A Bioeconomic Analysis of the Impact of Buyback Programs : Application to a Limited Entry Scallop French Fishery

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Abstract: The objective of the paper is to analyse and to simulate fishers dis-investment behaviour especially in the context of the French buyback policy. A case study, the limited entry scallop fishery of the Saint-Brieuc bay is used to consider the problem of excess capacity and to review the impact of the national decommissioning schemes on the scallop fleet. The role of financial incentives technical and economic are studied to explain individual decisions to stay or to leave the fishery. Considering these lessons, the second part of the paper aims at modelling fishers' behaviour in order to simulate the bio-economic impacts of buyback programs and the role of different incentive schemes. Special attention is paid to the assessment of willingness to accept to leave the fishery. The model is applied to the scallop fishery while highlighting agency problems such as the role of the regulator's information about fleet and cost structure. The problem of windfall gains problem due to the mis-specification of the buy-back programs is analysed. Spreadsheet simulations lead to cost-benefit analysis of different policy options.

Keywords: Fishing capacity adjustment, buy-back programs, premium, willingness to accept, bio-economic model, cost-benefit analysis.

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INTRODUCTION

There is an increasing concern about excess capacity in the fisheries at an international level as well as in the European Union (FAO 1997) (Gréboval and Munro 1998) (Hatcher and Robinson 1998). The economic analysis of these problems has focused on the factor explaining overcapitalisation and the policy options – market based or administrative systems - to control and reduce fishing capacity of the fleets (Newton 1998) (OECD 1997)[1]. Within management alternatives, buyback programs of vessels or licences is one of the tool used by countries to adjust their fleets in order to reach different objectives (Holland and al. 1999) (Holland 1999) (Metzner and Rawlinson 1998). They have been widely used to restore profitability to the fishery, to reach stock conservation objectives but they also lead to distributional implications in terms of transfer payments.

At European level, Adverse effects on fishing stocks (Anon 1990) (Anon 1996) has led to strengthen the role and to harden the constraints of Multi Annual Guidance Programs (MAGPs) within the Common Fishery Policy. The MAGP funding by the European Union is part of the structural policy budget which is also dedicated to the building and modernisation of the fleets (Giguelay 1999) (Hatcher 2000). Each member state has been required to adjust the national fleet through the MAGP since 1983. The MAGP objectives expressed in term of kilowatt or gross registered tonnage are linked to some general objectives expressed in terms of fishing mortality reduction. Faced by the increased tightening up of the MAGP objectives, the member states have implemented different types of public policies and buyback programs to fulfil fleet capacity reduction targets (Frost and al. 1995) (Anon 1997a) (Anon 1997b). In France, a sector-related policy based on entry barriers and individual permits has been used to control the fleet capacity. From 1991 to nowadays, vessel buyback programs linked to a premium offered by the government to the vessel owners has been adopted to reduce the fleet size (Daures and Guyader 2000).

Despite policy interest in buyback programs, there is few quantitative analysis of the implication of these program from an economic point of view (Anderson 1998)

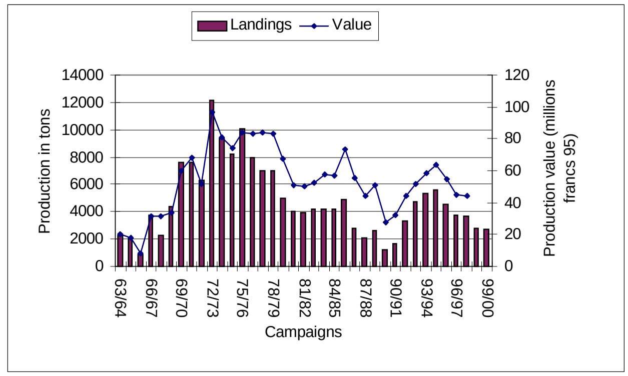
(Chuang 1999). More recently, Ikara and Odink (1999) used empirical data to examine fishers resistance to exit. Bioeconomic analysis of fleet adjustment do not include the cost of such programs and then overestimate their social benefits. Moreover, most of the approaches fail to consider the problem of asymmetrical information between regulators and fishers.

The first part of the paper describes the evolution of the limited entry scallop fishery in the Saint-Brieuc Bay. It examines the management options used to control the fleet fishing capacity, then analyses the conditions and the impact of the national decommissioning schemes on the scallop fleet during the period 1991-96. The nature of the applicants to these buyback programs and the role of economic parameters are also considered to explain exit behaviour. The second section deals with a model to consider the dis-investment strategies. The objective is assess the minimum willingness to accept (WA) for which decision to stay or to leave the fishery are equal. Sensitivity analysis of WA to model structure is undertaken and discussed. Then, the micro-economic model is linked to a more standard bio-economic approach that enables us to assess the macro-results of buyback programs as a function of premium level, public budget constraints. This finally leads to cost-benefit analysis of capacity adjustment and to focus on the windfall gains effects and the problem of lack of information in public policy

1. THE SCALLOP FISHERY IN THE SAINT-BRIEUC BAY.

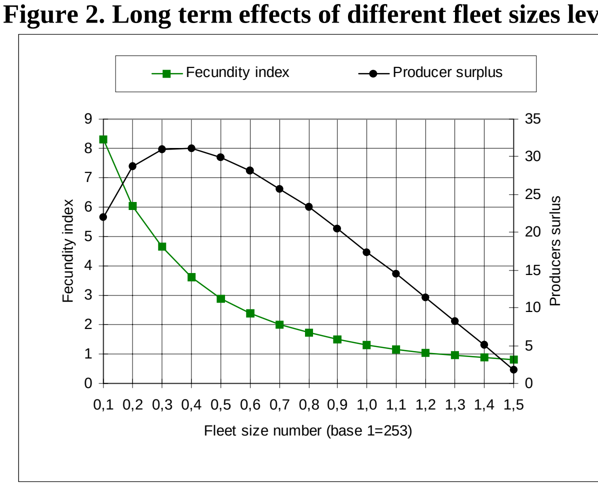
The Saint-Brieuc scallop fishery is located within the Oriental part of the English Channel (ICES area VIIE) and is not shared with other European countries. This is one of the two main scallop production areas in France. Annual official landings have reached around 3800 tons since the beginning of the 90's when the national production fluctuated around 10000 tons per year. The area is exploited by vessels using dredge gear which come from the maritime districts of the North of Brittany. The fleet is composed of small units (average of 10.3 meters long and 127 kw for their engine power) which are multipurpose vessels carrying out trawl, gillnets, pots, etc., outside the scallop season from October to April and outside the in-season fishing time[2]. The scallop turnover has oscillated between 30 à 100 MF (base 1995) over the last twenty years and the fishery is structuring activity for the coastal fleets of the area. The changes in production over the period are mainly due to modified stocks productivity and change in the fishing mortality.

Figure 1. Evolution of the scallop landings and turnover of the Bay



Scallop recruits are considered as highly variable (factor 1 to 15) and this is a disadvantage for the management of the fishery, based on an average situation. Relation between genitors and recruits is mainly disguised by environmental factors (Boucher 1985) (Fifas et al. 1990). Notwithstanding the good reproduction of the beginning of the 90', the potential fecundity index used as a proxy of the adult biomass has plummeted in the last fifteen years. Its level is now situated at about 10000 tons versus 30000 tons in the 70's but the stock is not considered as to be threatened by extinction. As a consequence, landings fell from around 10000 tons at the middle of the 70's to 1500 tons at the end of the 80's. After the increase of the beginning of the 90's and despite new management measures, the scallop fishery faces a new fall in official landings from 4200 tons for the 1995/96 fishing season to around 2800 tons for the 1998 and 1999 seasons. Despite high levels of regulation enforcement and monitoring, illegal behaviour seems to be prevalent.

Figure 2. Long term effects of different fleet sizes level



Note : sustainable level with current regulation on days at sea

As illustrated on the last figure, producers surplus but also stock situation will be improved by fleet reduction considering other regulations as a constant. A 45 percent increased rent will be obtained with only 30 percent of the current fleet level and stock fecundity improvement will increase the probability to reach better recruits in the future. As a consequence, the reduction of the fleet can lead to positive effects from economic efficiency perspective.

1.1. Management of the fishing capacity by fleet adjustment

The development of the scallop fishery is mainly explained by the switch of the coastal fleets from the clam fishery which collapsed in the 60's. In order to avoid the same event and to control fishing mortality in an indirect way, the management authorities decided in 1963 to limit entry in the fishery. Input regulations such as hours at sea, maximum engine power, vessel length and mesh size limits were also implemented. The licence system with a *numerus clausus* was put into force in 1973 with allocation based on historical rights. Finally, 466 licences were issued to the vessels from the main maritime districts for the 75-76 fishing season and this number declined to 447 in 1980 to 371 in 1985. The scallop fleet decrease went on to reach respectively 282 and 254 units in 1990 and 1997. Different factors may explain the 45 percent reduction over the period. First of all, the decline of the scallop stock during the 80's and the relative remuneration fall in the fishery give fishers incentives to leave it to other best alternatives. This implies that the fishing capital has not left the fishery sector. Second, natural retirement of fishers occurred and the management authority decided not to allocate all the free licences to the candidate for entry. The exit flows leads to distributive effects because most of the vessels excluded were from maritime districts outside the Saint-Brieuc Bay ; 85 percent of the vessels are now from Bay versus 65 percent in 1980. Finally, scallop vessels have been recently scrapped by different French buyback programs applied into the context of the Multi-annual Guidance Programs of the Common Fishery Policy[3]. Decommissioning programs were not dedicated specifically to the scallop fishery because there was not a discriminative policy within the French fishery sector (Daures, Guyader, 2000). Moreover, the scallop fishery regulators did not adjust the fleet size in proportion to the vessels scrapped.

Figure 3. Evolution of vessel number in the scallop fishery

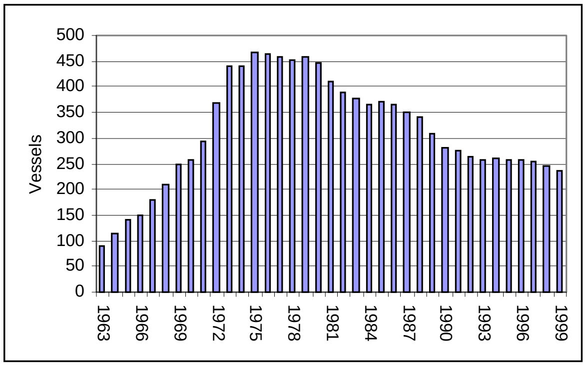
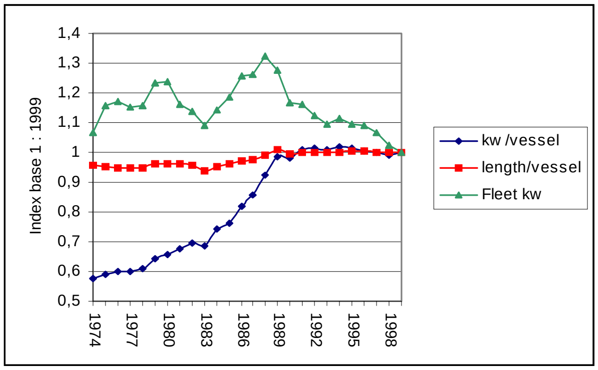


Figure 4. Fleet characteristics indexes



Source : IFREMER

The management of input regulation has not been really effective in controlling the fishing power of the fleet. Even though maximum limits for vessel characteristics had been implemented[4], there were economic incentives for vessel owners within the fleet to increase engine power by buying other vessels or upgrading the older ones before the implementation of fishing permits in 1989 which aimed at controlling it[5]. Since this period, capital stuffing has been still increased through investment in electronic fittings and improving skills (Guyader, Fifas, 1999). That is why management authorities decided to reduce days and hours at seas (from 120 to 43 hours between 1973 and 1997) in order to adjust the catches level to the state of the resources and to balance out the production over the years.

1.2 Buyback program and the role of technical and economic parameters

Considering the fleet dynamics, it is possible to carry out a preliminary study on the factors which may explain fishers exit within decommissioning schemes during 1991-1996. According to Frost and al. (1995), many factors like expectations on short-run or long run profits, age and value of the vessels, private wishes, premium level, etc. may be determinants of withdrawal. Daures and Guyader (2000) showed that there was no buyback

Table 1. Characteristics of the sub-fleet in term of vessel and skipper age

	[0-60kW]	[60-120kW]	[120-185kW]	[>185kW]	Total fleet
Skipper mean age	40.6	39.5	39.6	40.5	39.8
Standard Deviation	8.9	7.8	8.1	7.7	8.0
Variation coef.	0.2	0.2	0.2	0.2	0.2
Vessel mean age	20.1	19.0	13.5	8.1	15.8
Standard Deviation	7.1	6.9	8.2	7.1	8.4
Variation coef.	0.4	0.4	0.6	0.9	0.5

Test on skipper mean age : $F(3.269)=0.28<2.64$ for $p=5\%$

discrimination within the French fleet in terms of premium offered per kw[6]. The same conclusion can be made at the scallop fishery level with an average premium level offered of about 22 kf/grt in 1991 with no significant difference within scallop sub-fleets specified before. Consequently, exit behaviour has been influenced by other parameters. A large range of applicants were involved for an identical premium rate, either young fishers or older left the sector. For example, 10 percent of the [30-40[and [50-60[years old fishers decided to retire. The population of scrapped vessels was the oldest in frequency with 67 percent aged more than or equal to 20 years.

In order to take into account the total population structure, the percentage of vessels inside each age category is calculated for the total fleet at the end of 1990 and the population which left the fleet in 1991 by the first decommissioning plan. The figure 5 exhibits vessel age influence on the incentives to dis-invest from the fishery. About 45 percent of the decommissioned vessels are from 20-30 years old category which represents about 20 percent of the total population and only 32 percent of the scrapped vessels comes from the 10-20 category when it represents about 34 percent of the total population. The gap in percentage between exit vessels and total population skipper age is weaker but the rate of exit is nevertheless higher for the oldest fishers than their representativeness in the population structure. At global level, skipper age is likely a key factor in behaviour to leave the fishery but vessel age seems to be a more key parameter for a given fisher age in exit decision and the conclusion is strengthened by the analysis at scallop fishery level[7].

As shown on table 1, there is no statistical difference in vessel skipper age between the different sub-fleet categories. Average age is about 40 years and variance analysis test used to compare the different mean ages concludes that the hypothesis of a same mean can not be rejected at 5 percent level.

Figure 5. Age structure of the total population of active vessels and of decommissioned vessels*

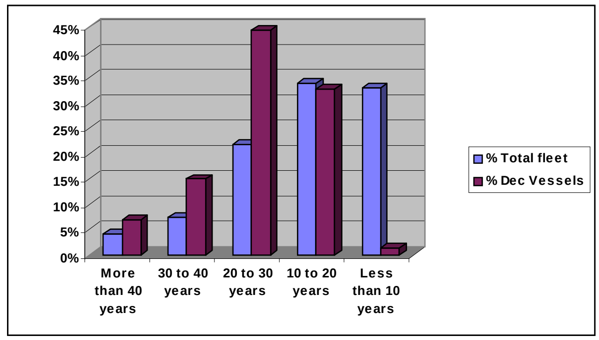
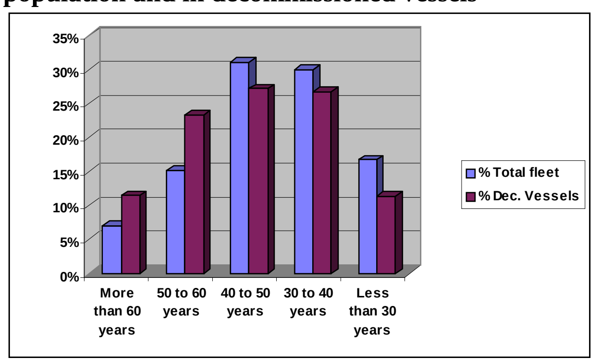


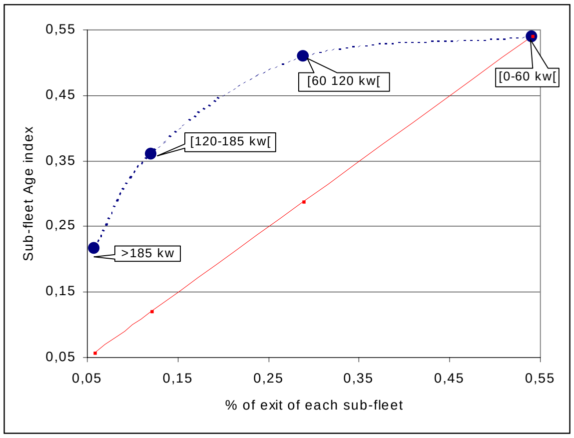
Figure 6. Skippers age structure in the total population and in decommissioned vessels*



* Vessels less than 12 meters long first Plan.
Source : IFREMER based on administrative data

However, there is a negative relation between the vessel engine power and the vessel mean age. The most recent vessels in the scallop fleet are generally speaking the most powerful because of the positive relation between vessel productivity and engine power that incite fishers to change their fishing unit. Then, the mean age per category is linked to the rate of exit in each sub-fleet throughout the 1991-1996 period (figure 7). During this period, 68 vessels having held a scallop licence previously decided to apply for the buyback program. About 76 percent of the exit flow occurred in 1991. The next figure illustrates that the rate of exit of the [0-60kw[sub-fleet is in proportion to sub-fleet mean age when the rate of exit is less for the other fleet components[8]. For a given age, the distance between the real rate of decommissioned vessels and the proportional rate of exit is a relative measure of the factors explaining the resistance to exit. Assume that infra-marginal skipper or marginal vessels and other individual influence are randomly dispersed between the different sub-fleets, these relative gaps can be considered as an index, measuring the differences in productivity, revenues and costs of the average vessel in each sub fleets.

Figure 7. Rate of exit as a function of vessel age



The next section focuses on the economic analysis of these differences in an attempt to value the minimum willingness to accept to exit the fishery. It is mainly based on theoretical considerations about economic behaviour and a model framework is presented to go ahead in the characterisation of fishers decision in the context of buyback programs.

2. A MODEL TO ASSESS WILLINGNESS TO ACCEPT (WA) TO LEAVE THE FISHERY.

The objective of this section is to model fishers behaviour in a certain environment and their decision to leave or to stay in the fishery sector. The aim of the developed tool is to assess the role of different economic incentives individual fishers face and their impact on the willingness of fishers to leave the fishery. Recent papers deal more or less with this realm (Wenniger and Just, 1997) (Guyader, 1998ab). More precisely, we assume that vessel-owners - and skippers in the context of small-scale production - are able to value the net present benefits (losses) to stay in the fishery and the opportunity cost or present benefit if they leave the fishery. The calculation gives us the evolution of minimum willingness to accept (WA) to leave the fishery that is compared with the premium offered by the buyback program organised by the public authority. The opportunity of including different components into the calculus is discussed. This approach is further combined with a bio-economic simulation model in order to assess the impact of capacity adjustment on fishery performance and the feedback effects on fishers decision to withdraw from the industry over the transition period.

2.1 Economic incentives to stay or to leave the fishery.

In the model, the decision to stay or to exit the fishery depends on the fisher's calculation of economic opportunities even if other factors can have an influence on their choice (Frost & al. 1995). The net present value of fishing activity (*npv*) discounts the sum of annual economic net streams during the actualisation period (see equality 1). Actualisation period ($A_{it} = T_i - t$) is the delay between the period of the retirement of each fisher (i) and the current period (*t*) but an other basis can be used. (r) is the individual psychological discounting rate to consider fishers preference for time but we use the capital cost funding rate or the opportunity cost of capital in order to take care of the present value of different alternative1. It can also include a risk premium to deal with the uncertainty in fishing activities.

The net present value of staying in fishing is the sum of different terms; the present value of net capital stream extracted from the fishery, the net present value at the end of the actualisation period (*T*) of the licence price (*PL*) if it can be sold and of the vessel sale price (*PK*). Even if the vessel price on the second hand market depends on regulations and public subsidies to the fishing sector, we consider that each vessel value is approached by its current value : e.g. the deflated purchase value of the fishing unit including the value of investments (engine, electronics and other equipment) and deducting the economic depreciation of the capital 2. The vessel value is then exogenous to the model and does not depend on fishing revenues that could capitalised in it. Finally the net present value of fishing activities and staying into the fishery includes the present value of net labour income streams for the skipper if he is also the vessel owner.

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1 In a situation of perfect capital markets, the individual psychological discount rate and capital cost rate equals.
2 It's also possible to consider insurance value as a proxy of capital value but this value change during the simulation according to vessel obsolescence and wear.

Table 2. Different components included to assess willingness to accept to leave the fishery (*discounted values*)

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Net fishing owner income (e.g. accounting flows)	♦	♦	♦	♦	♦	♦
Vessel resale price at the end of the actualisation period		♦	♦	♦	♦	♦
Net fishing skipper income (wage)				♦	♦	♦
Vessel resale price at present time			♦			♦
Opportunity cost of labour					♦	♦
Buy-back Premium	♦	♦		♦	♦	

Note : Different basis for income flow actualisation can be used : the income of the last year or the net income average over the two or three last years.

Note that the basis for net capital and labour stream calculation can be changed within the model. The last period or the average net incomes over a defined past period may be used to reflect the income expectancies in the future. Consequently, the net present value of staying is :

$$npvf_{it} = \sum_{t=1}^{T_i} ncs_{it}(.)/(1+r)^t + PK_{iT_i}/(1+r)^{T_i} + PL_{iT_i}/(1+r)^{T_i} + \sum_{i=1}^{T_i} nls_{it}(.)/(1+r)^t \quad (1)$$

On the other side, the present value of leaving the fishery can be expressed as the two further equalities :

$$npve_{it} = PK_{it}(grt_i) + PL_{iT_i} + \sum_{i=1}^{T_i} w_{it}/(1+r)^t \quad \text{or} \quad (2a)$$

$$npve_{it} = s_t.grt_i + PL_{iT_i} + \sum_{i=1}^{T_i} w_{it}/(1+r)^t \quad (2b)$$

In such a situation, each vessel owner has an alternative to leave the fishery, either by selling his vessel on the second hand market at the current period, or by withdrawing its vessel with a counterpart as the premium offered. (w_{it}) is the opportunity cost of labour that each fisher (i) may expect to earn elsewhere in the economy and the last right term of the equality represents the net present value of these incomes can be valued. (s) is the unit premium per GRT allotted by the administration to the fishers to buyback their vessel with (grt) as the vessel Gross Registered Tonnage.

The decision rule to stay or to leave the fishery at any time of the simulation depends on the form of the inequality :

$$npvf_{it} \underset{<}{\geq} npve_{it} \qquad \forall t = 1,...T \quad (3)$$

The right side of the inequality can be viewed as the opportunity cost of staying in the fishery. As shown hereafter, fisher exits (stay in) the fishery when the net present value of fishing is less (more) than the net present value of leaving it. From inequality (3) is deducted the unit premium per *grt* for which the two options equal.

$$s^*_{it} = \Big[\sum_{t=1}^{T_i} ncs_{it}(.)/(1+r)^t + PK_{iT_i}/(1+r)^{T_i} + PL_{iT_i}/(1+r)^{T_i} + \sum_{i=1}^{T_i} nls_{it}(.)/(1+r)^t - PL_{iT_i} + \sum_{i=1}^{T_i} w_{it}/(1+r)^t \Big] / grt_i \quad (4)$$

This amount reflects the minimum willingness to accept (WA) per *grt* necessary to incite vessel owners to leave the fishery. It does include working satisfaction bonus or loss (Anderson, 1980) that reflects this particular fisher interest for the job. The valuation of this component is not possible in this study.

2.2. An economic basis for assessing WA.

Even if the decision environment of the firm (e.g. the decision-maker) is certain, the problem of the basis for calculation of the WA can be asked. The fact is that one can include different components to represent and to model fisher behaviour. Empirical works do not give precise information on this realm and the aim of this paper is to underscore the sensitivity of the results to the different model structures. We do not actually use licence price valuation because non transferability of such fishing

use rights in the French management system.
Case number 1 includes only the net capital stream from one side and the buyback premium on the other side. This reflects the situation of the an exclusive vessel-owner or entrepreneur who is exhausting only the revenues of capital and combination of production factors with the fishing firm. Case 2 is not a remote structure because only the vessel resale price is added to the left side of the inequality. The next are likely the most appropriate combination in order to deal with the firm ownership structure of the Bay of Saint-Brieuc fishery. Case 3 and 6 consider the situation in which there is no premium offered. Exit is open to fishers and they decide to stay or to exit by comparing the alternative revenues of these two options. The difference is that case 3 does not use labour revenues when case 3 does.

Table 3. Figures regarding the scallop fishery – average data over the 1993-1998 period

Fleet categories	[0-60kW]	[60-120kW]	[120-185kW]	[>185kW]
Vessel number / category	26	101	96	30
kW / vessel	44	92	151	242
Crew / vessel	1.5	1.9	2.5	3.5
Scallop landings / vessel (tons/year) *	7.1	20.4	22.5	23.1
Scallop turnover / vessel (KF**)*	95.1	275.6	297.4	306.9
Total turnover less variable costs / vessel**	213	514	743	1330

* simulation results ** KF = Thousands francs

Finally, Cases 4 and 5 make nearly the same distinction (case 4 includes wage incomes in the fishery but no opportunity cost) but it gives the opportunity to the fishers to be compensated from the withdrawal of their vessels.

3. APPLICATION TO THE SCALLOP FISHERY.

This simulation model of capacity adjustment through exit is carried out and applied to the scallop fishery of the Saint-Brieuc Bay (area VIIE). The economic component developed before is connected to a bio-economic model of the fishery. Biological dynamics exploitation parameter are based on a structural and single species approach that take into account six cohorts ; mainly ages from 3 to 6 are subject to harvest (Fifas, 1993). A more complete description of the model as a whole can be found in Guyader and Fifas (1999). Notwithstanding biological impact of decommissioning schemes can be valued only from scallop stock point of view, economic impact can be assessed especially in terms of scallop activity but also in considering the different activities as a whole. We assume that capacity reduction does not lead to any effect on the other stocks. Finally, the Model building gives the opportunity to modify simulations parameters that can have an influence on fishers decisions.

3.1. Model parameters

The model is able to calculate crew, skipper incomes and vessel-owner revenues for each year not only for scallop campaign (October to April) but also for the other activities carried out all along the year. Then annual net operating income is calculated as the difference of gross profit less fiscal depreciation and interest charges, this difference being subject to income taxes. Net operating income that can be positive or negative. On another side, firm owners have to pay for boat investments in the form of annual cash payment if the owners finances it and (or) sequences of payment of interests and capital for loans subscripted if vessel owners take out a bank loan. The difference gives us net annual stream for the vessel owner (*ncs : net capital stream*). Most of the time, vessel owners are also skippers of their units, so that they are paid for the services due to working force and skills. Skipper annual net wage (*nls : net labour stream*) within share remuneration system can be included into calculation of the stream flows earned in fishing activity. Before analysing the simulation from a dynamic perspective, the next section focuses on the results of different model structure and pays attention to sensitivity results to parameters variations.

Table 4. Willingness to Accept (WA) per GRT unit as a function of fleet category (year 1999).

	0-60 kW	60-120 kW	120-185 kW	>185 kW
WA1	33.6	64.4	55.1	56.8
WA2	50.7	93.8	83.6	91.1
WA3	11.1	24.8	16.9	10.4
WA4	170.7	206.6	153.8	143.8
WA5	-30.8	89.9	86.2	110.3
WA6	-70.4	20.9	19.5	29.7

Private actualisation rate = 5% - actualisation period = 10 years
Opportunity cost of labour in the region (net wage for skilled worker)
Figures in thousands francs

3.2. Static Results.

Not surprisingly, the different modelling options described before give heterogeneous WA results. For a typical firm from [60-120 kW], the WA varies from 21 000 to nearly 207 000 francs in the first year of the simulation. In this last case, WA4 merges all fishing revenues for the vessel owner and vessel skipper who is supposed to have no opportunity cost (e.g. the fisher is not protected by unemployment insurance or he is not able to find a new job in an other sector. The incentives to leave the fishery are very low, conversely the value given to the fishing activity is very high. The introduction of the opportunity of labour in the region (case 5) lowers the minimum premium per GRT that the vessel owner may claim in order to leave the fishery. WA5 plummets to 89 900 francs. Comparison of WA2 and WA5 shows that including labour remuneration to fishers program has little influence on WA because [60-120 kW] fishers do not earn quasi-rents in the fishery with regard of the best opportunities in the economy. Conversely, this leads to positive effects for the last two class [120-185 kW] and [>185 kW]. The [0-60kW] fishers are in the opposite situation because their WA declines and become negative so that there is a natural economic incentive to leave the fishery this year. If we retain the 6th case as the best indicator of fisher behaviour and considering that there is no buy-back policy (WA6), only vessels of category [0-60 kW] are incited to leave the fishery and to sale their vessel on second-hand vessel market. Their present value of net benefit streams are lower than the resale price of their unit and we may ascertain exit flows from the fishery for the first category.

Table 5. Sensitivity of Willingness to Accept to the discounting period

	WA5			WA1		
Actualisation period (years)	*5*	*10*	*15*	*5*	*10*	*15*
0_60 KW	-4.6	-30.8	-54.2	19.2	33.6	42.0
60_120 KW	69.9	89.9	105.4	34.5	64.4	87.6
120_185 KW	69.1	86.2	99.3	31.3	55.1	73.5
>185 KW	86.7	110.3	128.7	32.2	56.8	75.9

Private discounting rate = 5%. Figures in thousands francs

Taking into account and characterising the opportunity costs of labour which could be heterogeneous within fishers is the key point of this analysis, because its introduction or exclusion in the fisher program can lead to broad effects on economic incentives and on the value given to WA. The dynamics of the fleet depends clearly on these values. The table 4 also shows differences in results within vessel categories for a same model structure. In the third case, WA of the [>185 kW] vessels is 10 400 f/grt the lowest so that they will likely be the first to exit, then the [0-60 kW] vessel with 11 000 f/grt will leave the fishery sector if the premium offered is equal or more than these WA. These differences are mainly explained by the gap in economic performance of the categories and in a reduced range due to the distortion in subsidies allocation. Different capital cycles that lead to an interests payments variation among the vessels.

In contrast, fisher population demographics may have a strong influence on time scales used by each fisherman. The time delay between decision period reference (current age of the fisher) and the normal end of the fisher activity can be used as the actualisation period. According to the net present value calculus, the higher the actualisation period, the higher the WA is. For a typical vessel of category [>185 kW], the WA5 shift is valued at about 40 000 f/grt when actualisation period change from 5 to 10. What is important to say about these results is that the structure in age of the fisher population has a strong influence on vessel exits per category.

Considering the model, the [0-60 kW] vessels will exit first whatever the population structure and with or without a buyback program. Fisher owner of a typical [>185 kW] vessel who expect to take retirement in five years will not leave the fishery if other owners have the same age and the same discounting period because his WA is the highest (86 700 f/grt for a 5 years period). Moreover, if the expectancies to find another job elsewhere are low, his WA will be more valued. But if other fishers of his vessel category or the next category are younger and would like to retire in a 15 years period, he will be incited to leave before them because they will need a higher premium per GRT; respectively 105 000 and 99 000 francs for [60-120 kW] and [120-185 kW] vessels.

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In conclusion, the structure of the fisher population through demographic consideration and the structure of the fleet in terms of economic results may explain exit behaviour. More than vessel performance over time, individual considerations like age and opportunity cost of labour may have a straightforward influence in the decision making process and the model seems to be good tool to assess individual WA. Nevertheless, it could be difficult to tune the model by comparing WA to real premiums offered by the administration because of the possible windfall gain captured by the fishers (see further). The next section considers the simulation of buyback programs.

Table 6. Evolution of fleet structure on scenario 3

Vessel class/ Years	1998	1999	2000	Variation rate 1998/2000
0-60 kW	26	0	0	-100.0%
60-120 kW	101	101	41	59.0%
120-185 kW	96	96	96	0.0%
>185 kW	30	30	30	0.0%
Vessel number	253	227	167	-34.0%
Total GRT	3089	2969	2489	-20.6%
Total KW	32084	30989	25465	-20.6%

Note : Basis for income actualisation : current year. Discounting period = 15 years

4. COST-BENEFIT ANALYSIS OF BUYBACK PROGRAMS.

We assume now that the public authority decides to fix the premium per *grt* offered and it is the same for the four vessel categories. Total budget available for administration is limited and we assume that government is able to choose the elected vessels to the decommissioning plan (e.g. the firms with the lowest WA first exit the fishery). Then, fishers apply or not to accept the total premium and their decision to stay in the fishery is open each year and it depends on economic incentives and public decision to organise or not a decommissioning plan. Vessel owner opportunities must be reconsidered at each iteration in spreadsheet in order to take care of the changing bio-economic environment and incentives. The simulation output gives the evolution of different indicators like the biomass level , individual and fleet production level and turnover of the fleet, surplus, public cost, etc. between 1998 and 2010 years. The next part only analyses the economic consequences of different capacity adjustment program from a public policy perspective.

4.1. Bio-economic simulation of decommissioning plans.

Initially, we compared the status quo results named as scenario 0 to a specific decommissioning plan output (scenario 3). The latter scenario provides administration a 30 million franc budget to be used in the first two years (1998 and 1999) and equally affected to both. Premium offered by administration to leave the fishery is allocated on an egalitarian basis and is equal to 50 000 francs per *grt* (Basis 100).

Table 7. Minimum willingness to accept to leave the fishery

Indicators/Years	1998	1999	2000
Average Willingness/GRT 0_60 kW	33.56	0	0
Average Willingness/GRT 60_120 kW	64.36	34.35	58.68
Average Willingness/GRT 120_185 kW	55.10	36.47	56.19
Average Willingness/GRT >185 kW	56.82	46.51	57.48
Total Willingness for fleet	176.5	114.9	141.7
Average Willingness/vessel	0.698	0.506	0.848
Average Willingness/GRT	57.17	38.72	56.95

Figures in thousands francs

The tables 7 indicate the willingness to accept (WA) for each vessel category compared with the premium and the consequent evolution of the fleet structure during the first three years. Only the first class [0-60 kW] has a WA per *grt* which value is under the premium offered in 1998. That is why all the vessels of this segment (26 units) leave the fishery. The annual budget available is enough to cover vessel exit cost estimated at 6.02 Million francs. The balance is then reported to the second year of the plan and 23.98 Million Francs are then available to be spent to withdraw 60 units of class 2. In 1999, WA declined due to lower revenues (lower stock level) and higher cost due to the replacement of different components of the engine. The premium is then enough to incite all the fishers to leave the sector (see table 7) but the spreadsheet excludes only those who have the lower WA. They are probably the more interested in exiting the fishery and the windfall gain per *grt*, the difference between premium and WA is higher for them.

As regards global fleet adjustment, respectively 34% of the scallop fleet and 20.6% of total fishing capacity expressed as total engine power in kW is decommissioned by this plan. But this policy can be viewed as not effective in reaching its objectives if the reduction in fishing power must reach 30 %. The amount spent in decommissioning plan has cost 30 Million Francs when the sum of total minimum willingness to accept to leave the fishery is valued at 20.53 Million Francs by the model. The difference is the total windfall gain transferred from taxpayers to fishers and windfall gains leads to huge distribution effects. Whatever the scenarios, their impact of these policies can be assessed through different indicators.
Reduction in fishing capacity and in fishing mortality gives rise to the shift of harvest profile per vessel and total landings. Vessel segment from 0 to 60 kW does not benefit from this because it leaves the fishery but increase in production level reaches durably 3.5 tons per season for the other fleet segment. The difference between the scenarios is small at the beginning of the period but the firms benefit rapidly from the stock growth due to lower fishing mortality.

As shown in Figure 9, landings increase in both cases but the fishery encounters a difference in supply valued at 660 tons in years 2000 but this gap is reduced at 120 tons in 2010. As a consequence, stock recovers from 9800 to 20600 tons in the scenario 3 when increase is limited from 9800 to 15100 in scenario 0 tons Stock rebuilding is due to better recruits during the period than over the last period, that’s why the stock adjusts to a new equilibrium.

From an economic side, the impact of status quo or decommissioning scheme can be assessed at firm but also fleet level. At micro-level, one can see that average willingness to accept per kW necessary to leave the fishery increases in both case, but the implementation of scenario 3 yields higher values than status quo. It exceeds nearly 10 000 francs for a 80 000 francs value. Macro-analysis is used in this study and the indicator of producer surplus exhausted from scallop activity is retained to assess the economic efficiency of the policy. Clearly, vessels withdrawal yields more annual economic rent than status quo excepted the first two years when the decommissioning plan has not produced its effects. As soon as 2001, the fishery will produce around 1 Million Francs more rent and this gap will continue to increase to reach nearly 5 Million Francs in 2010.

Figure 8. Total scallop landings during the transition period (scenario 0 and 3)

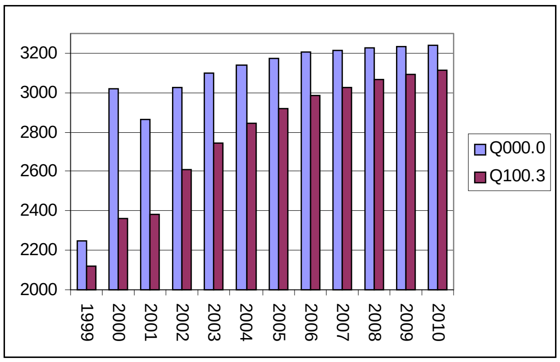
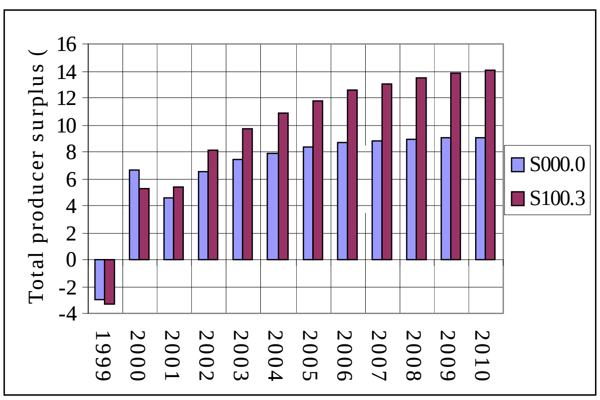


Figure 9. Total producer surplus trajectory under the scenarios 1 and 3



The Cumulative sum of these differences represents 31.8 Million Francs, but annual streams can be discounted to take into account the public authority preference for time. Discount rates vary from 0 to 10 percent. Whatever discount rate value, net present values (NPV) of producer surplus streams under scenario 3 exceed NPV of producer surplus that proceed from the application of scenario 0 (see table 8). Consequently, implementation of buyback program can be judged as the best policy if the public authority considers this indicator as the criteria for decision-making. Moreover, the cost-benefit analysis that relate public policy cost to surplus yields shows that the balance is always positive, from 23 to 6 Million Francs over the reference period. The difference is cancelled only for a 20% discount rate in this simulation.

There are different conclusions to this particular simulation. Notwithstanding the decommissioning plan does not achieve its objective expressed in kW, its effects are positive from efficiency consideration. Producer surplus increases with the buyback program and the net surplus is also positive for reasonable value of discount rate. On another side, technical progress incorporated by fishers to their vessels may lead to counterproductive effects to the buyback program as well as for the status quo situation. The problem is that increasing rent in the fishery will probably gives rise to competing behaviour between fishers, capital stuffing (Townsend 1985) that could dissipate the rent created by the buyback program. The other main problem from public policy perspective is the misuse of public budget because of the windfall gain problem. The definition of an optimal premium for each fishing firm at level a little but higher than their individual WA gives the opportunity to save money. And this sum could be allocated to buyback other vessels and to reach MAGP objective and increase efficiency.

Table 8. Producer surplus and net surplus (producer surplus minus public cost) under different scenarios.

Discount rate	Producer surplus* Scenario 0	Producer surplus* Scenario 3	Balance* S3-S0	Public cost* Scenario 3	Net Surplus* Balance including policy cost
0%	82.9	114.8	31.9	9.0	22.9
5%	57.5	77.3	19.8	8.2	11.6
8%	46.9	62.7	15.8	7.8	7.9
10%	41.3	54.9	13.6	7.6	6.0

* Figures in Million Francs.Note: As the scallops revenues account for 30% of the vessel turnover, we use the assumption that 30% of the total public cost plan is dedicated to this fishery. In France, public assessment of public scheme actually use discount rates (opportunity cost) values between 2% and 8%.

CONCLUSION

In fact, public authorities may adjust the premium level on a trial and error basis in order to minimise windfall gains. Unfortunately, this behaviour can lead to adverse effects examined by Daures and Guyader (2000). In an administrative system, the core of the problem is to match the premium level with the minimum willingness to accept to leave the fishery in order to spare public budget or to allocate these budgets in a better way. Assessment of the minimum willingness to accept to leave the fishery exhibits huge variations to sensitivity analysis fishery of including or not some of these variables The simulation showed that it is not without risk to reduce the premium if it does not give fishers the right incentives. It may postpone the vessels exits, delays the achievement of MAGP objectives and finally increase the total policy cost if the administration has to pay a higher premium to fishers. Of course, governments can use a tendering system to select the best offers but it leads also to some problems like collusion between fishers (Anon 1997a). Anyway fleet rationalisation or simply exclusion of marginal fishers through buyback schemes may lead under specific conditions to increase in average willingness to accept. The cost of capacity adjustment should then increase if the MAGP reached their objective to improve the economic situation of European Union fisheries.

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Notes

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[1] For a clarification of the concept of fishing capacity, see Kirkley and Squires (1999)

[2] In France, the scallop landings are prohibited from May to October due to sanitary reasons.

[3] These buyback programs consist in financial subsidies delivered to a vessel owner who is fishing in the European waters and applies to exit his vessel from the fishery activity. The design of buyback programs in each member state has to obey to some European recommendations if the UE contribution is required for the financing of the exit. Three major regulations must be noticed : the council regulations 4028/86, 3944/90 and 2080/93 which have successively fixed : a maximum subsidies amount per size category of vessel (Gross Registered Tonnage categories), some restrictive criteria such as the age of vessel, the EU contribution to the funding of the exit if these criteria are respected. The French fleet is distributed among six GRT categories to fix premium rate and for each kind of exit/ GRT category, the premium is composed with a variable part and a fix part. In addition to the PME system, buyback programs have been regularly implemented to achieve the MAGP objectives when some delays appeared. Over the period 1991-96, four buyback programs have been implemented. The first plan (the so called Mellick plan implemented in 1991) was predominant and has concentrated around 70% of the total public expenses to reduce the fleet capacity over 1991-96. Meanwhile, the amounts allocated by the EU and French Government to decommissioning schemes represented only slightly more than

1% of the total expenditures of these authorities in aid to the fishery sector over the same period (Giguelay, 1999).

[4] Vessel size limit has been bounded at 13 meters and engine power must not go beyond 185 kW since 1990, except for vessels using a licence before this date and benefiting for historical rights.

[5] Fishing permits as Permis de Mise en Exploitation.

[6] Premium is expressed in term of grt but administration used a corrective factor to the premium/grt to take care of the relation between grt and kw.

[7] The measure of the statistical analysis impact of the different factors is the further step.

[8] The results are quite the same if we do not consider mean age but percentage of vessels older than a specific age.