larval quality. The strict survey on their production process done by farmers, and the technical optimizations provided by Ifremer and CREAA mean that production is stable at present.

Extensive fish farming remains the less reproducible production, due to natural events. But the quality of the products is comparable with 'wild' fish. Optimization of the production processes have been proposed to stimulate private landowners, but whose interest in these productions has decreased for the last 50 years. But it is the urban pressure on the fish-farming marshlands, aiming to transform them into leisure land (gardening, hunting, *etc.*) that is still the highest risk to the disappearance of this activity in these large areas. Semi- intensive fish farms remain efficient, but their geographic importance in marshlands is low. Restrictive administrative constraints have stabilized their number. A few shellfish producers use their buildings to host nurseries and provide fry to surrounding farmers. This activity could take a greater importance because of its low impact on the environment, but it still relies on a further development of farmer skills - and most of them would need extra training and specific courses.

Fig.3 : Urbino Lagoon (Corsica) with ancient 'high tables' for oysters rearing on ropes .Source M. Gonzales

ITALY:

In the North Adriatic areas, valliculture has long represented a good example of the efficient use of coastal areas for productive purposes, and has made a decisive contribution to the conservation of wetlands in the context of coastal lagoons. The word *valle*, meaning embankment, is nowadays used only for coastal basins of the North Adriatic. Originally it indicated a simple primitive lagoon, enclosed for fish-culture purposes. From *valle* we have *vallicoltura* which is a term generally, but incorrectly, used to indicate all forms of aquaculture in coastal lagoon. Valli and Lagoons exploitation is optimized and shows steady productions levels (fish and molluscs) despite human pressures on ecosystems. Valli provide an optimal environment also for nesting, wintering and food supplies for many birds. Valli systems are low energy cost farming techniques that have ensured the conservation of the sand banks and shallow lagoon waters. In some lagoons, increased eutrophication due to aquaculture and agricultural activities, as well as the discharge of treated/untreated urban wastewater has gradually led to qualitative and quantitative ecosystem alterations.

The use of valli as areas of seeding and growth for aquatic species is widely recognised as an ecologically compatible exploitation system, but it must be managed and controlled to maintain exploited fish stocks, without negative impacts on natural fish resources. A set of recommendations for fish stock management has been established for that purpose. It includes the monitoring during farming cycle, the management of water level, hydrodynamism, and of fresh and salt water stratification in order to face extreme temperature effects on fish survival, the anticipation of the recapture time from November to September in order to avoid contemporary greatest abundance of fish-eating birds and migratory fish aggregations, the optimisation of seeding period and quantity of juveniles of autochtonous species.

The main bottleneck in valliculture is actually the augmenting populations of fish eating birds, which in the last 10 years have been responsible for a drastic reduction of recapture rates (about -30%). Their impact on stocked fish could be direct, when they are successful in catching them, or indirect, for the development of secondary infections in the escaped fish of the injuries inflicted by birds or for a general lowering of performance, due to different factors (e.g., stress, anomalies in lateral line as a consequence of the scars, lower accessibility to local sites with higher trophic availability where the presence of predator birds is higher). Furthermore, they provoke disorders on fish migration toward fish barriers, disbanding fish toward summer pasture zones so provoking death by cold during winter time.

In general, valliculture is an excellent model for sustainable coastal wetland management characterized by variable salinity.

GREECE:

Extensive coastal aquaculture can be performed at some 76 sites in Greece. However, most aquaculture development efforts (in terms of production volume) are done on intensive production in sea cages. Nevertheless several improvements could be done with existing extensive systems.

The major actions for the enhancement of the productivity of the estuaries include the maintenance and improvement of incoming channels, and overwintering facilities for fish. Extensive fish production in lagoons is subject to poor water quality when macro-algal blooms

occur. In many cases, technical staff are in charge for the removal of excessive vegetation. For semi-intensive production, efforts are focused on the surveillance of the lagoon area (or earthen ponds) for the avoidance of theft and the construction of overwintering ditches, which are especially important in earthen ponds in Northern Greece. The depth of the ditch is important for the successful outcome of this action. In addition, aeration of the lagoon and ponds in summertime with aeration paddle -wheels may be necessary depending on the stocking density of the ponds. Finally, the removal of predator fish, such as seabass, is of high importance to avoid severe losses of stocked populations.

In addition, surveillance of environmental factors is important to guarantee the viability of the fish populations and the safety of the product for consumers. Most locations that are used for extensive and semi-intensive aquaculture are in areas that are recipients of agricultural and rural wastewater and may be contaminated with pesticides and other harmful compounds. Management of lagoons and ponds therefore requires both technical and scientific expertise. This knowledge can be supplied by experienced personnel or by assistance of public services with the necessary scientific and technical background. Most efforts of fish farmers are directed to maintain the fish traps, remove plant material, and sort the fish.

ISSUES FOR EXTENSIVE AND SEMI INTENSIVE AQUACULTURE

Adequate legislative and governance implementations aimed at favouring extensive aquaculture in natural wetlands and the ecological maintenance of their functionality and productivity should be aimed at a 'good practices' formulation, taking into account the issues set below.

Engineering issues: regarding difficulties for farmers to sustain an extensive activity with sufficient incomes, research would help by improving natural productivity to ensure improved basic productions. Semi intensive systems would also benefit from engineering improvements through increased reliability and security in rearing processes. Particular attention should be given to provide water quality survey knowledge to farmers that are still relying on observation clues alone to control production, instead of preventing problems with basic survey principles (dissolved oxygen, salinity, temperature). Wetlands morphology management and restoration are the basis of land production potential. As many areas suffer from a lack of hydraulic intervention this potential is diminishing every day and further ability to reuse such hydrosystems would induce extra costs to get back appropriate design and hydrology regimes. A legislative framework should be devised to allow hydraulic and other works in coastal lagoons to be rapidly evaluated, regulated and implemented. Whenever possible, such works should be made on a collaborative basis between farmers and public agencies.

Ecological issues: the preservation of the ecological functionality of fragile ecosystems like lagoon, marsh and wetlands is closely linked to specific management practices and planning, at present mainly sustained by private companies. The management of these environments requires the identification of appropriate multilevel ecological descriptors and their continuous improvement, selection and monitoring. The integration and elaboration of available data should be used to interpret ecosystem dynamics, structure and function so as to predict the direction towards which the ecosystem under human control is evolving and thus manage it by means of appropriate interventions.

Social and economic issues: the labelling of the products of extensive aquaculture is one of the very few feasible paths for maintaining the profitability of this environmentally friendly animal production and to counter the market saturation of species such as seabream and seabass produced by intensive fish rearing. The possibility of combining aquaculture with multifunctional (i.e., tourism, educational, recreational) activities involving new generations of managers represents a focal issue for management continuity and the conservation of a traditional aquaculture, both of which are essential for ecosystem protection. However, such activities could be insufficient to guarantee economic profitability from extensive aquaculture. The development policies for the extensive aquaculture sector should be 'equipped', as was done for rural development in agriculture, with instruments to support the enterprises and designed to reward a utilization of the areas with methods having a high environmental value: in other words, defining an economic value to the extensive and environment-friendly use of the wetland areas.

CONCLUSION

Guidelines for the correct management of extensive basins have still to be formulated with sustainability purposes. Most of the extensive and semi-intensive aquaculture systems are environmentally friendly activities and contribute to preserve natural wetlands in coastal areas. The new governance must take into account some strategic issues regarding engineering, socio-economy and ecology for maintaining extensive aquaculture production at a satisfying level of profitability and ecosystem functionality.

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