IS THE CURRENT REGULATION OF THE VIII DIVISION EUROPEAN ANCHOVY OPTIMAL[*]?

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Abstract

This paper sets out to assess the workability of the regulation currently in force in the European anchovy fishery of the VIII division. Particular attention is paid to the importance of the institutional regime in the allocation of natural resources. The study uses a bio-economic approach and takes into account the fact that, not only the European Union and the individual countries involved, but also some of the resource users or appropriators intervene in its management. In order to compare the effectiveness of the rules which, at the various levels, have been set up to restrict exploitation of the resource, the anchovy fishery is simulated in two extreme situations: open access and sole ownership. The results obtained by effective management will then be contrasted with those obtained from the maximum and zero profit objectives related with the two above-mentioned scenarios. Thus, if the real data come close to those derived from the sole ownership model it will have to be acknowledged that the rules at present in force are optimal. If, on the other hand, the situation more closely approach the results obtained from the open access model, we will endeavour in our conclusions to provide suggestions for economic policy measures that might improve the situation in the fishery.

Key words:

Common Pool Resources, Co-management. European Anchovy Fishery, Open Access, Sole Owner.

JEL category: Q22; Q28.

0. INTRODUCTION

The exploitation of natural resources takes place within different institutional frameworks and, in particular, under different property regimes. These factors contribute to shaping the conduct of the agents involved and eventually the subsequent allocation of resources. Against this background, the analysis of the institutional regime emerges as one of the key pieces in the theory and application of natural resource economics. This is, of course, also true when it comes to fishing resources.

The VIII division European anchovy stock constitutes a particular example of co-management. Until the mid eighties, the resource was exploited almost exclusively by the Cantabrian purse seine fleet, whose actions were in the past and remain in the present subject to the rules imposed by the "Cofradías de Pescadores" (Fishermen's Gilds), many of whose agreements have been incorporated into the Spanish state regulation. At the time of Spain's entry into the European Union, France increased its presence in the fishery by the whirlwind development of its pelagic trawler fleet. Currently, the strong presence of the French fishermen has complicated the institutional framework surrounding the fishery. The fact is that, although the trawler fleet has its own organisations (such as the fishing vessel owner's co-operatives), these do not include the regulatory capacity of the "Cofradías". In addition to the rulings sent out by the two involved countries and those deriving from the self-management of the Spanish fishermen, the European Union intervenes in the supranational management of the resource through a system of TAC (Total Allowable Catch) and licensing.

Within this complex scenario, we aim to assess the workability of the different rules designed to place limits on access and exploitation of the resource. We will set out by acknowledging that self-management or even co-management can be an adequate system of governing the resources, contrary to what we may be led to believe if we are to accept an inaccurate interpretation of the *"the tragedy of the commons*" (Hardin 1968). The study takes a bio-economic approach, based on simulating the fishery within the scenarios of maximum profits (sole ownership) and long-term minimum sustainable profits (zero profits) associated with open access. Since these models reproduce situations at each end of the institutional scale, the resulting theoretical allocations will enable us to draw conclusions regarding the degree of optimality of the actual outcomes.

The paper comprises four distinct sections. The first stresses the importance of the institutional framework in the allocation of natural resources, including a few remarks regarding community-based management, often wrongly identified as open access. Prior to proceeding with a discussion of the models, section 2 presents a brief description of anchovy fishery. This is done with respect to the nature of the resource, the operating fleets, the evolution of catches and the current management of the fishery. Afterwards, the simulation models are carried out, providing us with results for completing the bio-economic analysis. In section three we point out some of the shortcomings of the present regulations and briefly outline a few management recommendations. The final section contains the main conclusions of our study.

1. THE ROLE OF THE INSTITUTIONAL FRAMEWORK IN THE ALLOCATION OF NATURAL RESOURCES

The literature on common property (Ostrom, 1990; Bromley, 1992; Stevenson, 1991; Hanna et al., 1996) acknowledges the existence of four types of pure or analytical ownership regimes, although in practice various combinations of these can and do occur. Thus, while in the case of *private ownership,* the rights of ownership[1] belong to one or several individual (who are then responsible for managing the resource), when it comes to *public property,* it is the state who regulates access and exploitation. *Common property* on the other hand, is distinguished by the fact that exploitation rights belong to clearly defined group of users (self-management) who also have the right to exclude others from the exploitation and management of the resources (Ciriacy-Wantrup and Bishop, 1975). Lastly, there exists a fourth analytical ownership type distinguished for the absence of property rights. Co-management (Jentoft, 1989; Dubbink and Van Vliet, 1996), for its part, comes "some-way" between public ownership and common property.

Just as lack of ownership leads to “use it or lose it” strategies and thereby to inefficient allocations, it is also worth stressing that efficiency or inefficiency can occur with any type of ownership. The fact is that neither the state nor the market is entirely successful in long term sustainable resources exploitation. Thus, though in the theoretic framework of sole ownership (Scott, 1955) the resources are efficiently allocated, the actual putting into practice and monitoring of optimal policies can pose serious problems and create perverse incentives among the agents involved. It is likewise a serious mistake to identify community-based management with inefficiency, because many communities have successfully entrusted the management of resources to bodies distinct from the state and the market[2] for long periods of time. Thus, there exist adequately governed Common Pool Resources (CPRs) and there also exist CPRs inefficiently governed.

After studying a wide variety of CPRs, Ostrom (1990) distinguishes a set of regularities present in properly managed CPRs. We briefly summarise above-mentioned regularities in the next lines. 1) The membership and the extent of the common goods must be clearly defined. 2) Rules of ownership and maintenance must suit local conditions. 3) Agreements must come about as the result of group decisions. 4) Mechanisms are present for control and sanctions. 5) The opportunity to solve conflicts at local level is readily available for both resource users and for arbitrators 6) Certain minimum rights of self-management are recognised by outside authorities. 7) The nesting of organisations one within another is possible.

Furthermore, Schlager et al. (1994) established that factors such as the mobility and the non-existence of storage capacity of the resources have a negative effect on the degree and extent of the problems of appropriation and provision, and accordingly on the probability of success of self-management.

The anchovy stock is, like the majority of fisheries, a clear example of a mobile resource with no possibility of storage. Another interesting feature is that its management is shared by the European Union, the two countries involved, and, in this last country, by the appropriators of the resource organised in "Cofradías"[3]. Although in the case of fisheries, rather than the matter of actual ownership, what concerns us is the exploitation regime by which they are bound, it must be said that the historic rights[4] to anchovy fishing have, since time immemorial, belonged to the fishermen of the Cantabrian. However, the increased presence of French pelagic trawlers since 1986 has brought considerable complications to the surrounding institutional framework and has caused serious conflicts to arise between the two fleets, mainly in connection with the coexistence of different fishing gears. The root of the conflict lies in the fact that Spanish legislation, as a proposal made by the "Cofradías" themselves, forbids Spanish vessels to fish anchovy with pelagic nets.

2. SIMULATION OF THE FISHERY UNDER OPEN ACCESS AND SOLE OWNERSHIP

2.1. *Some notes about VIII division European anchovy fishery*

As was pointed out earlier, two different fleets exploit the resource: the Spanish purse seine fleet and the French pelagic fleet. The purse seine fleet has undergone a continuous reduction in size, to the point that nowadays the number of vessels has dropped to 250. The French pelagic fleet, on the other hand, has enjoyed spectacular growth, bringing about, with its approximately 150 vessels, and in spite of the decline of the purse seine fleet, a considerable increase in the fishing pressure on the anchovy stock.

After reaching a historic high of over 80,000 tonnes in the mid-sixties, anchovy catches began a drastic decline lasting until the mid-seventies. 1975 herald a period of relative growth probably due to the spread of some technological advances such as radar and sonar. From 1978 onwards, however, there was another steep drop in catches, culminating in the historic lows of 1982 and 1986 when they dropped to 5,000 and 8,000 tonnes, respectively. The early nineties saw noticeable recuperation, with catches of over 30,000 tonnes. The last seasons, nevertheless, have been poor, especially for the purse seine fleet.

The findings of biological research into the anchovy stock suggest that the population fluctuates according to variations in recruitment, which in turn seems to be closely related to environmental conditions like the phenomenon of *upwelling* in the golf of Biscay (Borja et al., 1996; CIEM, 1997). Management experiences of pelagic species in Northern Europe, however, seems to indicate that pelagic stocks may require a critical breeding biomass, below which the likelihood of strong recruitment would be seriously jeopardised. It is in the light of this information that experts argue that the stock stands at appreciably lower levels than in previous decades. In addition to this, a decrease has been observed in the average age of the anchovy caught, which would seem to confirm the increase in fishing mortality rate.

Since the mid-eighties, the European Union has placed a restriction on catches by means of a TAC of 33,000 tonnes, 90% of which goes to Spain by virtue of her historic rights and the principle of relative stability endorsed in the Common Fisheries Policy (CFP). Access to fishing grounds is restricted by means of a licensing system[5].

The "Cofradías" exercise their own control on the maximum catch allowed for each vessel per day and on the length of the period they are allowed to remain at sea[6]. It is worth mentioning that many of the rulings included in Spanish legislation[7], among them the prohibition on the use of pelagic trawling nets have come about as a result of proposals made by the "Cofradías".

2.2. *The open access fishery*[8]

In this section we propose a model in which no restriction is placed on fishermen wishing to enter the fishing grounds. There is no limit on the amount of fish that may be caught by individual vessels and any effective control over the fishing effort. The main agent to be borne in mind within this framework is the individual fisherman, who will not take into account either the net social value of the resource or the effect of his own actions on the productivity of other fishermen or on the growth of the fish population. It is to be assumed, therefore, that the strategy to be employed by the agents involved will be of type *"first come first served"*.

The open access model we are applying to the anchovy fishery is based on equation (1) and (2). S(t) represents the biomass, NB(t) is the number of vessels, Y(t) is the volume of catches, Π(t) is the profits derived from the fishery, c/p is the ratio between the cost per unit of effort (c) and the price per tonne of fish (p) and *n* is an adjustment parameter indicating how quickly entry or exit responds to the existence of positive or negative profits. The population growth and production functions are given by g(S(t)) and f(S(t),NB(t)) respectively.

Equation (1) shows the population dynamics and states that stock variation in time t+1 is equal to the population growth for the period t minus the fish caught in the same period. Equation (2) describes the adjustment of the fishing effort. It implies that vessels enter or exit the fishery in relation to the standardised profit per vessel, so we are implicitly assuming that there is perfect flexibility to enter or leave. Steady state equilibrium comes about when the two movement equations simultaneously cancel themselves out.

$$\dot{S} = \frac{dS(t)}{dt} = g(S(t)) - f(NB(t), S(t)) \qquad (1)$$

$$g(S(t)) > f(NB(t), S(t)) \Rightarrow \dot{S} > 0 \Rightarrow S(t+1) > S(t)$$
$$g(S(t)) < f(NB(t), S(t)) \Rightarrow \dot{S} < 0 \Rightarrow S(t+1) < S(t)$$
$$g(S(t)) = f(NB(t), S(t)) \Rightarrow \dot{S} = 0 \Rightarrow S(t+1) = S(t)$$

$$\mathrm{N\dot{B}} = \frac{\mathrm{dNB(t)}}{\mathrm{dt}} = \mathrm{n}\left[\frac{\Pi(\mathrm{t})}{\mathrm{pNB(t)}}\right] = \mathrm{n}\left[\frac{\left(\mathrm{pf(NB(t),S(t)) - cNB(t)}\right)}{\mathrm{pNB(t)}}\right] \qquad (2)$$

$$\frac{\Pi(\mathrm{t})}{\mathrm{pNB(t)}} > 0 \Rightarrow \mathrm{N\dot{B}} > 0 \Rightarrow \mathrm{NB(t+1)} > \mathrm{NB(t)}$$
$$\frac{\Pi(\mathrm{t})}{\mathrm{pNB(t)}} < 0 \Rightarrow \mathrm{N\dot{B}} < 0 \Rightarrow \mathrm{NB(t+1)} < \mathrm{NB(t)}$$
$$\frac{\Pi(\mathrm{t})}{\mathrm{pNB(t)}} = 0 \Rightarrow \mathrm{N\dot{B}} = 0 \Rightarrow \mathrm{NB(t+1)} = \mathrm{NB(t)}$$

The application of the model needs the estimation of population and production functions, cost price ratio (c/p), and the parameter n.

The population analysis has been carried out using time series biomass and catch data for the period 1966-95. As we could not get environmental variables like upwelling indices we are implicitly assuming that environmental conditions remain steady.

We have tried to estimate a delay-difference equation (Clark, 1976; Bjørndal, 1988; Conrad, 1989; Bjørndal and Conrad, 1993), but it was impossible to detect any relationship between the parent stock and recruits. As a consequence, we have chosen a simpler population model. In this model, population in year t+1 is related to population and catches in year t. We have estimated different functional forms, such as Ricker, Beverton Holt, Cushing and logistic. Although econometrically all the functions fit the data fairly well, only Cushing's population function provides realistic figures of the estimated Maximum Carrying Capacity (MCC), Maximum Sustainable Yield (MSY) and other related variables.

The selected model takes the form $\ln(S_{t+1}+Y_t) = \ln a + b\ln S_t$ where one would expect $a>1$ and $1>b>0$. The OLS regression results indicate that both coefficients are significant at the 5% level and the signs are both correct. The adjusted R^2 is 0.61. Durbin Watson and Box Pierce tests do not detect autocorrelation while Jarque-Bera test let us accept the normality of the residuals. The R^2 of the auxiliary regressions is practically 0, so we consider that the degree of multicolinearity is acceptable. The functional form thereby obtained is $g(S(t)) = 72.2549S(t)^{0.645} - S(t)$. The MSY is 27,571.7 tonnes, the required biomass for MSY is 50,095 and the MCC is 172,479 tonnes. For further details, see (del Valle, 1998).

The production analysis has been carried out using time series data of catches, stock, number of vessels and their tonnage and horsepower for the period 1966-95. In spite of the fact that two different types of technology are in use, it was not possible to obtain reliable estimations for the French pelagic trawler fleet because the short length of the time series allow us a few degrees of freedom. Therefore, using a procedure similar to that of Sathiendrakumar and Tisdell (1987), we have opted for an equivalence criterion, taking one pelagic vessel to be equivalent of 1.59 purse seine vessels (del Valle, 1998).

Although we have estimated a translog separable production function (Squires, 1987; del Valle, 1998), the poor econometric results led us to a more restrictive Cobb Douglas functional form. The high correlation among the number of boats, tonnage and horsepower explains the high degree of multicolinearity in the Cobb Douglas function that includes these variables. Consequently, we have chosen a Cobb Douglas production function where the number of vessels represents fishing effort[9]. The estimated function takes the form $\ln Y = \ln q + \alpha \ln S_t + \beta NB_t$ $\alpha>o$, $\beta>0$. The model, estimated by OLS, fit the data fairly well. All the variables are significant at the 5% level and the signs are correct. The model seems to be jointly valid (F test) and the adjusted R^2 is acceptable (0.78). Durbin Watson and Box

Pierce test do not detect autocorrelation, while Jarque-Bera test let us accept the normality of the residuals. The R^2 of the auxiliary regressions is practically 0, so we consider that the degree of multicolinearity is acceptable. The estimated function is $f(S(t), NB(t)) = 0.319915 S(t)^{0.68226} NB(t)^{0.66562}$ (For further details, see del Valle, 1998).

It is worthy of paying a particular attention to the coefficient of the stock variable in the production function. This output elasticity shows the sensitivity of harvesting costs to changes in stock size. If this elasticity is positive a decrease in stock will cause an increase in unit harvesting costs and that implies a brake to stock depletion. The lower the value of this elasticity the less dependent harvesting costs will be to changes in stock size; so when the elasticity is zero, harvesting costs are independent of stock size and the stock may be driven to extinction under open access (Clark and Munro, 1975; Bjørndal, 1988; Bjørndal et al., 1993). We must remember that the fish stocks that are most prone to severe overexploitation under open access are schooling species. The "schooling effect" is related to the spread of modern searching techniques which is, at least in theory, linked with a low output elasticity. Although anchovy is a schooling species, the elasticity of substitution of the estimated production function is significantly different from zero, meaning that harvesting costs will depend on stock size. In consequence, an increase in harvesting costs due to a decrease in stock size will serve as a brake on stock depletion.

In relation to the adjustment parameter (n) and following Bjørndal and Conrad (1987)(a) and Amundsen et al. (1995) we tried to estimate directly the equation (2) but the results were very poor probably due to the short cost data series (1987-95). The adjusted R^2 was very low, and although n was significant at 10% level the sign was incorrect. As the value of n only affects the dynamics of the open access fishery and not to the steady state levels, we will follow a sensibility analysis for different values for n.

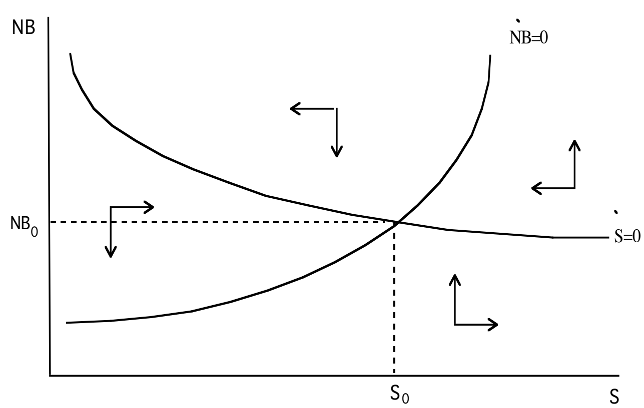
Following accounting criteria, the cost data were collected on an annual basis disregarding the fact that many fisheries work seasonally. So we had to calculate the proportion of total costs attributable to anchovy fishing, considering the time devoted to it. The costs-price ratio (c/p) is assumed to be exogenous. The observed values of this ratio range between 40 and 100 and its average value is 70 (del Valle, 1998).

Using the already estimated Cobb Douglas production function and Cushing's population function, the system of differential equations (1,2) can be expressed by means of equations (3) and (4).

$$\dot{S} = 72.2549 S(t)^{0.645} - S(t) - 0.319915 S(t)^{0.68226} NB(t)^{0.66562} \qquad (3)$$

$$\dot{NB} = \frac{(p0.319915 S(t)^{0.68226} NB(t)^{0.66562} - cNB(t))}{pNB(t)} \qquad (4)$$

- FIGURE 1- *Phase plane diagram for the open access model (c/p=70).*



In the open access model the steady state is asymptotically stable for every value of n in the estimated c/p interval. Taking into account the geometric shape of the trajectories, the steady state is a node or a spiral depending on the values of c/p and n. The steady state is a node when n<0.719 (c/p=70) and a spiral when n >0.719 (c/p=70).

2.3. *The fishery under a sole ownership regime*[10]

The sole owner, conscious of the fact that decisions taken in the present will unfailingly affect population dynamics and any future decisions, internalises the shadow value of the resource as well as the interactions or negative externalities between agents. He determines optimal stock, effort and catch levels after solving a discounted profit maximisation problem in an infinite time horizon. In the final instance, it is a case of defining the optimal extraction policy within a framework of dynamic optimisation, bearing in mind that the product in question is an interactive renewable natural resource.

Mathematically, the optimal solution is obtained from the following optimisation problem, in which the number of boats (NB(t)) represents the control variable and the stock (S(t)) is the state variable. Y(t) are catches in the period t, *r* represents discount rate and, and f(S(t),NB(t)) and g(S(t)) are respectively production and population growth functions.

$$\underset{NB(t)}{Max} \int_0^\infty e^{-rt} (pY(t) - cNB(t))dt$$

$$s.a \qquad \dot{S} = g(S(t)) - Y(t)$$

$$Y(t) = f(S(t), NB(t))$$

$$S, NB, Y \geq 0$$

By *Pontryagin*'s *Maximum Principle:*

$$\frac{\partial H_c}{\partial NB} = 0 \rightarrow J_{NB} + \mu(t) K_{NB} = 0 \tag{5}$$

$$-\frac{\partial \mathrm{H}}{\partial \mathrm{S}} = \dot{\mu} \rightarrow \dot{\mu} = \mathrm{r}\mu - (\mathrm{J_S} + \mu \mathrm{K_S}) \tag{6}$$

$$\dot{S} = 0 \rightarrow g(S(t)) = f(S(t), NB(t))^{11} \tag{7}$$

Where *H* is the current value Hamiltonian, μ *(t)* is the current value shadow price and $J = [pf(S(t), NB(t)) - cNB(t)]$, $K = [g(S(t)) - f(S(t), NB(t))]$.

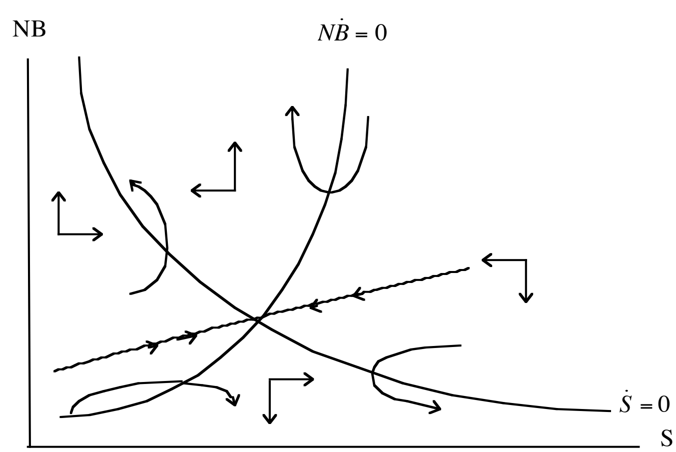
From equations (5), (6) and (7) and the parameters estimated for the Cushing population function and the Cobb Douglas production functions, it is possible to obtain the two non-linear differential equations, which form the basis to get the optimal solution for the fishery. The intersection of (8) and (9) determines the steady state. Steady state depends on c/p ratio and discount rate values. In the analysis we will take the average value of c/p ratio and a discount rate fluctuating between 0 and 0.1 as reference. As reference values we will take the average value of c/p (70) and a discount rate[12] fluctuating between 0 and 0.1.

$$\dot{S} = 72.2549S(t)^{.645} - S(t) - .319915S(t)^{.68226}NB(t)^{.66562} \quad (8)$$

$$\dot{NB} = \frac{-.636829S^{.68226}NB(t)^{.66562}}{(c/p)}\left\{\left(1-\frac{(c/p)NB(t)^{.33438}}{.212942S(t)^{.68226}}\right)\left(r+1-\frac{46.6044}{S(t)^{.355}}+\frac{.218265NB(t)^{.66562}}{S(t)^{.31774}}\right)-\frac{.218265NB(t)^{.66562}}{S(t)^{.31774}}\right\}$$
$$+\,2.04038\frac{NB(t)}{S(t)}\left(72.2549S(t)^{.645} - S(t) - .319915S(t)^{.68226}NB(t)^{.66562}\right) \quad (9)$$

As the following figure shows, the steady state is a saddle point; we can, therefore, say that there only exists one trajectory to the steady state.

FIGURE 2. – *Phase plane diagram for the optimal solution (c/p=70, r=0.05)-*



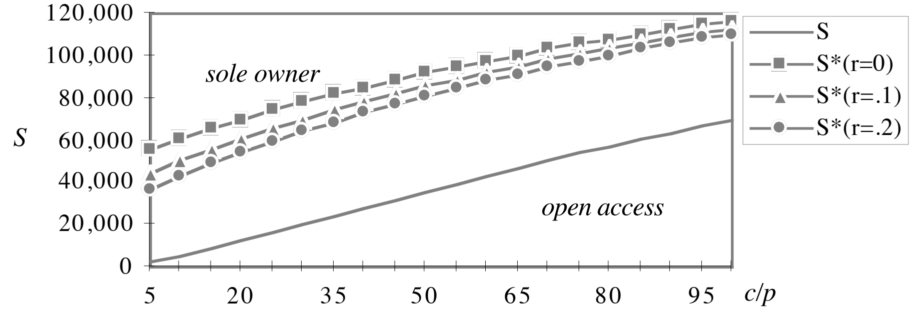
2.4. *Steady state solutions*

The steady state solutions associated with maximum profit (sole ownership) and zero profit (open access) for different values of c/p and discount rates are shown in Graphs 1, 2 and 3.

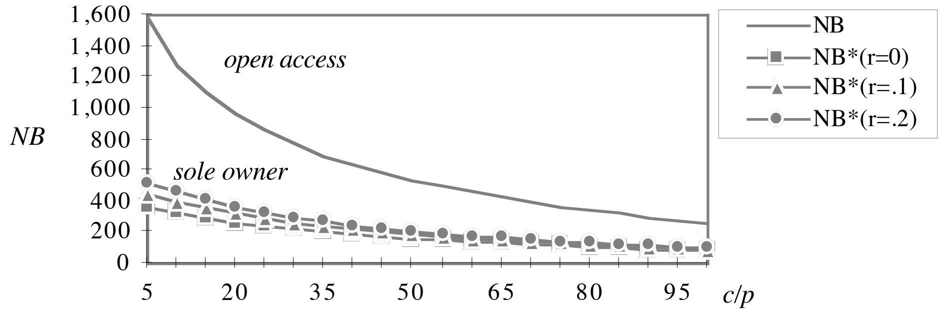
In the case of open access, graphs 1, 2 and 3 show that the fall in profitability brought about by increases in the ratio c/p result in higher steady state levels of stock and reductions in the number of vessels taking part in the fishery. The lowering of pressure on the stock as a consequence of c/p increases causes catch levels to rise. For values of c/p close to zero resources come close to extinction, while for abnormally high values of c/p (over 400) fishing is abandoned and the population returns to its MCC.

Steady state equilibrium for the sole ownership scenario depends on c/p and the discount rate. The ratio c/p, has a positive effect on stock, via the "Marginal Stock Effect" (MSE) (Bjørndal, 1987; Clark, 1990). Increases in the ratio c/p bring about the substitution of the effort factor by stock, such that steady state stock grows at a decreasing rate as long as c/p does so, while the number of boats decreases in absolute terms, though also at a decreasing rate. Catch levels fall, except for low values of c/p and $r>0$[13]. For values of c/p above 2,000, the optimum stock size reaches MCC and the corresponding catch level would obviously, therefore, be zero. The discount rate, on the other hand, is inversely proportional to the optimal stock level. Increases in r imply increases in profitability from fishing, so that the stock factor is substituted by fishing effort, which in the end results in an increase in catch levels. It must also be mentioned that the extinction of resources is not optimal for reasonable discount levels[14]. Results also reveal a slight sensitivity of optimal stock to variations in r.

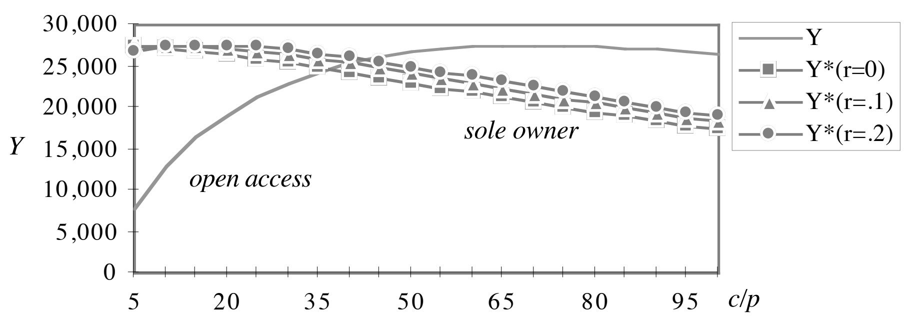
-GRAPH 1- *Stock in open access and sole ownership*



-GRAPH 2- *Fishing effort (number of vessels) in open access and sole ownership.*



-GRAPH 3- *Catch levels in open access and sole ownership.*



Stock size and fishing effort under sole ownership are above (in the case of stock size) and below (in the case of fishing effort) those occurring under open access. Theory-based predictions are, therefore, clearly fulfilled: open access results in over-fishing of stock and excessive fishing effort in the fishery. Catch sizes under open access show a more prolonged upward trend, due to the fact that the MSY is reached for high values of c/p (around 70), while steady state sole owner stock for zero costs come very close to the MSY.

Table I shows the steady state stock and fishing effort levels for the interval of estimated values for c/p [40-100] and r [0.05-0.1]; as indicated earlier, sensitivity of results to changes in r is very slight.

-TABLE I- *Steady state reference values*

	c/p=70, 0.05 <r<0.1	c/p=[40, 100], 0.05<r<0.1
Open access	S=50,335 NB=394	28,000<S<70,000 264<NB<634
Sole Ownership	S* = [98,000 - 100,000] NB*= [131 - 140]	78,000<S*<115,000 90<NB*<222

2.5. *Bio-economic diagnosis*

Graphs 4 and 5 show the actual evolution of the VIII division anchovy stock and the numbers of vessels during the period 1966-1995. Also included are the optimality and zero profit intervals shown in Table I. Graphs 4 and 5 enable us to make a diagnosis of some of the factors present in the fishery dealt with in this study.

1. *The actual evolution of the fishery is a long way from reaching economically optimal solutions*. If the actual situation of the fishery is compared with maximum profit allocations, stock is found to be well below what would be considered the optimal interval, the number of vessels is extremely high, and catch levels show signs of being unsustainable in the long term. The steady state solutions for the sole ownership model further enable us

to indicate a proposal for a bio-economic TAC of between 18,000 and 26,000 tonnes and a number of licenses no higher than 222.

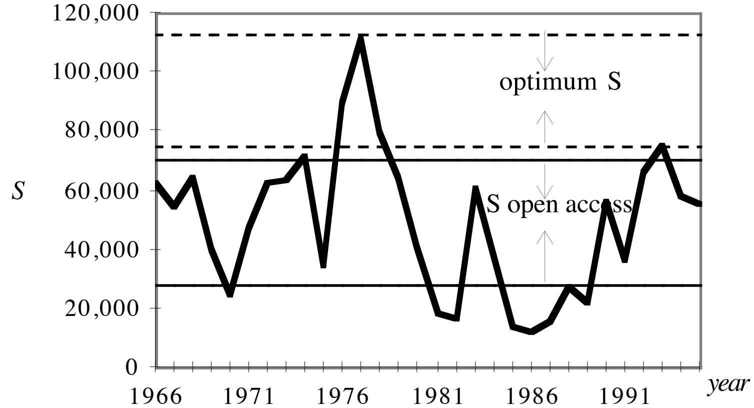
2. *The evolution of the fishery comes very close to the steady state solutions resulting from the open access model.* Although, as has been stated in section I, the fishery is not "de jure" open access, the fact is that the simulations carried out lead us to the conclusion that "de facto" is open access.

3. Therefore: *The rules introduced at different levels to manage the resource have not succeeded in putting the fishery on the path towards optimality*. Consequently, *the validity of the regulations at present governing the fishery must be questioned*.

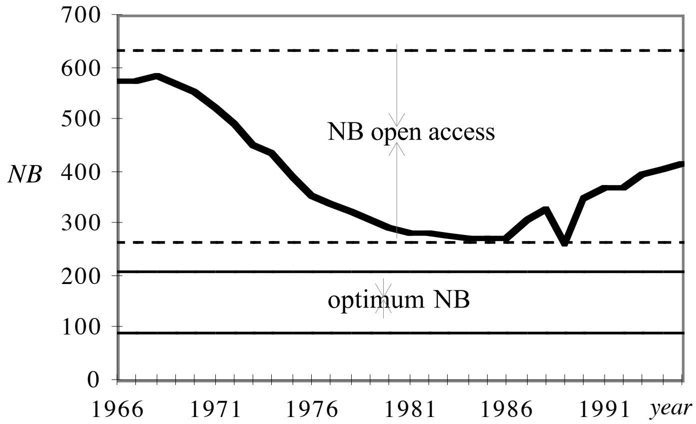
Non-workability of the rules should not lead us to cast doubt on the co-management regime as such. Indeed inefficiency may well be due to faulty decision-making (when establishing TAC levels or numbers of licenses to be issued), and also to the fact that rulings resulting from self-management do not involve all resource users.

Having reached this point, the question arises of how to explain why the existing rules do not necessarily lead to good management; this will be the subject of the next section.

GRAPH 4 – *Estimated biomass (1966-95) and steady state value intervals under open access and sole ownership.*



- GRAPH 5 – *Number of vessels (1966-95) and state value intervals under open access and sole ownership.*



3. A CRITICAL ANALYSIS OF THE CURRENT REGULATION PLUS SOME RECOMMENDATIONS

3.1. *In what way do the present regulations fall short?*

First of all, it must be pointed out that the 33,000 tonnes TAC placed on anchovy is based on the historic average of the catches made in the seventies, a period with a considerably higher catches than in the eighties and nineties. This explains the fact that the catches have generally fallen below the TAC, which in turn leads us to the conclusion that, as the bio-economic analysis carried out earlier testifies, the TAC is too high for the anchovy stock. Besides, French fishermen have exceeded their permitted quota in some years; this last fact shows additional problems of controlling the quotas and applying sanctions. Another striking fact is the transfer of 6,000 tonnes of Portugal's quota from IX Division anchovy to France; this implies exceeding the pre-established TAC and transferring possible catches from one stock to another.

In relation to restricted entry through licensing, rather than a fishing effort limiting mechanism, it seems more like a system for issuing fishing permits, which has, in practice, failed to place any great restriction on entry. Proof of this is to be found in the fact that 150 additional pelagic vessels have gradually been incorporated into the fishery. Although this expansion seems to be a bit odd with only the %10 of the TAC belonging to France (3,300 tonnes), the real participation of the French pelagic fleet is greater. This is due to the transfer of 6,000 tonnes from Portugal and 9,000 tonnes from the Spanish non-captured quota (result of the bilateral agreements of 1992 between France and Spain). On the other hand, it must be taken into account that anchovy is a marginal species for the pelagic fleet, whose principal catches are demmersals and sparids. The results of the simulation reveal an excessive fishing effort (number of vessels) on a diminishing stock, whose level is considerably lower than in previous decades.

At another level, the additional restrictions self-imposed by the "Cofradías" seem to have not been enough to avoid excessive pressure on stock and over-capacity of the fleet. It must be borne in mind that these restrictions only affect the Cantabrian purse seine fleet. Co-operation among agents is more difficult in the case of cross-boundary resources and even more difficult when not all the agents belong to the same group. In these cases, agents tend to blame stock depletion on the practices of foreign appropriators, since they are unable to intervene in decisions taken by those outside their own group. In short, co-ordination of activities with resource users from other countries not only increases transaction costs but also reduces the incentive for agents to restrict their own catches, the effect of which would be to benefit outsiders (Schager et al., 1994).

3.2. *Recommendations*

The TAC should be fixed in the light of the information gathered from bio-economic studies, whereas, in practice, in spite of recommendations on the part of experts, it usually ends up coming about as the result of mere political negotiations. As for the level established for the present, there is evidence to suggest that this is too high and should, therefore, be reduced. The TAC proposal resulting from this study is between 18,000 and 26,000 tonnes, which is considerably lower than the 33,000 tonnes of today (with no scientific endorsement since 1992).

In addition, the number of licenses should be greatly reduced, this measure could be accompanied by the relevant financial aid for the withdrawal of vessels and excess workforce. The withdrawal programme should address both quantitative issues (numbers of vessels) and qualitative issues such as the type of fishing technique used; considering as well the result of previous withdrawal programmes.

The reinforcement of the present system of supranational regulation by means of a more realistic TAC figure and a programme of restricted entry via a strict licensing system also requires credible controlling and sanctioning programs. The implementation of effective controls, however, depends on the political designs of the regulating authority. As Gallastegui and Chamorro (1997) point out, it seems not very adequate to continue with a system where control tasks are delegated to European member states. Unless the Commission guarantees the compliance of each and every one of its members, we can expect that individual states will relax control on their own fishermen.

As to the self-restricting additional measures imposed on themselves by the Fishermen's Gilds, it has to be admitted that co-operation among agents is more difficult when all the agents do not belong to the same group. To avoid falling into the drastic allocation resulting from the prisoner's dilemma, in which everyone loses out, all those involved should accept a common discipline to avoid the vicious circle of non-co-operation. The European Union ought to take up an active role in solving the problem of non-cooperation by ensuring compliance with rules and encouraging a process in which the self-restrictions of the "Cofradías" and the discipline of new incentives and restrictions can work together to overcome short-sighted practices.

Some of the newer fisheries regulation schemes recognise precisely this need to provide incentives to the agents themselves to protect the resources, by accepting the fact that inefficiencies arise from not internalising externalities or from badly defined or non-existent property rights. This supports the search for management plans based in the concession of individual rights ((Individual Transferable Quotas (ITQs), Individual Transferable Licences (ITLs)) or even collective rights ("area licensing" (Wilen, 1988)) above the resources, stressing some feeling of ownership is perhaps the most successful way of ensuring proper management.

Systems tending in this direction are among others second generation restricted entry programs like above mentioned "area licensing", successfully introduced in British Columbia and Alaska herring fisheries[15]. This system could be an interesting option for anchovy fishery regulation. It is closer to the current system than ITQs or ITLs and consequently fishermen could accept it more easily. It consists in setting up sub-areas for fishing with restricted entry and a quota limit per area. This is done after first reducing the number of participants via a conventional restricted entry programme, subject to the establishment of a global quota and a number of licenses in line with the bio-economic situation in the fishery[16]. Once the sub-areas have been set up, each one is fished by a part of the fleet, in such a way that, with fewer potential competitors, each fisherman keeps to his own area. The system is based on the idea of reducing the number of competitors to a level at which the dominant strategy of the group is one of co-ordinated action. What can not be denied, as empirical evidence shows, is that co-operative agreements are more easily reached within a reduced group of agents.

The experience of the "Cofradías" or Producer's Organisations (POs) could be of vital importance in setting up a system such as the one described above, since each sub-area would become subject to management by rules of access and exploitation evolved from collective action. The European Union could take on an active role to encourage co-operation, acting as an external arbitrator in the case of conflict and building up the observance of a discipline offering new incentives.

One of the main stumbling blocks to such a programme is probably the uncertainty it would breed among fishermen, since it would not be easy to make all sub-areas entirely equal. However, rotation systems are possible and different groups can be encouraged to establish agreements to guarantee protection against risks. In this respect, it must not be overlooked that, as in the albacore fisheries, there is a clear problem of the co-existence of different fishing gears and that this certainly complicates the process of achieving co-operative agreements.

4. MAIN CONCLUSIONS

The allocation of natural resources is closely linked to the institutional regime. Just as conventional theory relating to fishery resources associates the theoretical regime of sole ownership with efficiency and open access (or lack of ownership) to inefficiency, empirical evidence shows that self-management on the part of the appropriators of resources has sometimes led to their proper management.

The European anchovy in VIII division is an example of fishery where there is strong evidence of self-management on the part of some of the appropriators. Indeed, the fishery is a particular form of co-management, the main feature of which is the sharing of the management of resources among the State and some of its appropriators.

To compare the effectiveness of the rules introduced at national, European and local level, a bio-economic analysis was performed by simulating the fisheries at each end of the scale of institutional regimes, that of maximum profits (sole owner) and that of zero profits (open access). This enabled us to compare the steady state levels of stock and fishing effort with the actual evolution of these variables. Though this study is not thorough enough to test the validity of self-management or co-management, we think it is interesting enough in providing an adequate assessment of the workability of existing regulations.

The results obtained from the simulation lead us to believe that the actual evolution of the fishery is a long way from coinciding with the optimal outcomes derived from the sole ownership model, while coming very close to the steady state solutions resulting from the open access model. This lead us to claim that the rules established at different levels have not succeeded in putting the fishery on the path towards optimality. For this reason we question the validity of the present system of regulation. However, the non-workability of the rules should certainly not lead us to cast doubt or to rely on co-management, as rules deriving from self-management fail to involve all the users. Inefficiency may be due to faulty levels of the TAC and number of licenses or even to the fragile monitoring system.

We recommend fixing the TAC on the basis of bio-economic criteria. The bio-economic TAC that would be suggested by the outcomes of this study lies between 18,000 and 26,000 tonnes, well below the present 33,000 tonnes. In addition to this, the number of licenses should be greatly reduced to not more than 225 operating vessels. It is also essential to set up credible monitoring and sanctioning systems.

We would also underline the need to encourage co-operation between the agents involved, making conservation their dominant strategy. To this effect, area licensing is suggested as an alternative to current regulation. This would, however, require the prior introduction of a programme of global restrictions on catches and entry geared to the bio-economic situation of the fishery.

The past experience of the "Cofradías" is something to be taken into account when making a fuller assessment of the potential gains from the introduction of such a system, though the problem of the co-existence of different fishing techniques must not be overlooked. This problem was partially solved by the bilateral agreements of 1992, when it was established that access to fishing during the spring months would be restricted to the purse seine fleet only. In addition to the conflict between different fishing techniques, it has to be admitted that sub-areas for fishing could not easily be made to prove equally attractive and this would inevitably lead to further dismay among fishermen. In this respect, the European Union could adopt an active role in encouraging the use of rotational systems and agreements among groups with a view to guarding against risks. It could also act as external arbitrator in cases of conflict, encouraging observance of a discipline that would offer new incentives and restrictions designed to do away with short-sighted practices.

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NOTES

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[1] The term ownership rights refers to a whole range of rules, regulations, customs and laws developed over the course of time to govern rights of appropriation, use and assignment of goods and services. It may be interpreted to be a social relationship where some are admitted and some excluded from the making of decisions regarding the management and quiet enjoyment of resources and the services therefrom.

[2] Common property has frequently been erroneously equated with no property. The mistake is summed up in the “tragedy of the commons”. In an attempt to find the causes of the increase in world population and the subsequent growing need for food, Hardin uses the example of the shepherds, each of whom freely looses his sheep into a grazing area *open to all,* thus erroneously equating common ownership with open access. The famous “tragedy of the commons”, therefore, arises from the confusion between open access and joint ownership. This mistake has been carried through to the present day; evidence of the fact to be seen in some of the most widely used textbooks dealing with natural resource economic.

[3] The "Cofradía" is a corporation simultaneously embracing vessel owners and workers of inshore and artisan fleets of the Cantabrian. Among its basic functions we can quote the strict regulation of productive activity in such a way as to control not only the use of resources but also the organisation of access to them, including the sale of fish. For further details about the "Cofradías" of the Cantabrian, you can see Astorkiza et al (1998).

[4] Historic rights may be interpreted as a form of ownership over the resources, although, as everyone knows, the country or countries whose coasts border the fishing grounds hold full sovereignty within the 200 mile limit, for the exploration, exploitation, preservation and administration of marine resources.

[5] Vessels applying for access to the fishery must be included in a national census and be inscribed in the basic lists of vessels claiming an interest in participating in the fishing. Likewise, there is an upper limit on the number of vessels that may be allowed to remain at any one time in the fishing zone (160). In order to make the most of the licenses issued, these are shared by two or three vessels.

[6] In the case of the anchovy, the maximum load permitted per vessel is 10,000 Kg/day and vessels must set out to sea after midday on Monday, with the last permitted sale at 10 p.m. on Friday.

[7] The legislation on purse seine fishing in the national fishing grounds sets the minimum legal size of net mesh (14 mm), the length and depth of the net (450 and 90 metres respectively), and also the legal minimum size of species fished with purse seine techniques (12 cm for anchovy).

[8] Although there are numerous studies which analyse the exploitation of fishing resources under open access, we might give special mention to the studies of Bjørndal and Conrad (1987)(b), Opsomer and Conrad (1994) and Amundsen et al. (1995).

[9] In schooling fisheries like anchovy searching for schools is of predominant importance. Accordingly, in such fisheries the number of participating vessels may be an appropriate measure of effort.

[10] Although there are many studies dealing with optimal management in a wide range of fisheries, we might mention in particular those of Bjørndal (1988), Garza (1998) and Sumaila (1997).

[11] When dealing with *infinite horizon autonomous* problems, the transversally condition required to determine the boundary condition is replaced by the assumption that the optimal solution approaches the steady state situation.

[12] For information about discount systems for natural resources and environmental policies, see Kula, 1992.

[13] With sufficiently low values of c/p, optimal stock is below that associated with MSY, steady state catch levels, therefore, increase as far as MSY only to decrease as values of c/p increase.

[14] The discount rate would need to exceed 500% for the optimal extinction of the resource.

[15] The implementation of this system has brought about an increase in income for the fishermen, while reinforcing co-operative agreements among different groups with a view to improving the future prospects of the fisheries.

[16] The implementation of area licensing requires prior consensus on the part of the agents involved regarding the global quota and the total number of fishermen allowed accessing. Once this difficult consensus has been reached, the next step is to share out the quota among the different groups; who are then delegated the task of enforcing the rules and penalising those who fail to comply.