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The impact of economic and regulatory factors on the relative profitability of fishing boats: A case study of the seaweed harvesting fleet of Northwest Brittany (France)

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Abstract – This paper addresses the question of the relative importance of economic and regulatory (administrative) factors on the profitability of various components of a fishing fleet. The argument is that, while the official purpose of most regulatory measures is resource conservation, these measures may significantly influence the relative levels of incomes generated by various components of the fleet. When a large part of fisheries management is under the control of fishermen themselves, this illustrates how the endogenous generation of rules by groups of users may affect both economic efficiency and equity. The analysis relies on a field survey of a small-scale inshore fishing fleet of the Northwest part of Brittany (France),which provided data for simulations concerning the impact of various factors on the profitability of boats. According to the results of these simulations, two regulations, concerning the cost of access to some resources and the control of fishing effort, play a significant role in the difference of profitability observed according to boat size. At a time when the ageing of the fleet opens the question its renewal, this might influence durably the dynamics of the fishery.

Key words: Boat profitability / Vessel size / Regulatory measures / Seaweed harvesting fleet

Résumé – L'incidence des facteurs réglementaires et des facteurs économiques sur la rentabilité des navires de pêche. Le cas de la flottille goémonière bretonne. Cet article étudie l'influence relative des facteurs économiques et des facteurs réglementaires sur la hiérarchie des performances économiques au sein d'une flottille de pêche. Il met en valeur le fait que des mesures ayant pour objet explicite d'assurer la conservation des ressources manquent parfois fortement de neutralité économique. Lorsque l'aménagement d'une pêcherie est largement aux mains des pêcheurs eux-mêmes, ce phénomène illustre la façon dont la génération endogène de règles par des groupes d'usagers peut affecter à la fois l'efficacité économique et l'équité. L'analyse s'appuie sur une étude de terrain consacrée à une flottille artisanale côtière du Nord-Ouest de la Bretagne. Cette étude fournit des informations économiques à partir desquelles ont été réalisées des simulations relatives à l'impact de différents facteurs sur la rentabilité des navires. Selon les résultats des simulations, deux mesures réglementaires, concernant le coût de l'accès à certaines ressources et le contrôle de l'effort de pêche, contribuent de façon significative à la disparité des performances économiques constatée en relation avec la taille des navires. A une période où se pose la question du renouvellement d'une partie importante de la flottille, ce phénomène peut influencer durablement la dynamique de la pêcherie.

1 Introduction

According to Charles (1992), three major paradigms interact (and often conflict) in the definition of the management system and policy of a fishery: the conservation paradigm, which seeks resource conservation, the efficiency paradigm, which favours profitability of the fishing industry, and the social-community paradigm, which is oriented towards welfare of local communities and distributional considerations. A frequent view is that the management of most real-world fisheries is dominated by a combination of the two first paradigms, and leaves only a marginal place to the social-community paradigm (see for instance Crean and Symes 1996, for the European case; Boncoeur and Mesnil 1999 for a critical view).

Whatever the reliability of this opinion, there is little doubt that regulations aimed at improving resource conservation and/or increasing economic efficiency of the industry frequently have a distributional impact among fishermen (see e.g. Guyader and Thébaud 1999), which raises equity issues and is a major source of fisheries conflicts. In these conflicts, public concern for resource and ecosystem conservation tends to be intermingled with distributional considerations. For instance, debates concerning the need to limit or ban the use of some gears, though apparently focused on the "biological" impact of these gears, are often rooted in the vested economic interests of various interacting fleets. In such cases, the lack of clear and commonly accepted definition of individual use rights frequently leads to non-efficient solutions, since no Coasian-type bargaining process may take place (Boncoeur et al. 2000).

Another consequence of the connection between distributional and conservation/efficiency impacts of regulations is the difficulty to assess the respective roles played by "economic" and "regulatory" factors in the relative economic performance of various boats operating in a fishery: part of the observed differences may be due to an artefact, i.e. the (possibly unintended) result of some regulation. Underrating this type of phenomena may create some kind of circularity in the management strategy of the fishery and influence its dynamics in the wrong direction, since the most profitable boats usually tend to exclude the least profitable ones from the fishery.

This paper addresses the question of the relative importance of economic and regulatory factors on the profitability of various components of a fishing fleet. It is based on a case study concerning a small-scale inshore fishing fleet, the seaweed harvesting fleet of the Northwest part of Brittany (France), which was investigated by a field survey at the end of year 2000 (Alban et al. 2001). The first part of the paper briefly describes the fishery and its dynamics over the past three decades. Part 2 analyses the main results of the survey concerning the profitability of various components of the fleet. Part 3 displays two simulations concerning the impact of regulatory measures on the relative profitability of boats. The possible consequences of the regulatory measures on the dynamics of the fleet are discussed in the conclusion.

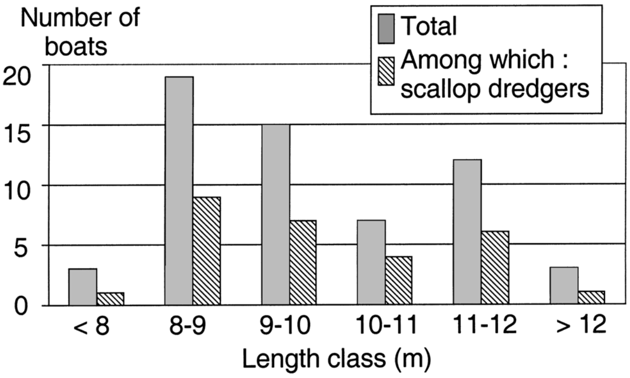

Fig. 1. Seaweed harvesting fleet: distribution of boats according to length class, year 2000 (data source: Ifremer).

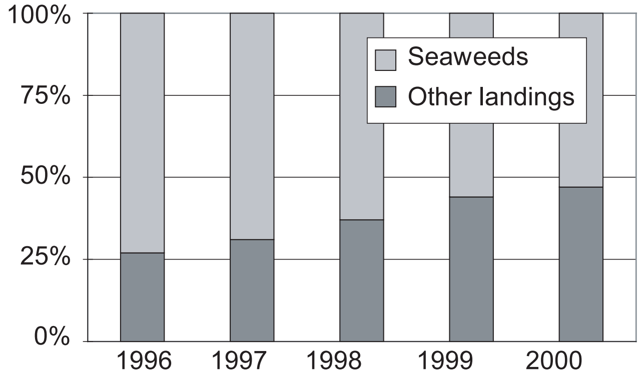

Fig. 2. Seaweed harvesters participating in the Bay of Brest shellfish fishery: shares of annual revenue due to seaweeds and other types of landings, 1996-2000, constant panel (data source: Observatoire économique régional des pêches maritimes de Bretagne).

2 The fishery

The bulk of the French seaweed harvesting industry is concentrated on the Northwest coast of Brittany. It is a traditional activity in this area (Arzel 1987), where some of the most important seaweed fields in Europe are located. Nowadays, the main commercial species is *Laminaria digitata*, which contains alginates that are used in the making of a wide range of manufactured goods (e.g. paints, cosmetics, pharmaceutics, food bulking, gelling and stabilising products). This species is harvested by a specialised fleet, composed of 48 boats in 2002. Boats use a specially designed gear, composed of a hook which is fastened to a hydraulically driven mechanical arm. Two processing plants, located near the landing areas, buy the harvest, and extract the alginates contained in the algae (Arzel 1998).

The harvesting activity is artisanal: all boats are between 7.5 and 13.2 m long (Fig. 1), most of them are operated by one person (sometimes two), and each boat belongs to its skipper. Contrasting with this structure of the primary sector, the processing sector is controlled by two multinational firms, and its output is sold on the highly competitive world market of alginates (Kervarec et al. 1999).

The harvesting of seaweeds by boats is considered by French law as a fishing activity. According to a 1991 law concerning the organisation of fisheries, the management system of this inshore fishery relies on a set of rules adopted by the "seaweed commission" of the Regional Committee of Fisheries of Brittany (a professional organisation), and validated by government authorities (Table 1). Fishermen form the majority of this commission, where the processing sector is also represented. Since 1985, the fishery has been managed on the basis of a limited entry license system, with regulations concerning fishing power and fishing effort. Some additional regulations concern the areas open to harvesting and the maximum quantities landed per boat in the first weeks of each harvesting season, which usually extends from May to October. Since 1987, boats have been limited to one landing per day.

Due to the seasonal character of seaweed harvesting, fishermen rely on additional sources of income. At the end of the seaweed harvesting season, some of them engage their boat in other fishing activities, mainly shellfish dredging in the Bay of Brest (half of the seaweed harvesting fleet in 2000). This activity has played an increasing role as a source of income for seaweed harvesters in the 1990s: according to data from a panel of seaweed harvesting boats participating in the Bay of Brest shellfish fishery, the average share of total revenue provided to these boats by shellfish landings rose from 27% to 47% between 1996 and 2000 (Fig. 2), a trend which is partly related to the impact of the Bay of Brest scallop restocking program (Alban et al. 2001).

The seaweed processing sector complements its local inputs by imported dried seaweeds. However, a major concern is to keep local landings at a level high enough to justify the

Table 1. Main features of the management system of the fishery (*L. digitata*).

Harvesting power	Harvesting time	Harvesting areas	Landings
Limited entry license system (65 licenses available each year since 2000)	Limits of the harvesting season (usually: May to October)	Rotation system at the beginning of each season**	Maximum 1 landing per day
Maximum boat length: 12 m*	Harvesting days and hours: from Monday to Friday, between sunrise and sunset		Weekly or daily quotas per boat (or per crew member) at the beginning of each season

* Except for boats operating in the fishery prior to the establishment of licenses. ** 5 first weeks. Source: Regional Fisheries Committee of Brittany.

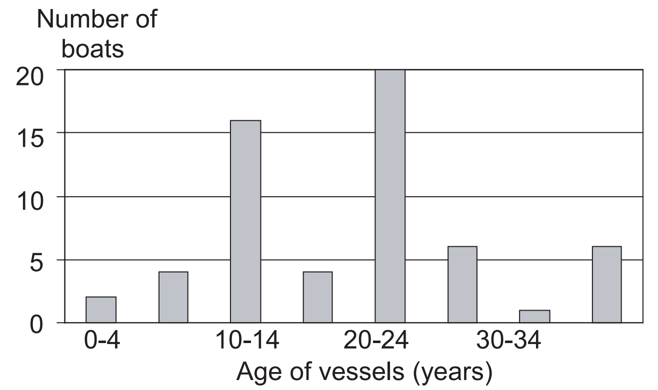

Fig. 3. Seaweed harvesting fleet: distribution of boats according to age class, year 2000 (data source: Ifremer).

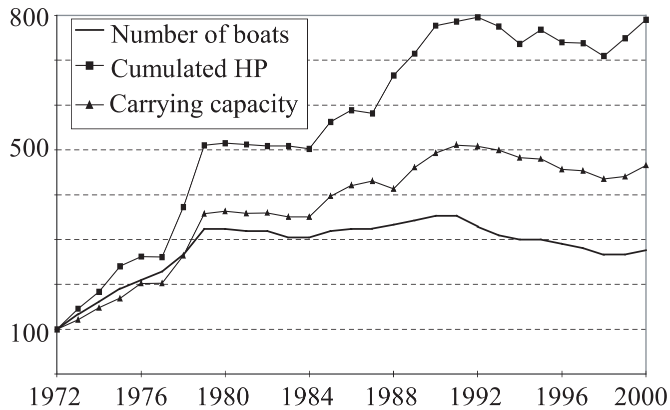

Fig. 4. Seaweed (mechanised) harvesting fleet, 1972-2000: number of boats, cumulated horse power (HP) and carrying capacity. Indexes, base 100 in 1972 (data source: Ifremer).

maintenance of the two factories in the area. Two causes of concern have arisen in the recent period: the ageing of boats and men, and the deteriorating condition of the resource.

In 2000, the average age of the fleet was 19 years, with 22% of the boats over 25 years, and only 10% under 10 years old (Fig. 3). The average age of fishermen was 43, with 25% of the total over 50, and only 8% under 30. Most of the boats forming the present fleet were built during two periods: the 1972-1980 period (44% of the fleet in 2000), and the 1985-1992 period (40% of the fleet in 2000). The older boats are usually between 8 and 9 m long, while more recent boats tend to be larger, with a length frequently between 11 and 12 m.

The present state of the fleet is the result of the evolution of the industry since the introduction of the mechanical harvesting technique in 1971. During the first years following this innovation, the number of boats using the new technique increased rapidly, from 21 in 1972 to 68 in 1980. By this year, the traditional non-mechanised fleet had almost disappeared (Arzel 1987), and the increase in the mechanised fleet became slower. A maximum of 74 boats was reached in 1990. The number of boats fell by more than 20% during the 1990s, but a good part of this evolution was balanced by the increase in the average horsepower and carrying capacity of boats (Fig. 4). This is due to an important change in the structure of the fleet: boats with a carrying capacity under 10 tons, which formed the majority of the fleet during the 1970s, had almost disappeared 20 years later. On the other hand, the number of boats with a carrying capacity over 20 tons grew from zero to 17 during the same period (Fig. 5).

Annual landings of *Laminaria digitata* (wet weight) increased from some 30 000 tons in 1980 up to a maximum of 65 000 tons in 1986 (Fig. 6). After this date, landings fluctuated around 60 000 tons for ten years (the year 1993 was exceptional, due to special conditions on the world market of alginates). At the end of the 1990s, landings fell to some 50 000 tons (51 416 tons landed in 2002), and their quality deteriorated, with an increasing proportion of stones and valueless seaweeds (*Sacchoriza polyschides*). The explanation for these changes is not yet completely clear. The recent decrease in landings was by no means balanced by a rise in their price, which is constrained by the situation on the world market of alginates, and has remained fairly stable (expressed in constant currency) since 1994.

Average landings per boat were multiplied by 4 between 1972 and 1986. After 1986 they have fluctuated between 800

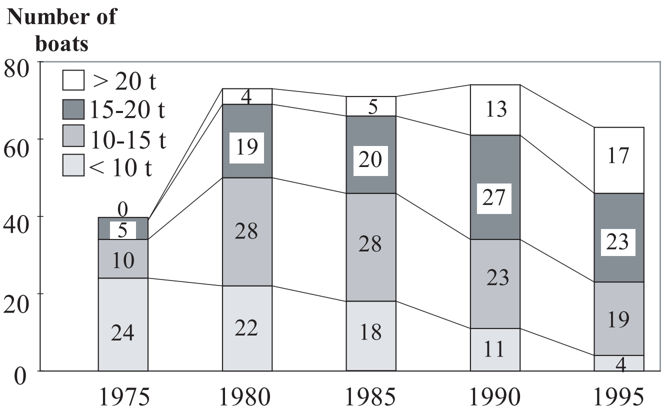

Fig. 5. Distribution of seaweed harvesting boats according to individual carrying capacity, 1975-1995 (from Arzel 1998).

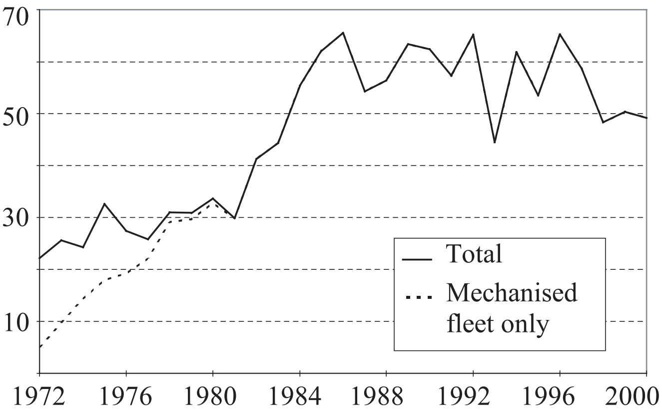

Fig. 6. *Laminaria digitata*: annual landings (10^3 tons), 1972-2000, Brittany (data source: Ifremer and Arzel 1987).

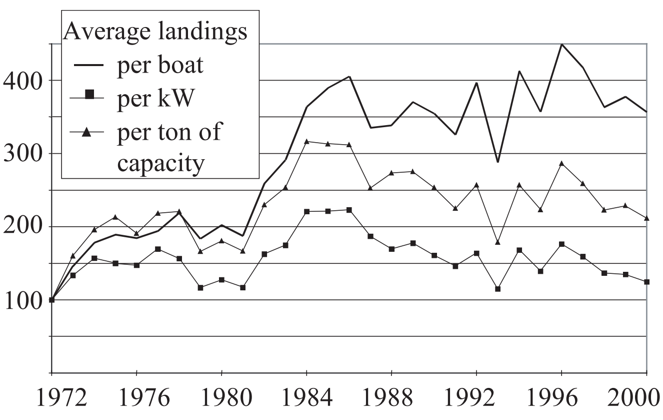

Fig. 7. *Laminaria digitata*: evolution of catch per unit effort (CPUEs), 1972-2000 (data source: Ifremer).

and 1000 tons a year (1071 tons in 2002). This apparent stability conceals a negative trend in average CPUEs since the mid-80s (Fig. 7), as the average capacity of boats increased significantly during the same period. The negative trend affecting the seaweed harvesting activity increases the strategic importance of complementary source of incomes, such as the Bay of Brest shellfish fishery.

3 Economic performance indicators of the fleet

In order to analyse the economic factors conditioning the renewal of the fleet, it was necessary to assess its economic performance. For this purpose, a field survey was conducted during the period of November-December 2000, by means of direct interviews with skipper-owners (Alban et al. 2001). The quota method was used as a basis for selecting the sample, with a stratification of the main population following two criteria: length class (over/under 10 m) and activity (boats participating in the Bay of Brest shellfish fishery, hereafter called "dredgers"/other boats, hereafter called "non-dredgers"). A total of 35 fishermen were interviewed, which represents an overall sampling rate of 60%. However, practical difficulties in meeting some fishermen have resulted in actual sampling rates varying according to strata, the main source of discrepancy being an underrepresentation of the category of non-dredgers under 10 m, where the actual sampling rate was only 25% (Table 2). To account for this fact, the weights that are used in the following simulations correspond to the structure of the main population. The reliability of the economic results provided by the survey was tested by comparing them to accounting data for a sample of 16 seaweed harvesting boats selected from a economic database of the fishing industry in the Brittany region (Anon. 2001).

The main results of the survey concerning the economic performance of the seaweed harvesting boats are summed up in Table 3. The reference period is normally the period of twelve months between October 1999 and September 2000.

The first part of the table is devoted to revenue (turnover). Average annual turnovers are differentiated by type of activity and by length class. In each length class, the average turnover is significantly higher for dredgers than for other boats. This difference is mainly due to the fact that seasonal harvesting of *L. digitata* is the only activity for a majority of non-dredgers (which does not imply that the skippers of such boats have no other source of income: a significant number are navy pensioners, or are engaged as crew-members on other boats after the seaweed harvesting season). Considering dredgers as well as non-dredgers, average turnover is significantly higher for boats over 10 m long than for smaller boats. This gap is partly due to a difference in fishing time, as may be seen from a comparison between annual and hourly average revenues. When only *L. digitata* harvesting is considered, the difference in fishing time accounts for approximately 1/3 of the difference in landings between the two length classes.

The central part of Table 3 presents for each stratum the level of full equity profit and profit rate (ratio of full equity profit to capital value). The difference is now mainly between length classes: while the activity of boats over 10 m generates on average a profit rate of 10−11%, the activity of smaller boats participating in the fishery cannot generate a positive average profit. Apparently, participating in the Bay of Brest shellfish fishery does not help increase profitability. For smaller boats, it even seems to worsen the situation: dredgers under 10 m. generate a loss on average while, in the same size class, boats entirely devoted to seaweed harvesting are just about to breaking even (assuming these boats do not bear any financial costs).

Table 2. Seaweed harvesting fleet: comparative structure of the main population and sample of the field survey.

Stratification criteria		Structure (% of the total number of boats)	
1. Length class	2. Secondary activity (if any)	Main population (n = 58)	Sample (n = 35)
Boats under 10 m			
	Dredgers*	29%	34%
	Others	35%	15%
	Total	64%	49%
Boats over 10 m			
	Dredgers*	21%	31%
	Others	15%	20%
	Total	36%	51%
Total			
	Dredgers*	50%	66%
	Others	50%	34%
	Total	100%	100%

* Boats participating in the Bay of Brest shellfish fishery. Sources: Ifremer (main population) / CEDEM survey (sample).

Table 3. Seaweed harvesting fleet: economic performance indicators, 1999-2000.

	Dredgers		Others	
	< 10 m	≥ 10 m	< 10 m	≥ 10 m
Revenue				
Annual (10^3 euros)				
Total				
- mean	**51**	**94**	**21**	**66**
- standard deviation	17	30	5	38
***L. digitata* only**				
- mean	**29**	**53**	**21**	**51**
- standard deviation	12	23	5	28
Per hour at sea (euros)				
Total				
- mean	**52**	**78**	**39**	**63**
- standard deviation	16	34	16	28
***L. digitata* only**				
- mean	**41**	**56**	**39**	**66**
- standard deviation	17	17	16	27
Full equity profit*				
Annual (10^3 euros)				
- mean	**–2**	**13**	**0**	**10**
- standard deviation	5	15	2	16
Profit rate (% of boat insured value)				
- mean	**–3%**	**11%**	**0%**	**10%**
- standard deviation	7%	12%	5%	11%
Skipper-owner's net activity income**				
Annual (10^3 euros)				
- mean	**10**	**29**	**5**	**21**
- standard deviation	12	15	4	20
Per hour at sea (euros)				
- mean	**10**	**24**	**10**	**21**
- standard deviation	12	16	9	18

* Revenue minus intermediate consumption, labour costs (including national insurance and imputed wage of the skipper-owner), landing taxes, licenses and capital depreciation. ** Net imputed wage of the skipper-owner + full equity profit - opportunity cost of capital (8% of boat insured value). Source: CEDEM survey.

Table 4. Simulation I: Impact of a change in the distribution of the cost of access to the Bay of Brest shellfish fishery on the relative profitability of seaweed harvesting boats (dredgers only)*.

Length class (dredgers only)	Turnover provided by shellfish (10^3 euros)	Contribution to the hatchery budget (10^3 euros)	Profit rate	Skipper-owner's net activity income (10^3 euros)
Under 10 m				
Base situation	21	5	−2.8%	10
Alternative scenario	21	3	−0.4%	12
Absolute change	0	−2	+2.4%	+2
Relative change	0%	−37%		+16%
10 m and over				
Base situation	40	5	11.3%	29
Alternative scenario	40	6	10.5%	28
Absolute change	0	+1	−0.8%	−1
Relative change	0%	+21%		−3%

* Average annual values per boat. Data source: CEDEM survey.

The share-system, which is the basis for crew rewarding in small-scale fisheries, contributes to blur the economic meaning of standard profitability indicators, since wages calculated according to this system cannot be simply assimilated to the opportunity cost of labour. The problem gets particularly acute when the crew is limited to one person (the skipper-owner), which results in making the distinction between wages and profits purely conventional (when the crew is limited to the skipper-owner, the share-system is not always used, which is a source of heterogeneity in the economic performance indicators; to circumvent this type of problem, it has been supposed during the processing of the survey results that the share-system applied to all boats). As classical profitability indicators are highly sensitive to the key adopted for the sharing of incomes between crew and boat owner, it seems advisable to make a lump of the incomes received by the skipper-owner as a labourer and as an entrepreneur (Boncoeur, Coglan et al. 2000). This is the purpose of the indicator which is presented in the lower part of Table 3: the net activity income of the skipper-owner is calculated as the sum of the net incomes he receives through the channels of the crew-share and the owner-share, minus the opportunity cost of his professional capital (estimated as 8% of the boat insured value). According to data presented in Table 3, the length class is a major source of difference between the levels of such incomes: between the two length classes, the ratio of average skipper-owner's net activity incomes is equal to approximately 3.4 if calculated on a yearly basis, and to 2.3 on a hourly basis.

4 Simulations

In this section, the impact of two regulations on the relative profitability of different groups of seaweed harvesting boats is considered. The first one is the system regulating the institutional cost of access to the Bay of Brest shellfish fishery. The second one is the system of control of fishing effort in the seaweed fishery. For each case, a simulation is presented, with the purpose of estimating the distortion created by the regulation system in the relative profitability of boats. The simplifying assumptions underlying these simulations should be kept in mind when discussing their results.

The annual cost of licenses giving access to the Bay of Brest shellfish fishery is set at an unusually high level according to French standards (4600 euros per boat in 2000). The reason for this peculiarity is that fishermen now have to finance the operating cost of the hatchery-nursery which is the base of the scallop restocking program at work in the bay. The contribution is uniform, but the fishing powers of the boats participating in the fishery are not (Boncoeur and Guyader 1995). As a result, the real burden of the financing of the program is a decreasing function of the value of landings of each boat, i.e. the unit cost of access to the resource is differentiated to the benefit of boats with the highest fishing power.

In order to estimate the impact of this distortion on the profitability of seaweed harvesting boats participating in the fishery, a shift to a non distorting system was simulated (Table 4). The scenario assumes that the uniform contribution to the hatchery budget is replaced by a contribution which is proportional to the value of the landings of each boat participating in the fishery, i.e. an ad valorem tax on landings. The constraint is that the global income collected through this tax should be equivalent to the one previously provided by the uniform contribution. On the basis of the value of landings during the 1999-2000 fishing season, it was estimated that the rate of the ad valorem tax should be 14% in order to satisfy this constraint. Two additional hypothesis were adopted for the simulation:

- Exogenous character of prices.
- Constant fishing effort of each boat participating in the fishery.

The first hypothesis reflects the marginal size of the fishery compared to that of the market. More open to criticism, the second hypothesis is merely the result of a methodological option, which is to measure the mechanical impact of a change in the financing structure of the restocking program, i.e. assuming constant behaviours of fishermen.

Under these assumptions, individual turnovers would be unaltered, and the contribution of each boat to the hatchery budget would decrease or increase according to the value of

Table 5. Simulation II: Impact of a change in the system of effort control on the relative profitability of seaweed harvesting boats*.

Length class (all boats)	Total number of hours at sea	Global turnover (10^3 euros)	Profit rate	Skipper-owner's net activity income income (10^3 euros)
Under 10 m				
Base situation	752	35	−1.6%	8
Alternative scenario	826	40	1.7%	12
Absolute change	+74	+5	+3.3%	+4
Relative change	+10%	+13%		+55%
10 m and over				
Base situation	1142	82	11.0%	26
Alternative scenario	985	74	7.5%	20
Absolute change	−157	−8	−3.5%	−6
Relative change	−14%	−10%		−23%

* Average annual value per boat. Data source: CEDEM survey.

its landings. Considering only seaweed harvesters participating in the shellfish fishery, the simulation shows that, on the average, the contribution of boats under 10 m would drop by 37%, while that of larger boats would increase by 21%. This change would moderately reduce the gap between the profitabilities of the two groups, with a relatively greater impact on the situation of smaller boats than on that of large ones: while the average skipper-owner's activity income would rise by 16% on boats under 10 m, it would be reduced by only 3% on boats 10 m long and over. Even after this change, the gap between the two average incomes would be noticeable, the average skipper-owner's activity income on boats 10 m long and over being 2.4 times that of skippers of boats under 10 m (against 2.8 under the actual conditions).

Another distorting regulation concerns the control of fishing effort in the seaweed fishery itself. In this fishery, effort is controlled by direct means (limitation of the fleet size, boat length and fishing time), but also indirectly by limiting to one the number of authorised landings per day (see Table 1). This constraint is usually not binding for larger boats, which have been designed for operating on the basis of one trip per day. But it is prejudicial to smaller boats, which operate closer to the shore and get fully loaded in a shorter time.

For assessing the impact of this distortion on the relative profitability of seaweed harvesting boats, a change in the effort control system was simulated. The scenario assumes that the constraint on the maximum number of landings per day is replaced by a uniform effort quota (number of hours at sea dedicated to seaweed harvesting), calculated over the whole harvesting season. The constraint is that the global yearly output of kelp (*L. digitata*) remains unchanged, due to the limiting character of the resource. On the basis of the average outputs per hour of each boat in the fleet, the effort quota was estimated to be 690 hours of seaweed harvesting for each boat, to produce the same global output as in 2000. The following assumptions were also adopted:

- Proportionality between harvesting time and number of hours at sea during the harvesting season.
- Constant CPUE of each boat.
- Variable costs (fuel and lubricant, gear renewal and repair, broken down by type of activity) proportional to time at sea.
- Effort quota constraint saturated for each boat.

The first result of the simulation (Table 5) is a significant shift in the distribution of effort between the two length classes of boats: the scenario would result in an increase of 12% of the total seaweed harvesting time for boats under 10 m (+10% of their total yearly fishing time), compensated by a reduction of 19% of the total seaweed harvesting time for boats 10 m. long and over (−14% of their total yearly fishing time). As a consequence, annual turnover would increase by 13% for smaller boats, and decrease by 10% for larger boats. The distributional impact would be significant, as average skipper-owner's activity income would increase by more than one half on smaller boats, while that of larger boats would drop by nearly 25%. The impact of the scenario on the global profitability of the fishery would be ambiguous in its sign, but moderate in its scale: the global full-equity profit would drop by 4%, but the global activity net income of skipper-owners would rise by 3%.

As the two simulations described above rely on scenarios which are independent of each other, it is possible to assess simply their cumulated effect on the economic performance of the two length classes of boats. In Table 6, figures concerning simulation I (change in the financing system of the hatchery budget) are different from that of Table 4, because the average impact is now calculated on the basis of the whole seaweed harvesting fleet, and not just its component participating in the Bay of Brest shellfish fishery. According to the cumulated results of both simulations, introducing a non distorting cost of access to the Bay of Brest shellfish fishery and a non distorting effort regulation system in the seaweed harvesting fishery would significantly alter the distribution of incomes between groups of fishermen: the average profit rate of smaller boats would rise from some −2% to 4%, while that of larger boats would fall from 11% to 7%; skipper-owner's net activity incomes would rise by 65% on the average in the first group, and decrease by 27% on the average in the second group. Globally, it appears that the distorting regulations considered in the simulations account for the largest part of the

Table 6. Cumulative impact of simulations I (financing of hatchery budget) and II (effort control)*.

Length class (all boats)		Profit rate	Skipper-owner's net activity income (10^3 euros)
Under 10 m			
	Initial situation	−1.6%	8
	Change due to simulation I	+1.9%	+1
	Change due to simulation II	+3.3%	+4
	Cumulative change	+5.2%	+5
	Modified situation	3.6%	13
	Relative change		+65%
10 m and over			
	Initial situation	11.0%	26
	Change due to simulation I	−0.6%	−1
	Change due to simulation II	−3.5%	−6
	Cumulive change	−4.1%	−7
	Modified situation	6.9%	19
	Relative change		−27%

* Average annual value per boat. Data source: CEDEM survey.

Table 7. Views of fishermen concerning the fisheries management system, according to boat size.

		< 10 m	≥ 10 m
Maximum one landing per day (seaweed)*			
	agree	29%	67%
	indifferent	12%	22%
	disagree	59%	11%
	total	100%	100%
Uniform contribution to the hatchery budget (Bay of Brest)**			
	agree	72%	81%
	disagree	28%	13%
	do not answer	0%	6%
	total	100%	100%

* Opinions of skipper-owners of seaweed harvesting boats. ** Opinions of skipper-owners of dredgers operating the Bay of Brest fishery. Source: CEDEM survey.

observed gap between the average profitability levels of the two groups of boats: the simulations suggest that, if these regulations were replaced by non distorting regulations, the average gap between skipper-owner's net activity incomes of these two groups would be reduced by two-thirds (from 18 000 euros to 6000 euros), and the corresponding average gap between profit rates would be reduced by some 75% (from 13% to 3%).

The opinions expressed by fishermen during the field survey testify that they are aware of the distributional impact of regulations (Table 7). This is particularly the case with the maximum of one landing per day which is enforced in the seaweed fishery: this limitation is supported by 67% of the skipper-owners in the "10 m and over" boat length class, but is disapproved of by 59% of the skipper-owners of boats under 10 m. As regards the uniform license cost system enforced in the Bay of Brest shellfish fishery, the distinction between the two groups is not so clear-cut. In both groups, a strong majority of fishermen express their support to the system. This situation may be explained by two facts: *i*) the lack of transparency of landings in this fishery, and *ii*) the existence of an individual catch quota system in part of the fishery (called "reserve"), also set on a uniform basis for each boat, and which up to now has generated for each fisherman a revenue somewhat higher than the cost of the license. However, the proportion of opponents to the system is significantly higher in the group of boats under 10 m (28%) than in the group of larger boats (13%).

5 Conclusion

At first sight, reviewing economic performance indicators of boats operating in the seaweed harvesting fishery seems to comfort the usual view that larger boats tend to replace smaller ones because they are economically more efficient. It also suggests a fairly simple forecast: the renewal of the fleet (if any) is bound to establish the generalisation of the "10 m and over" boat model, simply because the smaller boats cannot cope with these more efficient competitors. Due to the limiting character of resource availability, the economic sustainability of this scenario requires that the number of boats in the fleet pursues its downward trend: as a boat 10 m long or over lands, on the average, twice as much kelp a year as a boat under 10 m, a simple calculation indicates that an output similar to that of year 2000 could be realised with a number of boats reduced by 1/3 if the fishery was operated only by boats 10 m long and over. Half of the way towards this situation was actually covered in 2001: between years 2000 and 2001, the number of boats in the fishery dropped by −17% without any significant reduction in the global landings of seaweeds.

However, the support such a scenario may expect from the "efficiency paradigm" corner in Charles's triangle is liable to erode if it turns out that regulatory factors account for an important part of the greater profitability of larger boats (it is also liable to some criticism from the "conservation paradigm" corner, since the generalisation of the larger boat model would mean an increase in the spatial concentration on seaweed fields which are already overexploited, and the neglect of fields which may be reached only by smaller boats; see Arzel 1998). A look at the regulations applying to the related seaweed and Bay of Brest shellfish fisheries suggests that the observed gap between the profitability indicators of smaller and larger seaweed harvesting boats does not merely reflect genuine differences in economic efficiency, but also differential rents created by the regulating system itself. According to the above described simulations, two regulations account for more than one half of the observed gap between the average profitability levels of smaller and larger boats operating the fishery. The opinions expressed by fishermen during the field survey indicate that they are well aware of this distributional impact of regulations.

Within a general legal framework imposing rather loose constraints on the activity, both seaweed and Bay of Brest shellfish fisheries are in fact self-managed by fishermen through their professional organisations at the local level, providing an interesting illustration of the subsidiarity principle at work (in the case of the seaweed fishery, one may speak of a de facto co-management between fishermen and the processing industry). Even if management rules have to be validated by state authorities before they become enforceable, under most circumstances the intervention of these authorities is very limited concerning the design of new regulations, and the initiative in this field comes from elected fishers representatives. Despite the fact that a majority of the fleet surveyed in this paper is composed of boats under 10 m, it is noticeable that some of these regulations significantly favour larger boats. This stresses the fact that "community-based management" is not by itself a warrant of equity in management, as might be suggested by a quick look at Charles's triangle of paradigms.

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