

**COMPARING ECONOMIC DYNAMICS OF OYSTER AND MUSSEL FARMING,  
WITH PARTICULAR EMPHASIS ON THEIR PROFITABILITY:  
AN APPLICATION IN THE MONT-SAINT-MICHEL BAY (FRANCE)**

Rémi MONGRUEL & José A. PEREZ AGUNDEZ,  
Marine Economics Department, IFREMER. BP 70, 29280 Plouzané, France  
[Remi.Mongruel@ifremer.fr](mailto:Remi.Mongruel@ifremer.fr)  
[Jose.Perez@ifremer.fr](mailto:Jose.Perez@ifremer.fr)

**ABSTRACT**

This paper sets out an evaluation of profitability differentials within shellfish farming activities of the Mont-Saint-Michel Bay. The objective is to examine whether profitability differentials have consequences in terms of economic dynamics and of management arrangements. The paper divides into four parts. The first part presents a retrospective analysis of shellfish farming activities in the Bay, which are nowadays dominated by Pacific oyster (*Crassostrea gigas*) and Blue mussel (*Mytilus edulis*). The second part consists in measuring the economic performances of enterprises. The indicators are based on the data provided by two surveys conducted in 2002 (mussel-farming) and 2004 (oyster-farming); methodological difficulties due in particular to the status of shellfish farming land are addressed here. The third part examines the determinants of the profitability for each sector, the profitability being the result of a combination of factors such as natural productivity, technical practices, production costs and products pricing. The last part discusses the implications of profitability differentials. Profitability differentials seem to be correctly reflected in land prices, but not necessarily in the annual ground fees perceived by the Administration. However, shellfish farming profitability should be included in redistributive mechanisms, as its relation to primary resources exploitation and management is not neutral. Thus, empirical evidence suggests that profitability differentials create bargaining powers which influence the results of negotiation between actors regarding the management of the Mont-Saint-Michel Bay.

**Keywords:** shellfish farming, profitability, management, fees

**INTRODUCTION**

The Mont-Saint-Michel Bay is located between Brittany and Normandy in the Western coast of France. The Bay is both a unique natural area, with tidal ranges as high as 14 meters, and a site where many fisheries and aquaculture activities (dedicated to the production of oysters and mussels) have been developed for centuries. Nowadays, uses of the tidal part of the bay are dominated by shellfish farming. The shellfish production is the final outcome from complex processes including terrestrial flows, coastal currents, sedimentary deposits and phytoplankton development in the water column. The total primary resources in an area define its carrying capacity, and as every user is affected by any additional stocking, the natural feeding capacity used by shellfish farmers is a common-pool resource (Fontenelle et al, 1998). The conservation of the potential of primary marine resources for shellfish farming is ensured by co-management measures taken by the farmers' organisations and the administration, which define both the

total extension of the shellfish farming zone, its allocation to different cultural practices and the intensity of the exploitation. In addition, coastal marine resources belong to the Maritime Public Domain, and are therefore managed by the administration in the prospect of the society's best interest. Shellfish farmers benefit from temporary individual land-use rights on the tidal zone, called "concessions"; the duration of a concession can not exceed 35 years, and its use is submitted to the payment of an annual fee. Hence, the administration might address the distributive issues raised by the exploitation of the coastal public resources in two ways: i) the administration might grant individuals with factors of rent generation, through the allocation of the coastal area to exclusive uses and ii) the administration might ensure the recovery of part or any of the resource rent on behalf of the society, mainly through taxation (Dumont, 1987). In the following analysis, we take the existing allocation of coastal resources to exclusive private uses as an invariant and focus on shellfish farming activities in order to examine the recovery of the resource rent by the society, which basically rests on the annual fees paid for concessions exploitation. As regards ordinary practices in the shellfish farming sector as well as in the fishing sector, the annual fees are simply considered as being the counterpart of the use rights, which are often called "privileges" in the literature when they applied to public resources. Therefore, evident linkages do exist between annual fees' amount and the profitability of each activity. In addition, when the use right becomes transferable, the expected profitability will determine the trade-in value of the right. Shellfish farming concessions being transferable in France, this is the reason why annual fees are an issue to be addressed by considering both the profitability of shellfish farming activities and the prices of land in this sector. This paper address some of the distributional issues raised by the economic development of shellfish farming in the Mont-Saint-Michel Bay, based on a comparative analysis of oyster and mussel farming profitability. The paper divides into four parts. The first part presents a retrospective analysis of shellfish farming activities in the Bay, which are nowadays dominated by Pacific oyster (*Crassostrea gigas*) and Blue mussel (*Mytilus edulis*). The second part consists in measuring the economic performances of enterprises with indicators based on the data provided by two surveys conducted in 2002 (mussel-farming) and 2004 (oyster-farming). The third part examines the determinants of the profitability for each sector. The last part discusses the implications of profitability differentials, in terms of wealth distribution and management.

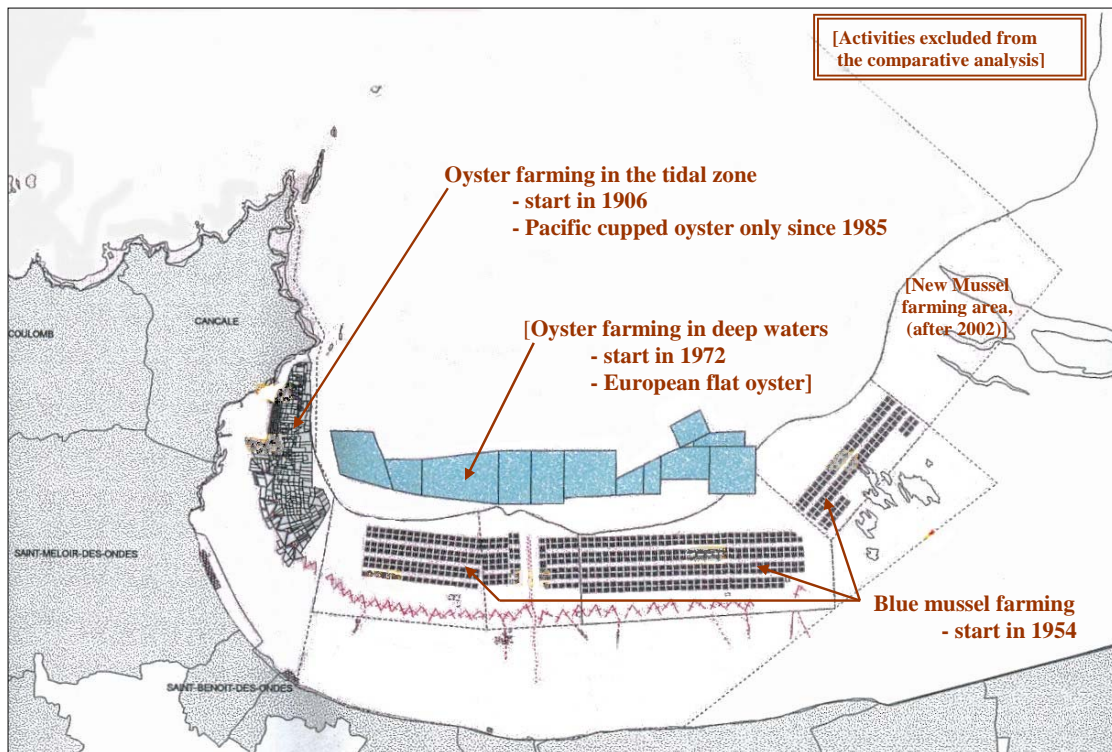
## **THE DEVELOPMENT OF SHELLFISH FARMING IN THE MONT-SAINT-MICHEL BAY**

In the Mont-Saint-Michel Bay, shellfish farming activities developed after the progressive depletion of wild oyster fisheries. As early as at the end of the XVIII<sup>th</sup> century, first management measures were taken in order to stop the over-exploitation of natural oysters banks, including a time limitation of the fishery. Despite these regulations, the depletion of the natural oyster schools continued and the fishery was finally closed in 1931 (Pichot-Louvet, 1982). Meanwhile, the first attempt to grow oysters in the bay had been conducted during the second part of the XIX<sup>th</sup> century, and oyster-farming experienced a cycle of rise and fall between 1906, when concessions seem to have been awarded for the first time, and the end of the 1930s. After World War II, shellfish farming developed again as a modern activity, by the end of the 1940s for oysters and from 1954 on for mussels. As natural spat-collection is not possible in the Mont-Saint-Michel Bay neither for oysters nor for mussels, spat is originated from the Atlantic sounds (Gasquet, 1996; Le Mao and Gerla, 1998; Fontenelle, 2000).

The development of the oyster-farming activity was then punctuated by epizooties and the introduction of new species. European flat oyster (*Ostrea Edulis*) was the first cultivated species, but it was decimated by parasites and diseases. It was first supplanted by the Portuguese cupped oyster (*Crassostrea angulata*) in 1959, and then by the Pacific cupped oyster (*Crassostrea Gigas*) in 1971; nevertheless, the cultivation of European flat oysters started again from the year 1972 in deep-water grounds, implementing an extensive production system (Gasquet, 1996; Le Mao and Gerla, 1998; Fontenelle, 2000). At the beginning of the 2000s, the annual production of the bay was around 700 to 1 000 tons of Flat oysters and around 3 500 to

4 000 tons of Pacific oysters. Because of its limited annual production and of the low number of enterprises involved in this activity (8 enterprises in 2004), the European flat oyster sector is excluded from the analysis. The intertidal area is entirely dedicated to the Pacific oyster since 1985, but oyster farming is confined in the zones where productivity is the weakest and sedimentation is the highest. That is why the intertidal oyster-farming area should also benefit from the transfer by gliding of all the shellfish farming area eastward, initiated by mussel-farmers in 2002. Before this reorganisation of the intertidal oyster-farming area intervenes from 2004 on, 336 hectares were awarded to Pacific oyster farmers, from which 20% might be unexploited<sup>1</sup>.

Mussel-farming activity is based on the cultivation of Blue mussel (*Mytilus edulis*). The initial expansion was extremely rapid, as evidenced by the evolution of the length of mussel bed lines, which rose from 12 kilometers in 1954, to 78 kilometers in 1958 and 128 kilometers in 1960. Spat from the South-West of France was introduced in 1957. Despite several interruptions in production due to the *Mytilicola intestinalis* parasite in the 1960s, the length of mussel bed lines increased to 197 kilometers in 1968. Differences in the biological productivity of farming zones soon became apparent, with a decreasing East/West gradient of productivity. This observation led to the transfer of some of the least productive lines in front of Saint-Benoît-des-Ondes to a new production zone located towards the East, in 1975. A second partial transfer of existing mussel bed lines to this new zone took place during the early 1980s and a third one took place in 1984. These transfers allowed significant productivity gains, which were soon weakened by new occurrences of *Mytilicola intestinalis* in 1983 and 1984. A reduction of the number of stakes was accepted by producers in order to reduce the risks of new parasite contaminations. The development of mussel farming areas in the bay then stabilized, with a total length of mussel bed lines of 272 kilometers and an average annual production of 10 000 tons (Mongruel and Thébaud, 2006). Before the last transfer intervened from 2002 on, shellfish farming activities of the Mont-Saint-Michel Bay extended over the coastal zone according to the spatial distribution represented by figure 1.



**Figure 1. Shellfish farming activities in the Mont-Saint-Michel Bay: location until 2002 (Blue mussel) and 2004 (Pacific oyster).**

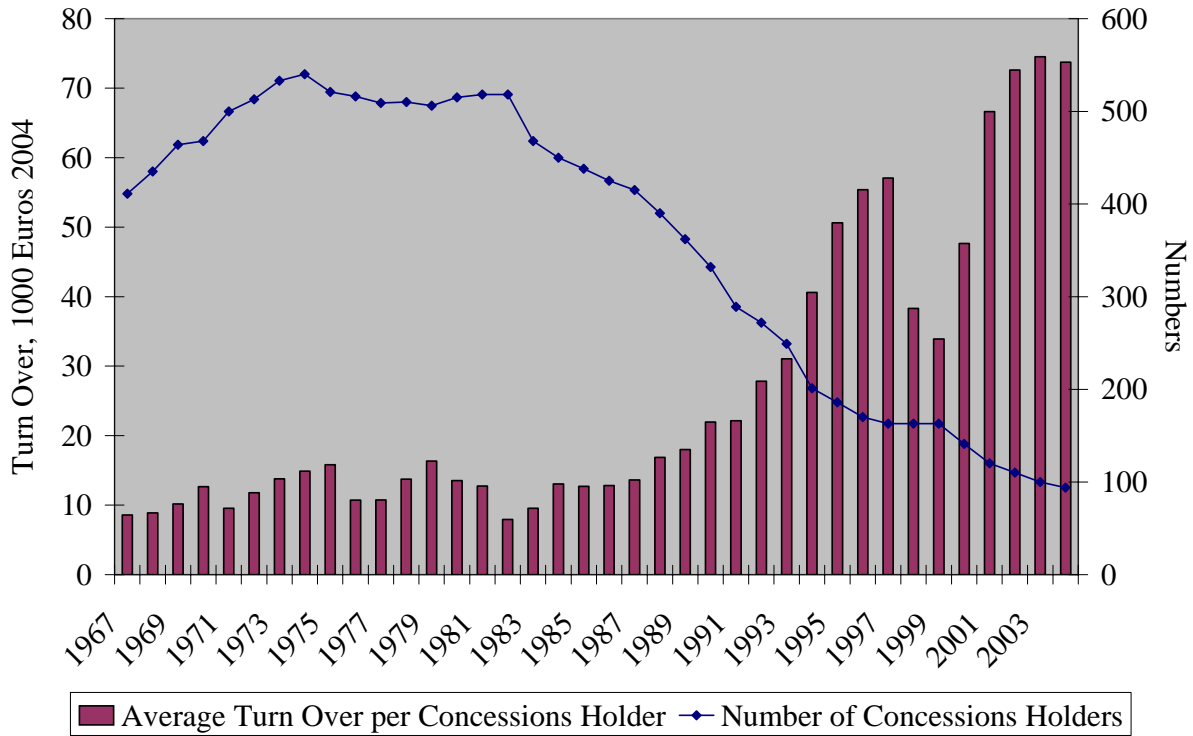


Figure 2. Number of oyster-farmers and average turn-over per concessions holder, 1967-2004.

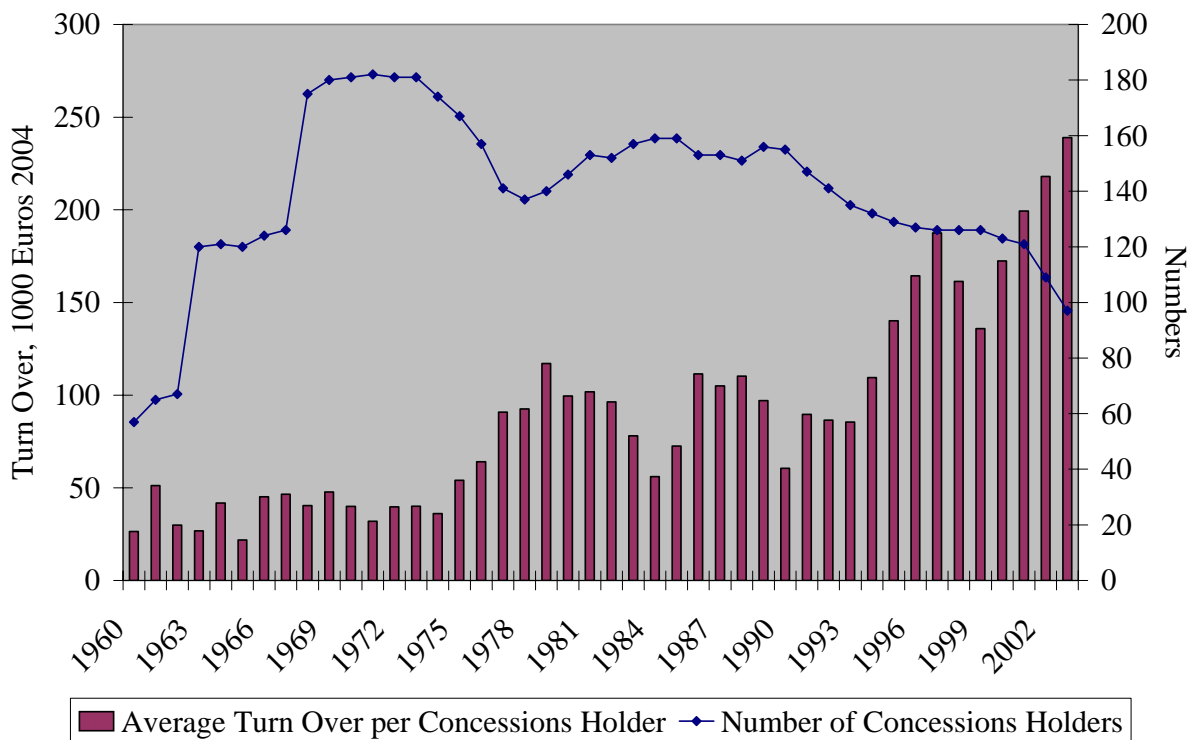


Figure 3. Number of mussel-farmers and average turn-over per concessions holder, 1960-2003.

Figures 2 and 3 depict the structural change in the shellfish-farming sector of the Mont-Saint-Michel Bay since the 1960s, based on the data provided by the administration (Marine Affairs Delegation in Ille-et-Vilaine) and on shellfish prices time-series. At the end of the 1960s, the number of oyster farmers (estimated by the number of concessions holders) increased from 400 to 500; this increase was linked to the introduction of a new cultivation technique (oysters are placed in bags put on tables). This technical innovation made it possible to pass besides the impact of envasement, but only temporarily, as the sedimentation then affected again the concessions, mainly the one located on the coast side. A dramatic decrease in the number of concessions holders was observed from 1983 to 1993, due to deterioration of exploitation conditions, which seems to have in particular discouraged farmers whose revenues came not mainly from oyster cultivation. Following this demographic evolution of the sector, it may be assumed that all the remaining oyster farmers do exercise this activity as professionals. From 1993 to 2004, the number of concessions holders fell from about 200 to a little less than 100. During the same period, the average turn-over per concessions holder was multiplied by 2, and reached 70 000 Euros per year.

As the mussel-farming zone was still expanding until the end of the 1960s<sup>2</sup>, the number of mussel farmers increased from 57 in 1960 to 180 in 1968. A first episode of rapid decrease in the number of concessions holders took place between 1972 and 1975, before the first transfer towards the East. The evolution of the average turn over per concessions holder during between 1975 and 1984 is similar to the one of an overexploitation cycle. The hypothesis of an episode of overexploitation is coherent with the parasite contaminations which occurred in 1983 and 1984, as the diseases are favored by excessive biomass density. The number of concessions holders decreased slightly from 155 in 1990 to 126 in 1999, and then fell rapidly to slightly less than 100 in 2003. In 1999, professionals reached an agreement regarding the last transfer towards the East. This was thus the second time when changes in access regulation led to a reduction in the number of farmers. These observations show that the reorganization of a shellfish farming area may be accompanied with some merging of the industry. Today, the number of mussel concessions holder is comparable with the one of the oyster farming sector, but the average turn-over per concessions holder, which was comparable in the 1960s, is now far much higher for mussel farming (more than 200 000 Euros per year). This may indicate that productivity gains have been superior in the mussel farming sector.

## **ECONOMIC PERFORMANCES OF SHELLFISH FARMING ENTERPRISES**

### **Materials and method**

The analysis of shellfish-farming enterprises economic performances is based on two surveys, carried out so as to depict the activities before their respective transfers toward the East: the survey of mussel-farms was conducted in June 2002 and the survey of oyster-farms was conducted in May 2004. The surveys, based on direct interviews, focused on two sets of questions dealing with: 1) land structure, equipments and workers; 2) production, costs and earnings. As no listing of enterprises was available, shellfish farmers were listed thanks to the professional pages of the phone book or directly contacted in the big land-based farming centers of Cancale (for oyster-farming) and Le Vivier-sur-mer (for mussel-farming). All the farmers responding positively to the survey in these centers were interviewed. The quality of the sample of interviewed farmers was controlled ex-post, based on data available to describe the population of mussel farmers and their activity. Although no a priori sampling strategy was used, this allowed an analysis of the sampling rate, according to the type of farms operating in the bay.

Overall, a fairly good coverage of the population was achieved in the survey (see table 1). The sample covered 29% of all mussel farms and 27% of all oyster farms in the bay. The proportion of mixed enterprises covered is coherent with the sample rate in both sectors. In terms of land structure and

production, the sample is biased. For the mussel-farming-sector, the survey covered 38% of the mussel bed-lines and of the production, and for the oyster-farming sector, the survey covered 46% of the exploited surfaces and 48% of the production. Large and medium-sized firms are thus over-represented in the sample as compared to smaller firms. This bias is more important for the oyster-farming sector.

**Table 1. Surveyed sample compared to the global population of shellfish-farming enterprises.**

1 - Pacific Oyster				
	Number of enterprises	incl. mixed enterprises	Exploited surfaces (ha)	Production (tons)
Population	62	22	248	3 500
Survey	17	5	114	1 653
Survey / Population	27,4%	22,7%	46,0%	47,2%
-----				
2 - Blue Mussel				
	Number of enterprises	incl. mixed enterprises	Exploited length (km)	Production (tons)
Population	73	22	272,10	10 000
Survey	21	7	103,35	3 757
Survey / Population	28,8%	31,8%	38,0%	37,6%

Even if the coverage of the population was significant, the quality of the information collected was highly heterogeneous: some variables were poorly detailed or were not available, and extrapolations have been required using the information available for other enterprises, or using complementary sources. First, the following structural indicators were estimated: 1) production, 2) labor use, defined as the number of workers (including farm owner(s), permanent employees and seasonal workers), measured in terms of full-time equivalent; 3) current value of the capital invested, including the value of land and equipments. Second, the following economic performance indicators were estimated: 4) turn over, taking into account the variety of the outlets of each enterprise; 5) apparent labor economic productivity, defined as the annual turnover obtained per full-time equivalent worker; 6) added value, defined as the turnover less intermediate consumption costs; 7) gross exploitation revenue (GR), defined as the added value less remuneration paid to workers, social security contributions and taxes (based on the assumption that the operator's labor is paid on the basis of the remuneration of a full-time employee with the highest qualification); 8) net profit, defined as GR less interest on capital and annual provisions for capital; 9) net return on total capital, defined as the ratio of the net profit over total capital value; and 10) rate of net profit to turnover, either called profitability.

Except turn over for both activities and intermediate consumptions in the case of mussel farming, other economic indicators were estimated according to pessimistic and optimistic hypotheses, which allows to bracket value the results. For oyster-farming, intermediate consumptions vary depending on the origin of spat and on maintenance costs. The estimates of gross exploitation revenue vary depending on the status of workers, and on the taxation regime which applies to the enterprise. Net profit varies depending only on interests on capital, as provisions for capital depreciation were exactly estimated. Provisions for capital depreciation were estimated on the basis of the declared value of equipment only: no depreciation of land was included assuming that, in the bay, land has an increasing value over time, and does not need to be replaced. Interest payments on total capital costs were estimated on the basis of the investments needed to cover both equipment and land acquisitions, according to the following hypotheses: under the optimistic hypothesis, capital opportunity costs are assumed to be exactly equal to declared interest payments (and are therefore probably underestimated); and under the pessimistic hypothesis, interest payments on capital costs are based on annual rates of 11% for equipments and of 15% for land<sup>3</sup>.

## Results

The results are presented in table 2. The average production per enterprise is far much higher in the mussel-farming sector, although the bias of big enterprises over-representation was superior in the oyster-farms sample. Conversely, the average number of workers per enterprise is higher in the oyster-farming sector. This leads to a low physical productivity of labour in the oyster-farming sector. The average fixed capital is twice superior in the mussel-farming sector.

Average turn over per enterprise in each sector is sharply different from the one observed through the estimates presented in the previous paragraph for the entire population: the estimates resulting from the samples are higher in the mussel-farming sector and much higher in the oyster-farming sector. This may be explained by the following reasons: 1) the survey provided data per enterprise, which are less numerous than the concessions holders (in 2001, there were 73 enterprises but 121 concessions holders in the mussel-farming sector, and 62 enterprises but 120 concessions holders in the oyster-farming sector); 2) the total production of the bay may be underestimated; and 3) as the samples over-represent big enterprises, especially in the oyster-farming sector, this leads to an over-estimation of average turn-over per enterprise.

**Table 2. Average results per enterprise in each sector, under low and high hypothesis.**

	Oyster Farming		Mussel Farming	
	pessimistic hypothesis	optimistic hypothesis	pessimistic hypothesis	optimistic hypothesis
Production (tons)	97		179	
Number of Workers	5,9		3,7	
Capital Total (current value)	267 424 €		551 616 €	
Turn Over (TO)	321 072 €		301 228 €	
Labour Productivity to TO	53 993 €		82 421 €	
Added Value	233 042 €	255 451 €	256 085 €	256 085 €
Gross Exploitation Revenue	66 461 €	77 283 €	140 882 €	158 955 €
Net Profit	18 721 €	42 576 €	53 055 €	80 349 €
Return on Capital	7.0%	15.9%	9.6%	14.6%
Rate of Profit	5.8%	13.3%	17.6%	26.7%

The estimates of average turn over in both sectors are relatively closed. However, the apparent labour economic productivity (measured by the turn over per unit of labour) is 1.5 times higher for mussel-farming than it is for oyster farming. Then the average added values of both sectors remain also relatively closed, indicating that no major differences do exist in terms of intermediate consumptions. But labour costs turn out to be logically higher in the oyster-farming sector, because of a more important use of the workforce. Thus, the average gross exploitation revenue of the oyster-farming sector rises less than the half of the one of the mussel-farming sector. The same difference appears when comparing average net profit. Although average net profits are sharply different, the estimated returns on capital of both sectors belong to the same value order: from 7% to 16% in the oyster-farming sector and from 10% to 15% in the mussel-farming sector<sup>4</sup>. Conversely, the levels of profitability, measured by the ratio between net profit and turn over, are completely different: the rate of profit is more than twice higher in the mussel-farming sector, because of twice higher average net profit to be compared with slightly less level of turn over.

In addition, both samples have been divided so as to estimate separately the performances of small enterprises and the performances of mixed enterprises (in the case of mixed enterprises, the questionnaires and estimates have been conducted by considering fractions of enterprises dedicated to one activity or the other, according to the sample to which the enterprise belongs). In both sectors, small enterprises have lower level of return on capital and of profitability than the overall sample, and in both sectors, mixed enterprises have lower level of return on capital and of profitability than the overall sample. These results show that enterprises of the mussel-farming and of the oyster-farming sectors in the Mont-Saint-Michel Bay do manage to realise economies of scale and economies of scope.

## HOW TO EXPLAIN THE PROFITABILITY DIFFERENTIALS

The average production in quantity per enterprise in the oyster-farming sector is inferior to the one observed in the mussel-farming sector. Thus, mussel-farming enterprises benefit from a highest level of physical production. Nevertheless, oyster-farming enterprises reach a slightly highest average turn over than mussel-farming enterprises do. This demonstrates that in terms of gross revenue, natural productivity differentials are almost compensated by products pricing. The average prices paid to the producers amounted to 3,2 €/kg for oysters and to only 1,6 €/kg for mussels. Products pricing is also strongly dependent on outlets, and although the prices are almost comparable when the product are purchased by wholesalers or retailers, there is a premium for the price in case of direct selling to the consumer. The premium due to direct selling is of +0,9 € (2,5 against 1,6 €/kg) for mussels and of only +0,3 € (3,5 against 3,2 €/kg) for oysters. Nevertheless, according to the surveys results, direct selling represents up to 32% of oyster-farming outlets and less than 2% of mussel-farming outlets. Thus, oyster-farming enterprises develop direct selling strategies although the level of the incentive is low: this indicates that such strategies are perceived as indispensable to maintain a sufficient amount of turn over, and possibly a minimum level of profitability, even if it certainly induces a need for additional labour.

As turn over per enterprises are comparable, the explanation of profitability differentials may be found in the higher average labour productivity and in the higher average net profit of mussel-farming. But although average net profits are sharply different, returns on capital range in the same value order in both sectors, because the oyster-farming sector uses a twice lower level of capital. In particular, oyster-farming enterprises have a fixed capital in equipments 1.6 times lower than the one of mussel-farmers (200 000 € per enterprise against 320 000 €), and a fixed capital in land 3.5 times lower (66 000 € per enterprise against 230 000 €). Within the fixed capital composition, land value amounts to 25% in the oyster-farming sector and up to 42% in the mussel-farming sector. The higher expectations of net profit per enterprise in the mussel-farming sector appear to have been transferred into a superior valuation of mussel grounds. This is the reason why the returns on capital are comparable in both sectors: assuming that costs and profitability of capital invested in equipments are also relatively equivalent, it may be considered that land prices do correctly reflect farmers' expectations regarding the global level of returns on capital.

The main differences between both sectors concern the profitability to turn-over. As there is no significant difference in terms of investments profitability, the higher profitability of mussel-farming is due to a lower level of labour utilisation, permitted by more mechanised technical practices. In the mussel-farming sector, equipments such as, *inter alia*, amphibian boats and harvesting machines have an impact on capital invested, but they also result in a very high labour physical and economic productivity. As labour costs are comparable in both sectors, the profitability of each unit of labour is much higher in the mussel-farming sector. The mussel-farming production system rests on a combination between capital and labour, which minimizes labour costs and generates a higher average net profit per enterprise. Basically, this may be due to the mechanisation of certain tasks as well as to shorter production cycles. The latter aspect leads back to the notion of natural productivity differentials.



## PROFITABILITY DIFFERENTIALS AND DISTRIBUTION OF WEALTH

### Annual land fees and the capture of the resource rent

The exploitation of shellfish farming concessions can be analyzed as the exploitation of collective resources toward private economic objectives, because these activities are developed on the coastal area placed into the maritime public domain (MPD). The nutrients diluted in the coastal water which feed the cultivated animals are limited and shared by producers: this primary resource has a statute of common-pool resource. But this resource becomes almost privatized through the concessions allocation system, because the purchase of a concession grants a right to farm shellfish according to a given density<sup>5</sup>, and then to capture a given portion of the primary resource. The concessions grant producers an access' exclusivity, which generate private economic rents. Nevertheless, the limits between the private field and the public domain are relatively narrow here. The access rights attached to the concessions are precarious and revocable, accordingly to the principles proclaimed since the edict of June 30, 1539, which conferred to the public authorities all the prerogatives related to the MPD occupation and utilisation. After the MPD had been created, exploitation privileges were granted to reservists ("*inscrits maritimes*" in French) as counterpart of "military constraints", the reservists remaining in the position of being called in the Army at anytime. These privileges were reinforced by the decree of the April 17, 1873: the State introduces royalties attached to the shellfish farming concessions, but reservists were exempted to contribute to these taxes (Orfila, 1990). Afterwards, the 1915-1919 new regulations for the establishments of shellfish farming concessions accorded a preferential right to reservists when a vacant concession was the object of several concurrent demands. This particular status of these reservists disappeared in 1967, but it was necessary to wait until the end of the 1980s so that the law was changed again. The annual fees to be paid for the exploitation of shellfish farming concessions were revised in a 1989 decree, which determined the amount of fees according to the species cultivated and to the technique used.

Taxes linked to the exploitation of shellfish farming concessions can be considered as natural resources management tools, allowing transfers of economic rents. Management systems based on tax mechanisms must be justified by its economic effectiveness considering the political choices in terms of resource allocation and its social impacts. The main criteria justifying taxation are economic, social and political.

- *Economic criterion*: Taxation as a tool for management of natural renewable resources has widely been analysed by the economic literature. The implementation of taxes in activities exploiting natural renewable resources has as origin the correction of externalities (Pigou, 1920) at lower costs (Kneese and Bower, 1968). Managers, knowing individual demand functions, production functions of the companies and externality functions, can determine the pareto-optimal quantity of output (Kneese and Bower, 1968) and the equivalent level of taxes creating incentives for controlling production and externality levels by modifying the individual behaviour of agents (Baumol and Oates, 1971), without needing a constant administrative interventionism (Buchanan and Tullock, 1975). Even if efficiency can be reached by production controls, taxes mechanisms ought enterprises to produce efficiently and to limit externalities.

- *Social criterion*: The resource allocation has redistributive effects since contradictory interests may exist. Because it is not possible to maximize production and utility functions of each agent, consensual processes are needed. The concept of equity intends to combine equality, legitimacy and temporality. Moreover, the concept of equity and inequality are not necessarily contrary when compensatory transfers are operated from the most favoured agents towards those who are worse off (Rawls, 1971). In his "theory of justice" Rawls search the compatibility between inequality and equity by applying the "maximin" criterion (maximization of the minimum) which defines its maximum equitable economic criterion. In opposition to the neo-classic utilitarian economy, according to Rawls, an economy does not reach the economic optimum when the social function of welfare is maximized, but when the welfare function of the least favoured individuals are maximised. Consequently, the transfers of income between the individuals can make compatible economic Pareto-optimal situations and equitable situations. Finally,

temporality implies to take into account of the intergeneration relationships. Hicks and Kaldor showed that, if satisfactions and sacrifices of some agents are expressed in monetary terms, the degradation of certain situations is not necessarily in contradiction with a Pareto-optimal situation, gainers being able in principle to compensate the losers if global gains exceed aggregated losses.

- *Policy choice criterion*: The principal controversy of the tax management tools relates to the arbitrary character of its application, which can induce distortions according to criterion chosen (Baumol and Oates, 1971). The use of a particular management mechanism concerns a political choice after analysing the effects of each one of them. Effects induced by management must be considered on the reorganization of the sector, the existing enterprises and those which pretend to enter the sector. In the case of fisheries, empirical studies suggest that the search for institutional arrangements should help to make taxes a management instrument socially acceptable, in particular for those who are directly affected.

### **Determination of annual land fees in the shellfish farming sector**

In the French shellfish farming sector, annual land fees are simply considered as being the counterpart of the use-rights. The annual land fees to be paid for the exploitation of shellfish farming concessions are fixed by the 1989 decree, and the law do not envisage any procedure for fees' amount revision, not even in case of a particular evolution of the exploitation conditions, which would require a re-organization of the management system. Thus these fees are only expected to ensure the recovery of all or part of the resource rent by the society. The following further analysis examines whether the resource rent recovery in the case of shellfish farming activities of the Mont-Saint-Michel Bay is appropriate.

As all production factors tend to adjust toward comparable levels of cost in both sectors while the net profit per enterprise is sharply higher in the mussel-farming sector, this indicates that the primary public resources of the bay tend to generate a higher net rent when being used by mussel farming than when being used by oyster-farming. An appropriate taxation system should reflect the highest profitability of mussel-farming. If it does not, part of the resource rent may be assumed to be transferred to mussel-farmers without due cause, while oyster-farmers and/or the society may be considered to be worse off.

In order to address these issues, table 3 compares the following indicators for both sector: 1) annual fees per concession (in Euros per hectare (ha) or per 100 m) as fixed by the regulation; 2) annual enterprises average expected turn-over per concession as estimated according to the surveys; 3) annual enterprises average expected net profit concession as estimated according to the surveys; 4) average land value per concession according to the transactions observed during the years 2002-2003 for oyster concessions and 1999-2001 for mussel concessions; 5) annual fees expressed as a percentage of the expected average turn-over per concession; 6) annual fees expressed as a percentage of the expected average net profit per concession; 7) annual fees expressed as a percentage of average land prices per concession.

The annual amount of the fees reflects the traditional perception of the oyster-farming as being able to generate a higher turn over. The results of our estimations confirm that the economic parameters on which the fixed fees' amount did rest may be the turn-over, as the fees expressed in percentage of the expected turn-over are comparable if not similar in both sectors: the fees per concession expressed in percentage of the expected turn-over are between 2 to 3 times higher in the oyster-farming sector. But when they are expressed as a percentage of the expected net profit, the fees are between 5 to 10 times higher in the oyster-farming sector. Thus, if the taxation system would have rested on profitability differentials, it would not have resulted in such unequal rates. Therefore, the fees as expressed as a percentage of the land prices are ten times higher in the oyster-farming sector. This demonstrates also that the value of land, which reflects the expected profitability of each activity, might be used to determine more appropriate fees, especially since land prices are known as concessions transfers are registered by the administration.

**Table 3. Fees and economic performances per concession.**

	Oyster Farming (€/ha and %)		Mussel Farming (€/100m and %)	
	optimistic hypothesis	pessimistic hypothesis	optimistic hypothesis	pessimistic hypothesis
Annual Fees*	185 €/ha	231 €/ha	9,9 €/100m	9,91 €/100m
Annual expected Turn-Over	47 879 €/ha	47 879 €/ha	6 121 €/100m	6 121 €/100m
Annual expected Net Profit	6 349 €/ha	2 792 €/ha	1 633 €/100m	1 078 €/100m
Land prices	13 202 €/ha	13 202 €/ha	7 470 €/100m	7 470 €/100m
Fess % Turn-Over	0.39%	0.48%	0.16%	0.16%
Fess % Net Profit	2.91%	8.27%	0.61%	0.92%
Fess % Land Prices	1.40%	1.75%	0.13%	0.13%

\*: in the case of oyster-farming, annual fees may increase by 25% depending on the cultivation practice.

The highest level of profitability of the primary resource when being used by mussel generates a differential rent which is captured by mussel-farmers first because of the inappropriate amount of the land fees in the mussel farming sector, and second because of the highest increase rate of land prices on the mussel-concessions market<sup>6</sup>. These results confirm what was predicted by economists when the law was changed in 1987, allowing concessions transfers: if the annual fees are not properly reevaluated, the introduction of a land market on the Maritime Public Domain would cause the inclusion of most of the resource rent in the land prices. Thus, concessions salesmen are able to capture a bigger part of the resource rent to the detriment of other producers, future producers and of the entire society. In addition, high land value makes it difficult for new producers to create enterprises, especially when young. These arguments should justify more appropriate annual fees, possibly variable, which would allow to avoid speculative behaviours and to decrease barriers to entry in the sector, when new producers are needed.

## CONCLUDING REMARKS

Expressed as a percentage of expected net profits, the amounts of annual fees appear to be very low, and not to reflect properly the profitability differential between mussel-farming and oyster-farming. Thus, most of the resource rent is transferred from the society to concessions holders, and concessions prices are too high. The taxation system may thus consider resting on net profit rather than turn-over, and therefore fees should rest on concessions prices as they indicate producers' revenue expectations. In addition, an increase of the fees amounts should also result in a decrease of the concessions prices, as intended.

In the Mont-Saint-Michel Bay, mussel-farming produces a higher profitability, mainly because mussel-farming uses more equipments and less work than oyster-farming does. But mussel-farming generates also negative externalities: in particular, the harvesting system fails to select only the mussels above the minimum commercial size. Due to highly mechanised cultural techniques, mussel farming in the MSM bay generates ecological waste. As intensive mussel-farming does not optimise biomass exploitation, it should be possible to produce more with a higher labour/capital ratio, and therefore to create jobs. On the other hand, the work in the oyster-farming sector is harder and is thus less attractive. Equity concerns may suggest more mechanisation in oyster-farming and more selectivity, through labour utilisation, in mussel-farming. In any case, such a transition toward more "responsible" shellfish-farming should certainly be implemented after social consensus and by using economic incentives and redistributive mechanisms.

## REFERENCES

- Askenazy, Philippe, 2003. Partage de la valeur ajoutée et rentabilité du capital en France et aux Etats-Unis: une réévaluation, *Economie et Statistiques*, 363-364-365, pp. 167-189.
- Baumol, William J. and Wallace E. Oates, 1971. The Use of Standards and Prices for Protection of the Environment, *Swedish Journal of Economics*, 73, pp. 42-54.
- Buchanan, James M. and Gordon Tullock, 1975. Polluters' Profits and Political Response: Direct Controls Versus Taxes, *American Economic Review*, 65(1), pages 139-47.
- Dumont, Philippe, 1987. Utilisation du Domaine Public Maritime par l'ostréiculture et problèmes de tarification, *Cahiers d'économie et sociologie rurales*, n° 4, pp 45-66.
- Fontenelle, Guy, Denis Bailly, Patrick Le Mao and Daniel Gerla, 1998. *How and why blue mussel growers succeeded in developing a long term co-management process to use marine open access resources*. Paper presented at the VII<sup>th</sup> Annual Conference of the International Association for the Study of Common Property, "Crossing boundaries", Vancouver, June 1998.
- Fontenelle, Guy, 2000. Dynamiques de cogestion : un problème, plusieurs solutions ; cas de la baie du Mont-Saint-Michel, France. *Revue de l'Université de Moncton*, hors série, 19-45.
- Gasquet, Richard, 1996. Historique et évolution de la conchyliculture dans la baie du Mont-Saint-Michel. Master's thesis, INA-PG, Paris
- Kneese, Allen V., and Blair T. Bower, *Managing Water Quality: Economics, Technology, Institutions*. Baltimore, Md.: Johns Hopkins University Press.
- Le Mao, Patrick, and Daniel Gerla, 1998. La conchyliculture en baie du Mont-Saint-Michel. *Bulletin Trimestriel de la Société pour l'Étude et la Protection de la Nature en Bretagne*, 169, pp. 28-37.
- Mongruel, Rémi, José A. Pérez Agúndez, Sophie Girard and Denis Bailly, 2006. Analyse des stratégies d'occupation de l'espace maritime côtier : le cas des concessions conchyloles. Rapport final du projet, Programme National sur l'Environnement Côtier (PNEC), forthcoming.
- Mongruel, Rémi and Olivier Thébaud, 2006. Externalities, institutions and the location choices of shellfish producers: the case of blue mussel farming in the Mont-Saint-Michel Bay (France), *Aquaculture Economics and Management*, forthcoming.
- Orfila, Gérard, 1990. *Droit de la conchyliculture et de l'aquaculture marine*. Éditions Bordessoules.
- Pigou, Arthur C., 1920. *The Economics of Welfare* (Macmillan, London).
- Rawls, John, 1971. *A Theory of Justice*. Cambridge, Massachusetts: Belknap Press of Harvard Un. Press.

## ENDNOTES

<sup>1</sup> According to the results of the national census of shellfish farming activities carried out in 2002.

<sup>2</sup> The later extensions of the mussel farming zone were associated with reorganizations of the sector (transfers); that is why they did not result in increasing the number of farmers.

<sup>3</sup> The 11% rate corresponds to a 4% credit rate over a 20 years period, and the 15% rate corresponds to a 5,16% credit rate over a 30 years period.

<sup>4</sup> The net return on capital has been estimated to be around 17% for the agro-industry in France during the years 1990s (Askenazy, 2003). No data is available for agriculture, even if the return on capital should be assumed to be lower in this sector.

<sup>5</sup> Co-management measures taken by farmers' organization and the administrations in each shellfish farming production basin specify technical practices: number of tables and bags per hectare for oyster-farming, density of the wooden stakes and percentage of spat sowing for mussel-farming. The combination of this cultivation rules with natural productivity of shellfish farming area makes the concessions quasi-equivalent to transferable production rights or quotas (Mongruel et al, 2006).

<sup>6</sup> If non significant data are excluded (the year during which concessions transfers are not numerous), the evolution of land prices in the Mont-Saint-Michel bay during the period 1990-2003 is almost linear: the average value of oyster-farming concessions increased from 9 000 to 13 000 FF/ha while the average value of mussel-farming concessions increased from 29 000 to 51 000 FF/ha (Mongruel et al, 2006).