Aquaculture International
NOV 2002; 10(6) : 507 - 525
http://dx.doi.org/10.1023/A:1023975418669
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Shellfish farming and Coastal Zone Management (CZM) development in the Marennes-Oléron Bay and Charentais Sounds (Charente Maritime, France): A review of recent developments

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Abstract:

France is currently one of theleading shellfish production countries inEurope, harvesting more than 150,000 metrictons of the Pacific cupped oyster (Crassostrea gigas) and 60,000 tons ofmussels (Mytilus edulis and M.galloprocincialis) each year. Amongrearing areas, the Charentais Sounds and theMarennes-Oléron Bay rank first in Europe,with an annual production of 40,000 and 15,000tons of oysters and mussels respectively. Morethan a third of French production is marketedfrom the Marennes-Oléron area. As naturalC. gigas and M. edulis spatfall islimited to the Atlantic coast, theMarennes-Oléron Bay and the CharentaisSounds play a critical role nationally,representing more than half of French oysterand mussel spat production. The stockingbiomass in this area was recently estimated at125,000 and 20,000 tons of oysters and musselsrespectively. This biomass is deployed over4,000 ha of leasing grounds along the coastalarea and 3,000 ha of wetlands (oyster ponds),which are environmentally sensitive and subjectto numerous recent regulations.
Although a traditional, century-old activity,the shellfish industry now has to addressvarious new internal and external constraintsaffecting overall economic yield andsustainability. These include the management offreshwater inputs into the coastal area,impacted at the watershed level by agriculturefrom a qualitative and quantitative point ofview (e.g. irrigation activity). Moreover, theCharentais Sounds need to remain competitive onthe open market with other French and Europeanproduction sites, whereas its biological yieldremains one of the lowest in France. This hasprompted the industry to optimize spatialdistribution, restructure current leasinggrounds and assess new management practices aswell as new rearing techniques (offshore, longlines), which have led to conflicts overavailable space. In addition to technicalconstraints, local, national and Europeanregulations have increased significantly. Thecoastal law, water law, bird directives, andregulations concerning the preservation ofnatural habitats, wild flora and fauna andprotected areas are among the acts likely tohave an impact on the shellfish industry in thenear future.
These internal and external constraints onaquaculture sustainability are analyzed, andcertain case studies in the Charentais Soundsthat have led to user conflicts are reviewed.The diversity of habitats, human activities andinterests along this coast have resulted inhighly complex situations in which somemanagement attempts have been partly successfuland others have failed. These managementoptions are analyzed, and ongoing newapproaches are described, including cooperativestrategies among marine biologists,sociologists, economists, managers, coastalusers, and the shellfish industry. Based onthis analysis, requirements for the developmentof an integrated CZM plan in the CharentaisSounds are suggested, including the use of aproactive approach, geomatics and operationalmodels, as well as the development ofintegrated decision making structure to developCZM and then, the use of a stepwise model ofagreement-focused negociation for furtherconsensus building.

Keywords: Bay of Marennes-Oléron - Charentais Sounds - Coastal Zone Management - Conservation - Environment-aquaculture management - Stepwise model of agreement

Introduction

France is currently one of the leading countries in Europe for shellfish production, harvesting more than 150,000 metric tons of the Pacific cupped oyster (*Crassostrea gigas*) and 60,000 tons of mussels (*Mytilus edulis* and *M. galloprocincialis*) each year (Figure 1) (Goulletquer, 1998). Among the rearing areas, the Charentais Sounds and Marennes-Oléron Bay rank first, with an annual production of 40,000 tons and 15,000 tons of oysters and mussels respectively. More than a third of French production is marketed from the Marennes-Oléron area (Figure 2).

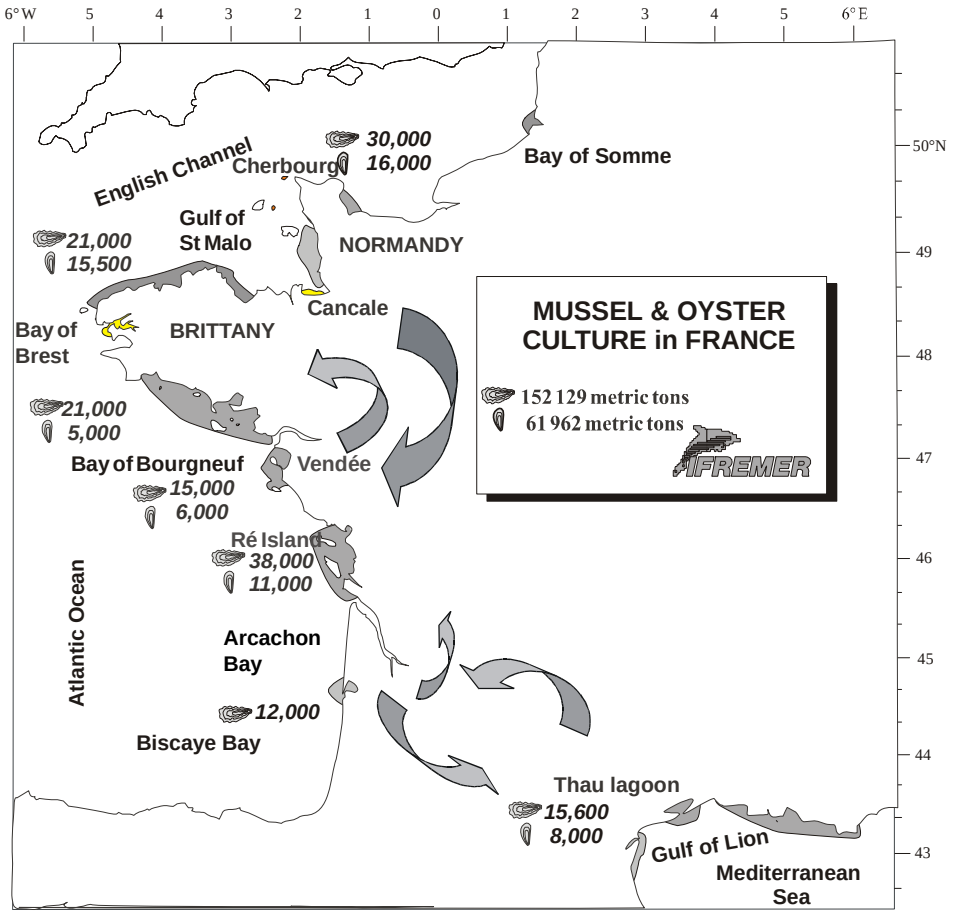

Figure 1 : Shellfish production in France and principal stock transfers (arrows) among French rearing areas (from Goulletquer, 1998).

As natural *C. gigas* and *M. edulis* spatfall is limited to the Atlantic coast, the Marennes-Oléron Bay and the Charentais Sounds play a critical role nationally, representing more than half of French oyster and mussel spat production (Goulletquer and Héral, 1997). Management practices have prompted shellfish farmers to use various coastal areas to sustain production. Shellfish biomass is frequently transported among French as well as European production sites, ensuring optimal growth conditions for each part of the rearing cycle. Using statistical stock assessment methodology, the stocking biomass in the Charentais Sounds was estimated in 2001 at 125,000 and 20,000 tons of oysters and mussels respectively (Figure 2).

This biomass is deployed over 4,000 ha of leasing grounds along the coastal area and 3,000 ha of wetlands (oyster ponds), which are environmentally sensitive and subject to many recent regulations. As traditional shellfish production has occupied this coastal zone for more than a century, the industry has played a critical role in shaping the environment as well as the social and economic organization of local populations. However, the shellfish industry is now faced with several internal and external constraints affecting overall economic yield and sustainability. Basically, the contribution of this industry to coastal management has progressively shifted, and its role in the decision-making process is no longer dominant. The sustainability and further development of this industry need to be considered in terms of a resolution of conflicts between the preservation of natural resources, on the one hand, and economic exploitation or other human interests and activities, on the other. The development of an integrated coastal management plan for the Charentais Sounds is likely to be the major objective in the near future.

This study analyzed current internal and external constraints on aquaculture sustainability and reviewed case studies in the Charentais Sounds concerning user conflicts. Some management attempts have been partly successful, despite a highly complex situation, while others have failed. These management options are analyzed, and ongoing new approaches are described, including cooperative strategies among marine biologists, sociologists, economists, managers, coastal users, and the shellfish industry. Based on this analysis, requirements for the development of an integrated CZM plan in the Charentais Sounds are suggested.

Figure 2 : Current situation of the aquaculture in the Charentais sounds (shellfish stocking biomass, and private finfish farms' distribution) (LCPC, 2001).

1. Review of various internal and external technical constraints affecting aquaculture sustainability in the Charentais Sounds

1.1 Seawater and spatial management for the finfish culture industry

Although a recent activity, the significant increase in intensive finfish culture production in the Charentais Sounds has led to direct conflicts of interest with environmentalists, the tourism industry and other industrial sectors, including shellfish culture (Figure 2). Several farms located in the Ré Island wetlands are pumping underground seawater and freshwater. The seawater temperature is constant throughout the year, and there is no particulate matter or bacteria. Recent higher production has led to increased pumped volume, affecting underground layers, and caused side effects relating to interactions between salt and freshwater aquifers. Moreover, farm seawater outputs and the location of facilities in wetlands have been considered by several users as damaging for the environment. In the absence of any joint agreement among users, several lawsuits have been initiated by environmentalist groups to rescind state authorization for underground seawater exploitation.

1.2 Freshwater management for the shellfish industry

As early as 1985, the Marennes-Oléron Bay was considered to be overstocked, with 100,000 metric tons of cultured oysters deployed over 3,600 ha of leasing grounds, 23,000 tons of wild oysters, and more than 50,000 tons of other benthic filter-feeders (Héral, 1985). Bay carrying capacity had been exceeded through overexploitation, thereby leading to a significant oyster growth rate and resulting declines in economic yield (Bailly, 1989, 1994). Progressive increases of cultured stocking biomass by an emerging industry over a century contributed to a concomitant increase of the oyster mortality rate and an overall decline of growth performance (Héral, 1993). In the meantime, coastal primary productivity became directly affected by freshwater inputs, mainly from the Charente River, which contributes more than 90% of all nutrients reaching estuaries (Raillard and Menesguen, 1994) (Figure 3). Actually, the use of freshwater for irrigation is one of the main objectives of agriculture interests in this watershed that covers 1 Mha. More than 720,000 ha are currently used by agriculture (30,000 farms), and corn production represents 40% of the activity. Irrigated land has increased progressively from 17,000 to 45,000 to 64,000 ha in 1980, 1987 and 1995 respectively. Irrigation time has similarly increased, as well as the volume used per hectare (1,000 to 3,000 m^3). This overall trend has led to a drastic decline in Charente River flows in summer, from 16m^3 (1980s') to 6 m^3 (1990s'), and to almost no flux during dry years (e.g. 1998). This significant trend has affected primary productivity along the coast as well as natural spatfall, since oyster larvae require decreased salinity to survive (His et al., 1989; Héral, 1990).

In addition to quantitative needs for inputs, the quality of freshwater is also critical for the shellfish industry. Increased land drainage in the watershed for the development of agriculture has increased micropollutants input into coastal areas which resulted in downgrading the sanitary zoning from 'A' to 'B' in several shellfish production sites (e.g. Aiguillon Bay) (Figure 4). The downgrading has economic side effects, by the requirements for a depuration process, or a temporary arrest of product marketing. As coastal users are at the end of the freshwater cycle in spatial terms, this represents a significant external constraint on shellfish quality, which may permanently affect the industry. Therefore, both quantitative and qualitative approaches have led to conflicts of interest with agricultural activity.

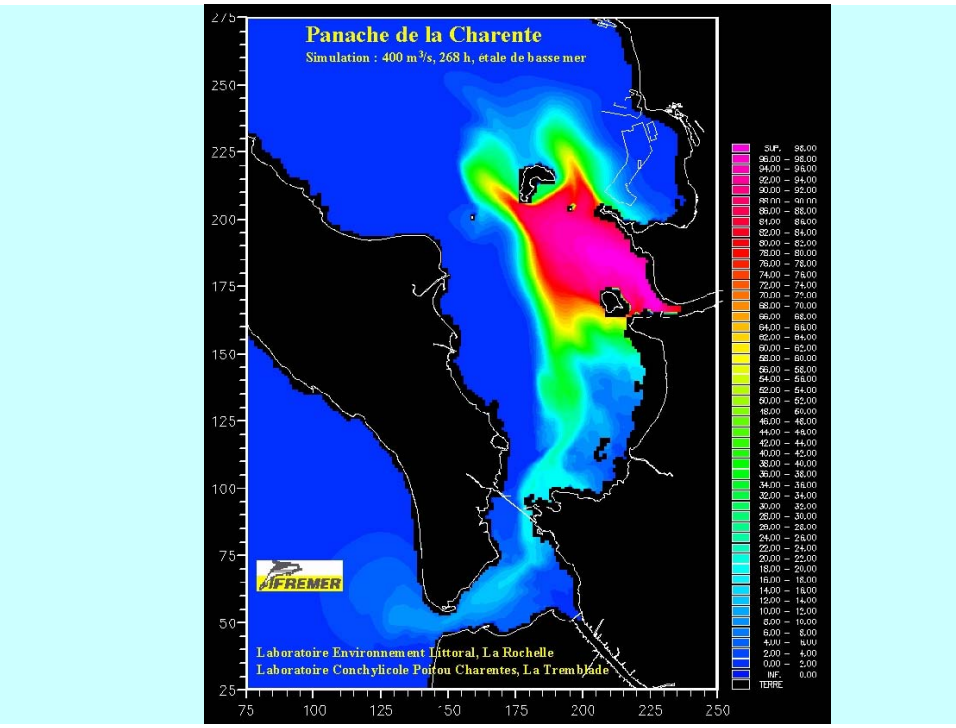

Figure 3 : Freshwater flows from the Charente River (DEL, 2000).

1.3 Competitiveness of the shellfish industry

As demonstrated by the French national monitoring network (REMORA) for the assessment of overall *C. gigas* performance, current growth rates in traditional areas such as the Marennes-Oléron Bay remain well below the national average. The consequences of this has been an economic decline on the open market for these productions (Figure 5). The local shellfish industry responded to this challenge initially by managing the stocking biomass, eradicating wild populations, and restructuring leasing grounds. New techniques (dredging) using traditional tidal leasing grounds were then assessed. More recently, offshore production using subtidal as well as new areas and long-lines have been used to decrease the stocking biomass within the Marennes-Oléron Bay. It aims to transfer off shore a part of the stocking biomass and to deploy shellfish far from potential point sources of pollution. It is expected that shellfish quality and growth performance will be improved through the application of these new approaches. However, the transplantation of cultured shellfish into new grounds has led to conflicts of interest with other coastal users, including: the shellfish industry involved in public fishing activities (e.g., scallops), the finfish fishing community as well as tourism and shipping interests when long-lines interfere with navigation (Figures 6 & 7).

Figure 4 : Seawater quality zoning for the shellfish production in the Charentais sounds and the Bay of L'aiguillon (Anonymous, 2000)

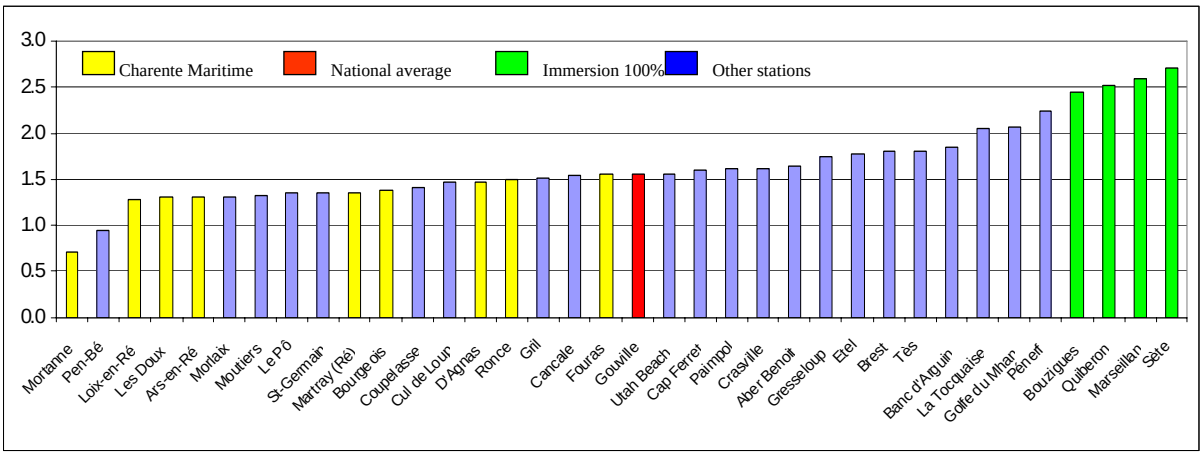

Figure 5 : *C. gigas* growth results from the national monitoring network (REMORA). Cultural practices are standardized to facilitate inter site and pluri-annual comparisons (Fleury et al., 2001). All rearing stations, but the subtidal ones, are intertidally located. Standardized culture conditions : oyster bag on trestles.

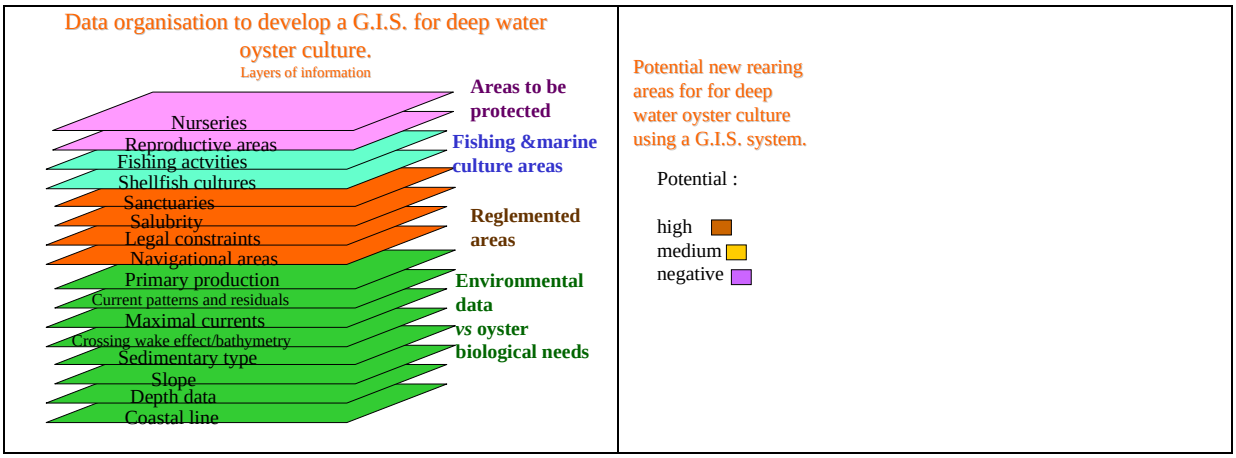

Figure 6 : GIS development to assess potential areas for deep water oyster culture (overlaid layers of information, resulting map) (Populus et al., 1997).

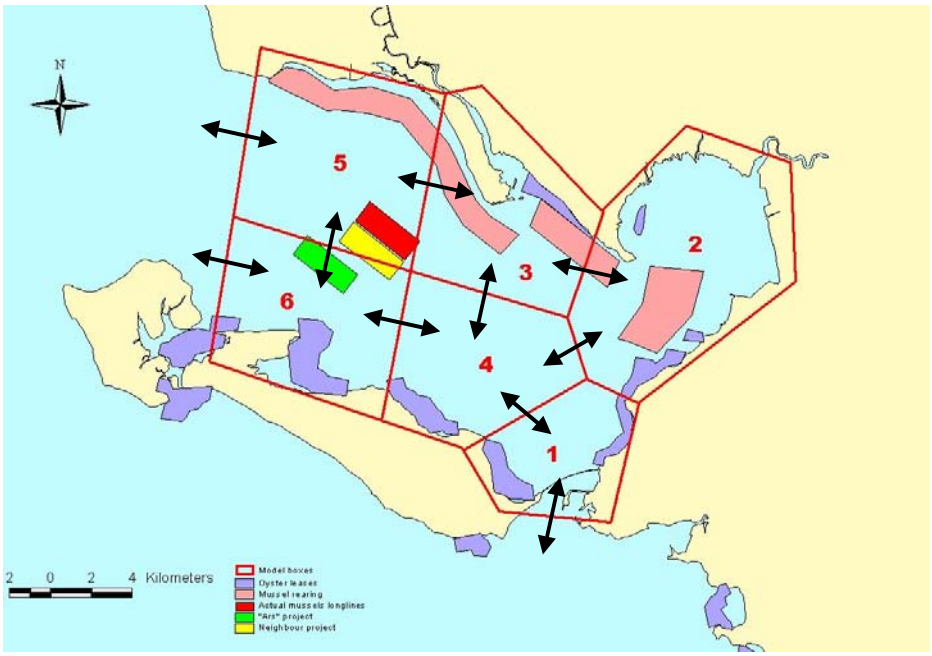

Figure 7 : Long lines project in the Breton Sound for mussel and oyster culture development. Based upon an analytical model including hydrodynamic model, stock assessment and growth rates, environmental data, freshwater nutrients inputs, food quality and origin parameters. Arrows represent quantified fluxes of seawater and primary production (Robert et al., 1999, modified from Fabien, 1997).

2. Review of recent legal regulations affecting shellfish production

Regulations in coastal areas such as the Charentais Sounds are based on several sources, including : local and regional management entities (parks, sanctuaries), national agencies (coastal and water laws), European environmental directives (‘Habitat’, ‘Protected Sites’, ‘Natura 2000’, ‘Wild Flora and Fauna’), directives concerning shellfish products directly (‘Sanitary and Zoosanitary Zoning’), and international treaty commitments (RAMSAR, RIO). Wetland zoning has usually led to conflicts of interest among managers, environmentalists and the shellfish industry. The latest European Union directive concerns micropollutant thresholds, which have been halved, leading to management problems for the Charentais Sounds (Figure 8).

Several field transcriptions of these recent regulations are shown on the map below (Figure 9). These regulations are highly varied, lack effective coordination and require a good understanding to reach a global view, assess overall impact and balance the preservation of natural resources with social and economic needs. The impact on the shellfish industry may be decreasing land and coastal access, as well as restricted development.

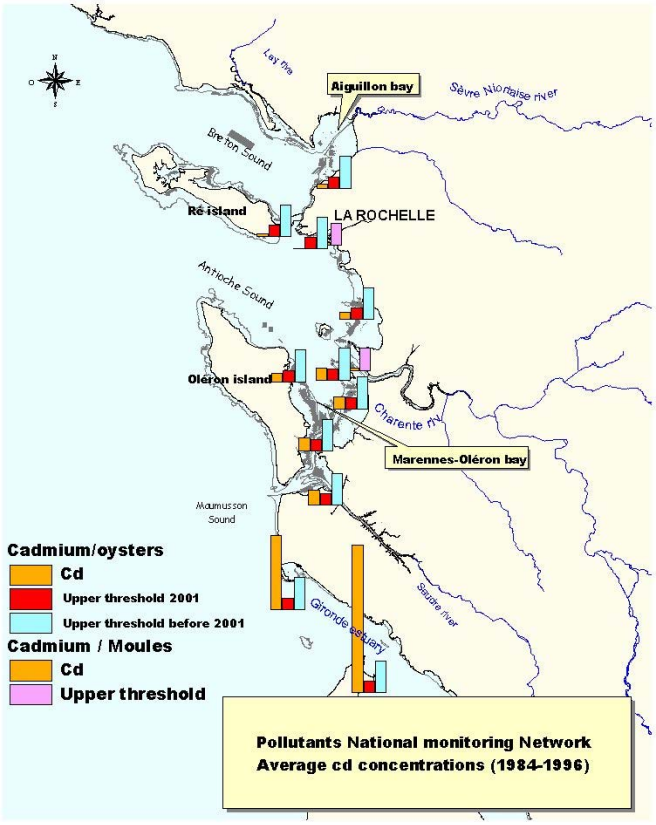

Figure 8 : Comparisons between present levels of Cadmium in shellfish and past upper threshold and new EU regulation (Anonymous, 2000).

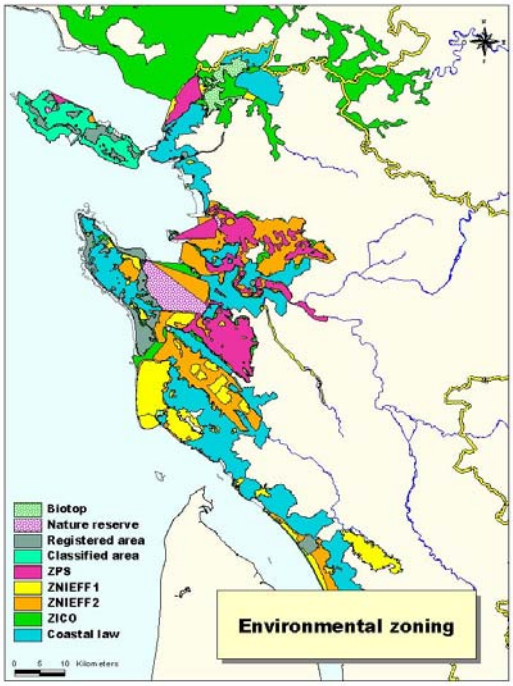

Figure 9 : Protected areas from various and overlaid regulations (‘Sanctuaries and protected sites, ‘Bird’-‘Habitat’-‘Wildlife Flora and Fauna’) in the Charente Maritime area (Anonymous, 2000).

3. Review of cooperative works intended to integrate management options

Several management options developed for the Charente Maritime coast are presented in table 1. The cases, though not comprehensive, represent important efforts to negotiate and address conflicts of interest among partners. A bilateral approach was usually undertaken to address acute problems that could have resulted in critical consequences for shellfish production. For example, during the 1980s several grounds near oyster ponds were drained for intensive agriculture production : the use of phytosanitary products by agriculture activity would have impacted shellfish quality as well as primary productivity in oyster ponds due to the near vicinity of both activities. Therefore a joint agreement was negociated to optimize overall area management. A critical and often neglected consideration for wetlands management in Charente Maritime is that their existence is actually the result of decades of human management, including the digging and maintaining of the hydraulic network of canals for shellfish farming activity. Without this human intervention, those ‘artificial’ wetlands would have quickly resulted in siltation. The decreasing use of oyster ponds during the 1980s led the Regional Coastal Agency to buy farms and grounds and then lease the properties under a specific contract between the Agency and the shellfish farmers to comply with significant constraints relative to environmentally-sound practices. This approach is now applied to agricultural farms as well. Similarly, a recent agreement between the shellfish industry and agriculture representatives facilitated the development of agricultural management practices to limit microbiological contamination during the mussel-growing season (B zone in Breton Sound) (Figure 4).

The development of a multilateral approach has been less successful to address on-going user conflicts and benefits for the shellfish industry being usually limited. One conflict

of interest cited above concerns the management of freshwater fluxes relative to the Charente River. Projects have occasionally been proposed to ensure minimum freshwater input into the coastal area in summer, but improvement and enforcement of the freshwater policy have not, as of yet, completely addressed this issue. Subsequent to long negotiations and several public inquiries, a dam project, managed by the elected political structure ('Departement of Charente Matitime'), was finally approved both at local and national levels in order to sustain and regulate freshwater inputs. However, environmentalist groups are still opposed to the project in spite of public inquiries showing a majority of users favorable to the dam construction.

An attempt to develop a comprehensive management scheme in Charente Maritime in order to specify and map future priorities in terms of development and preservation interests has recently failed for several reasons. Firstly, a lack of cooperation when the management plan was undertaken gave the impression that it was a state proposal instead of a common joint agreement. Secondly, this proposal was not consistent with French decentralization laws enacted over the last 20 years, which provide greater responsibilities at the local level. For example, each town ground and harbor management scheme would have had to be modified to be compatible with the global scheme, therefore affecting possible development at the local level. Thirdly, from a scientific perspective, a lack of adequate assessment of populations of wild species, the natural habitat, and interactions among species led to the overestimation of figures and areas, thereby weakening the proposal. A more local management scheme recently developed on Ré Island has resulted in a negative impact for the shellfish industry, as the interests of a bird sanctuary were favored to the detriment of traditional use of oyster ponds.

On a smaller scale, an ongoing recent research and development program has focused on using a new approach to test the feasibility of deep-water offshore oyster culture (Goulletquer, 1998). A special committee composed of state managers, scientists, and representatives of all users of the coastal area, including the fishing community (a strong opponent of the project, which considers this spatial use as unfair competition) was established. This body plans to receive recommendations for limiting the impacts of shellfish culture and developing sustainable practices. As a result of the committee establishment, new scientific questions have arisen, mainly ones concerning interactions between shellfish culture and finfish populations, therefore prompting scientists to develop programs to address the issues (behavior, nutrition, nurseries). This approach, which is quite similar to others already in existence for agriculture, is intended to consider the social structure and interactions among users, in addition to economic interests, in proposing a management scheme. Scientific tools have been developed for site selection by using GIS mapping, which facilitates the superimposition of several layers of information, including regulations, biological and physical constraints, fishing activities, and coastal uses (Figure 6) (Populus et al., 1997). Moreover, the development of this oyster culture might induce conflicts of interest, if it led to a major and fast change in economy, and therefore possible impacts on the current industry : production costs with this technique might decrease significantly, inducing significant price distortion, thereby affecting the present social and economic structure. Similarly, the development of new culture methods would result in a need for different equipment, greater investment and eventually different types of companies. To address these issues, sociologists and economists have been directly integrated into the project to assess the social links and the relationships among communities relative to their respective analysis and perception of other coastal users. Economic models are under development to quantify, simulate and forecast expected changes. Under terms of a 5-year experimental period, the leasing grounds have recently been seeded and monitored, whereas sociologists and economists are developing their own approach. The committee is expected to review the work and provide

recommendations on a yearly basis and has the power to stop the experiment if any significant unexpected side effects occur.

Management options	Partners	Years	Not completed	Effects on the shellfish industry	
				Negative	Positive
Bilateral approach					
	Shellfish industry and agriculture representatives	80s			Joint agreement on managing new drained land near oyster ponds
	Coastal agency (Conservatoire des Espaces Maritimes – Conservatoire du Littoral) and shellfish industry	90s			Management of shellfish farms to maintain human activity on wetlands (oyster ponds)
	Environmentalist groups and shellfish industry	90s			Joint agreement on sanctuary management
	Shellfish industry and agriculture representatives	00s			Joint agreement to limit side effects of agricultural practices on freshwater quality (microbiological contaminants)
Multilateral approach					
	State and representatives of all coastal users	90s 00s	Development of an integrated coastal management plan (Schema de Mise en Valeur de la Mer-SMVM)		
	State and local representatives	00s		Development of a global management scheme for Ré Island (e.g. bird sanctuary)	
	State and regional representatives — Environmentalists — Shellfish and agricultural industries	00s	Ongoing project	major conflicts with environmentalists	Dam construction to sustain freshwater fluxes in summer (Charente River)

Table 1: Several case studies of management options affecting the shellfish industry in the Charentais Sounds

Requirements for developing an integrated coastal management plan in the Charentais Sounds

CONCLUSION

Managing impacts and the balance of interests remains a difficult task, and several attempts have fallen short of their objectives due to unforeseen interactions among sectors.

The two most recent cases are significant, as they specify the need to develop an effective integrated management plan. It appears critical to obtain the highest quality scientific information in a format useful to coastal managers for decision-making. The NOAA Coastal Ocean Program (COP) has already considered this need as a critical step in developing a management plan (Scavia, 1995). The recent introduction of geomatics into the management process can be considered as appropriate for addressing this issue and facilitating analysis,

review and decision-making (Populus et al., 1997). Therefore, multidisciplinarity and integrated projects are probably the best approach for addressing questions arising from coastal ecosystem functioning and uses, assessing dynamic aspects of interactions among coastal users, and facilitating critical review of regulations used in coastal ecosystems and the research for management alternatives. All these issues require the standardization of data, reviews and appropriate representations of coastal ecosystems through an information system. This will involve coupling several operational models to a database and information system to facilitate decision-making for coastal managers through a simulation process. Although not yet a comprehensive management tool, the carrying capacity model of the Marennes Oleron Bay represents an example for further development for decision-making management tools (Figure 10). The cases reported here indicate that multidisciplinarity and integrated projects, when initiated, should include sociologists and economists in addition to coastal ecologists, managers and users. Therefore, a suitable coordination structure is required to identify issues, facilitate negotiations and resolve conflicts as recommended by Henocque et al. (2001).

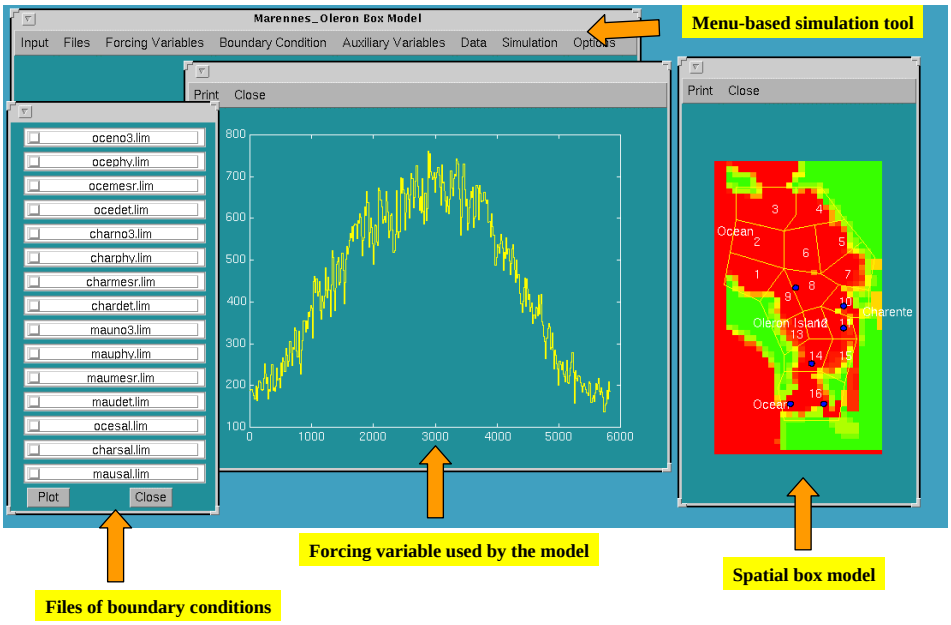

Figure 10 : Development of the Marennes Oleron operational multibox model coupling hydrodynamic, primary and secondary production models (Bacher et al. 1998, 2000).

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