Differences of Profitability Within a Multi-species Multi-gear Multi-area Fishery: How much is explained by barriers to entry?

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Abstract. The fishing activities within the English Channel may be regarded as various components of one large multi-species multi-gear multi-area fishery. As a result of a bioeconomic analysis of this fishery, significant differences in profitability between activities were outlined. According to industrial economics, such differences may be regarded as the result of barriers to entry limiting the access to the most profitable activities. The aim of this paper is to determine which part of the differences of profitability outlined in the survey can be explained by usual barriers to entry (geographical, technical, institutional, informational), and which part should be attributed to other factors, such as non monetary arguments of the utility function of producers. It is based on a socio-economic survey of 160 French fishermen. The interest of this analysis is both theoretical and practical: on one side, it intends to provide some new evidence in the debate concerning the economic rationality of fishermen; on the other side, it helps to identify the range of remote constraints fishery management has to cope with.

Keywords: barriers to entry, economic behavior, English Channel fishery.

1. INTRODUCTION

Developed in the fifties in North America, fishery theory mobilizes the results of the neoclassical microeconomic theory to explain the fishers' behavior. On the traditional assumption of perfect mobility and perfect information, producers based their strategies on the principle of profit maximization. As a result, they allocate their inputs in the fishing activities[1] that offer the best profitability, until the equalization of the levels of profitability (Gordon, 1954). In the long run the well-known result of this behavior in open-access is over-capacity and over-exploitation, which account for managers intervening (Scott, 1955).

However, in the fishery economics literature several works have questioned the validity of this profit maximization hypothesis, stressing the fact that the models that referred to it obtained mistaken results (Smith, 1981; Gatewood and McCay, 1990; Frost et al., 1993).

Yet, knowing the behavior of individual fisherman and predicting the aggregate fishing effort among alternative fishing activities is fundamental from a management point of view, especially in a multi-species, multi-gear, multi-area fishery. This preoccupation has conducted to a piece of literature on modeling individual fishing activity choice and entry-exit decisions (see for example, Bocksteal and Opaluch, 1983; Sampson, 1992; Holland and Sutinen, 1999; Latouche and Le Floch, 2000).

The purpose of this paper is to see what has taken place in the English Channel fishery. Due to the strong biological, technical and economic interactions between the various fishing activities in this area, the whole Channel may be regarded as one large multi-country, multi-gear and multi-species fishery, rather than a number of separate fisheries geographically co-located. Therefore, in this fishery, each producer can allocate his means of production in any of the 53 activities identified.

As a part of a bioeconomic analysis of this fishery, a socio-economic survey was conducted, in order to assess the economic performance. One result of this survey is the existence of permanent differences of profitability between fishing activities, which leads to a number of "unprofitable situations" and brings into question the validity of the traditional assumptions presented above

[1] A fishing activity is defined here as the association of the gear used, the area fished and the species or group of species targeted.

(part 1). The aim of the paper is then to determine which part of these so-called "unprofitable situations" can be explained by different forms of barriers to entry inside the traditional economic framework (part 2). A discussion will take place about the theoretical issue of this research on the producers' behavior, as well as about the nature of barriers to entry on which the fishery manager could act to achieve a more efficient exploitation (part 3).

2- THE PROBLEM: THE EXISTENCE OF PERMANENT DIFFERENCES OF PROFITABILITY BETWEEN FISHING ACTIVITIES INSIDE A COMPLEX FISHERY.

2.1 The English Channel fishery.

The English Channel fishery (ICES areas VIId and VIIe) is commercially exploited by fishing boats of several European countries. The fleet is composed of nearly 4000 boats. Most of them are small inshore units having several activities. Their size can vary from 6 meters to more than 30 meters. Almost 75 species are commercially exploited (Tétard et al., 1995). The boats present different exploitation strategies, which can vary according to their size, their location or their main activity. For most of them, their annual performances will depend on the practice of several distinguished activities along the year. As a result, the average level of polyvalence per boat is 2.5 activities a year (Tétard, op.cit.), and each entrepreneur has to choose, at a trip level, one single activity between 53 available.

Given the lack of data, this analysis only involves the French part of the Channel. In 1994, the French fleet was composed of 1674 units, from 6 to 25 meters long, accounting for 35 % of the national production for the fresh fish market. As usual in the small scale fisheries, it's a heterogeneous fleet, in terms of structure of production as well as in terms of exploitation strategy. Boats are thus gathered in sub-fleets (noted fleets in the rest of the text), based on three criteria: size of the boats, location port and main activities. Inside each of these fleets, the boats are assumed to be homogeneous.

There are three main interests in gathering fishing boats into fleets. First, this allows us to define a smallest number of entities likely to be studied and managed individually. Secondly, this notion is closer to the traditional economic concept of activity sector (sum of production units having similar main activity). Last, but not least, it's not necessary to get information about the individual behavior. A group's behavior can be modeled following traditional economic principles, even if each person behaves differently. This, however, implies that the above-mentioned groups must be built so that the internal variability is reduced to a minimum.

Three class sizes have been selected: less than 10 meters, 10 to 16 meters and 16 to 25 meters. This segmentation is justified by the fact that these size limits are discriminating as for the geographical range of fishing of the boats (Berthou, 1997). Taking into account the physical differences between boats belonging to each size class, all the comparison between activities' profitability will take place inside each size class. In the rest of this paper, the analyze will focus on the 10 to 16 meters class size.

As the English Channel is mainly an inshore fishery, the port's location takes an important place in the analysis. Six areas were then identified, in order to take into account the geographical, legislative and biological specificities of the littoral: maritime districts of Brest and Morlaix (B1), Paimpol and de Saint-Brieuc (B2), Saint-Malo and Ouest-Cotentin (B3), Est-Cotentin, Caen and Le Havre (B4), Fécamp and Dieppe (B5), and Boulogne (B6) (See the map in Appendix).

Nine (sub)fleets were identified, which present a significant level of homogeneity: trawlers, trawler-dredgers, other dredgers, netters, netter-potters, potters, whelkers, seaweeders, liners. These fleets are based on the criteria of similar pattern of activity.

The English Channel fishery is mainly a " small scale" one, from the point of view of the financial structure of the firm. This particularity has two important consequences for our problem. On one hand, it implies that the owner of the capital works onboard as the skipper, choosing the allocation of the input, as any Schumpeterian entrepreneur. Regarding the traditional distinction made by the theory, there is then a confusion between the functions of entrepreneur and owner. This allows us to deal easily with the question of who has the decisional power in the firm. Also objectives conflicts pointed by the managerial economics are not likely to exist in this case (Cyert and March 1963).

In the other hand, it implies to precise the notion of profit. Traditionally, the economic profit is derived from the concept of Full Equity Profit (gross margin net of depreciation cost). The rate of return on capital, or rate of profit, is then a classic indicator of economic profitability that is sometimes used for the analysis of economic performance in the fishing industry (Davidse *et al* 1997). It is calculated by dividing full equity profit by the value of capital invested in the firm. Full equity profit is what the owner of the firm would get if the activity of his firm

was fully self-financed. However, attention should be paid to what is exactly termed as profit, and this question is of special importance in the case of "small scale" fisheries like those of the English Channel. In such fisheries, the economic significance of full equity profit is not perfectly clear due to the peculiarities of the share-system for the rewarding of the crew (that is, the so called "wage costs" includes an element of profit, Sutinen, 1979), and the rate of profit does not look like a reliable economic performance indicator if one compares the relative profit rates by length class to the actual dynamics of the fleet over the last decade (Boncoeur, Le Gallic and Pascoe 1998). Therefore, it was decided to calculate another performance indicator, representing the net income of the skipper-owner[2] *(NISO*). It is defined as the sum of the wage he gets from his work onboard and the Full Equity Profit.

2.2 Fishing activities' performances

Inside a complex fishery, this latter annual indicator of performances is derived from the results of various fishing activities. It was then necessary to propose another approach, in order to express the annual indicator as a function of the daily Margin on Variable Costs per activity (Le Gallic, Le Floch, 2000) :

$$(1)\quad NISO = \sum_m e_m.MVC_m - FC$$

where $NISO$: net income of the skipper-owner
e_m : number of days at sea in each activity m
MVC_m : daily margin on variable costs per activity m
FC : economic fixed costs

The daily margin on variable costs per activity is the difference between the total revenue by activity and the total variable costs linked to this activity, including the crew costs, but excluding the wage of the skipper-owner. The daily margins on variable costs per activity and by area are presented in Table 1. They are derived from an economic survey of 160 skipper-owners[3], representing 10 % of the French fleet operating in the English Channel (for the methodology, see Boncoeur and Le Gallic, 1998).

Fishing area / fishing activity	B1	B2	B3	B4	B5	B6
Otter trawling		1500	2200	2800	3500	
Midwater trawling					2800	
Beam trawling			3500	3800	3100	
Scallop dredging	2800	4800	4700	3400	4600	
Bivalves dredging	4200	2000	3150			
Fish netting	3100		2100	3200	3500	2600
Crustacean netting	3200	1800	4500			
Crustacean potting	3700	2000	3200			4100
Whelk potting		2400	3400			
Cuttlefish potting		2500			4200	3100
Line		2100				
Seaweed	3900					

Table 1 : daily margin on variable costs per activity and per area for the 10 to 16 meter boats, in francs.

In this table, one can see that high differences exist, either between activities or between fishing areas for a same activity. The problem we have to face is that some fleets choose the less profitable activities, which leads to a misallocation of the means of production (the economic theory expects that an efficient fleet will adjust in order to equalize the profitability among the various fishing activities, Gordon, 1954). These unexpected situations are called « unprofitable situations » in the rest of the text.

2.3. Quantification of the "unprofitable situations".

The methodology proposed to quantify « unprofitable situations » can be described as follows : for each fleet, we compare the daily margins on variable costs obtained from the activities conducted to the daily margins of variable costs that can be obtained from any of the alternative activities. An example of the methodology is presented in Table 2.

[2] This indicator is equal to the actual income of the skipper-owner only if the opportunity cost of capital employed in his firm is equal to its net financial costs

[3] This survey was conduct as a part of an European founded project, concerning the bioeconomic modelisation of the English Channel fishery.

Name of the fleet / Area of location		Trawler-dredger B2		
fishing activity / Fishing area		Scallop dredging B2	Bivalves dredging B2	Otter trawling B2
DMVC (number of days)		4800 (50)	2200 (20)	1500 (130)
Daily Margin on Variable Costs of the alternative fishing activities in each area				
Otter trawling	B2	1500	1500	1500 D
	B3	2200	2200	2200 M
	B4	2800	2800 M	2800 M
	B5	3500	3500 M	3500 M
Scallop dredging	B1	2800	2800 M	2800 M
	B2	4800 D	4800 M	4800 M
	B3	4700	4700 M	4700 M
	B4	3400	3400 M	3400 M
	B5	4600	4600 M	4600 M
Bivalves dredging	B1	4200	4200 M	4200 M
	B2	2200	2200 D	2200 M
	B3	3150	3150 M	3150 M

Table 2: quantification of the "unprofitable situations"

For the fleet analyzed – trawlers/dredgers of area B2 – the daily margins on variable costs of each of the activity done (scallops dredging, bivalves dredging, otter trawling) are compared with the daily margins on variable costs of all the alternative activities (including those already practiced). It's noted D when the alternative activity considered is done, M when it's more profitable. In this example, 20 more profitable situations can be identified. Following this methodology for the whole 10 to 16 meter fleet, it is possible to identify 691 "unprofitable situations". The aim of the following section is to explain them.

3. THE DIFFERENT FORMS OF BARRIERS TO ENTRY.

The second stage of the methodology is to find any reason that allows us to understand why these situations continue, or why an entrepreneur do not re-allocate his inputs to the most profitable activities. It will refer to an Industrial Economic result, theconcept of barriers to entry. This concept can be defined as all of the « *obstacles* » preventing the capital from flowing to the more profitable activities (Morvan, 1981, p.83).

3.1 The costs of "moving" as a barrier to entry.

In Table 1, daily margins on variable costs are given with respect to the area of fishing. However, as the boats are located along the coast, they are not equal from a cost to access to the fishing area point of view. Traditionally, access costs are derived from the « steaming » time, at a trip level. However, given the size of the boats concerned here, they are not able to change from a fishing area to another one within a trip. The costs of "moving" of the activity are then the sum of two factors : hotel costs and travel costs. On the assumption that a boat changes from an area to another at least for 2 weeks (observed behavior), the Daily Cost of "Moving" of the activity (DCM) can be expressed in the following way, in francs:

$$(2)\ DCM = 600 + 50 * Bi$$

Where 600, the fixed factor, represents the hotel cost, on the assumption of three men onboard, and 50* Bi, the variable factor representing the travel cost, takes into account the distance between the fishing area and the location area of the boat (Bi is the number of gap of areas). The daily costs of "moving" are presented in Table 3.

fishing area	location area					
	B1	B2	B3	B4	B5	B6
B1		650	700	750	800	850
B2	650		650	700	750	800
B3	700	650		650	700	750
B4	750	700	650		650	700
B5	800	750	700	650		650
B6	850	800	750	700	650	

Table 3: daily cost of "moving" from the location area to a fishing area, in francs.

It's then possible to recalculate the daily margin on variable costs of the alternative activities, net of the moving cost. Taking the same example as previously, the new results are presented in Table 4:

Name of the fleet Area of location		Trawler-dredger B2		
Name of the fishing activity Fishing area		Scallop dredging B2	Bivalves dredging B2	Otter trawling B2
DMVC (number of days)		4800 (50)	2200 (20)	1500 (130)
Daily margin on variable costs (including the moving costs) of the alternative fishing activities in each area				
Otter trawling	B2	1500	1500	1500 D
	B3	1550	1550	1550 T
	B4	2150	2150 **T**	2150 M
	B5	2750	2750 M	2750 M
Scallop dredging	B1	2150	2150 **T**	2150 M
	B2	4800 D	4800 M	4800 M
	B3	4050	4050 M	4050 M
	B4	2700	2700 M	2700 M

Table 4: quantification of the "unprofitable situations" when taking into account the moving costs.

In this example, two "unprofitable" situations become profitable (noted **T**), as the daily margin on variable costs obtain from the conducted activities become higher than the alternative ones.

For the whole fleet, it is possible to identifie 261 of the 691 "unprofitable" situations that can be explained by this first barrier to entry.

3.2 Uncertainty as a barrier to entry.

Fishing activities are characterized by many types of uncertainty (e.g., see Gates, 1984). This is especially the case regarding the production. Yet, the second type of barrier to entry identified concerns the fact that variability in the production can prevent the skipper-owner from reallocating his inputs (risk aversion behavior). In our case, we decided that all the differences of profitability less than 15% should be considered non-significant. This choice is due to the fact that this threshold represents the average standard deviation. This second barrier to entry can explain eighty-eight situations of the 691 initial differences of profitability.

3.3 Technical specificities as a barrier to entry.

From a mid-term analysis, the nature of the physical input (the boat) must be considered as a constant. As a result, various types of boats are not able to practice some activities : for example, a boat belonging to the potters' fleet won't be able to dredge, without fundamental long term changes. This phenomenon can refer either to the problem of the *non-malleability of the capital* (Clark, Clarke and Munro, 1979) or to the question of the technology frontier discontinuity (Nelson and Winter, 1982). The possibility for a given boat belonging to any of the fleets to practice a given activity is presented in Table 5, when Y (for Yes) can be read. Sixty-seven situations of the 691 initial "unprofitable situations" can be explained by this third barrier to entry.

	trawler dredger	Other dredger	potter	netters	liners	seaweed
Otter trawling	Y	Y	N	N	N	N
Midwater trawling	Y	Y	N	N	N	N
Beam trawling	Y	Y	N	N	N	N
Scallop dredging	Y	Y	N	N	N	N
Bivalves dredging	Y	Y	N	N	N	N
Sole dredging	Y	Y	N	N	N	N
Crustacean potting	Y	Y	Y	Y	Y	Y
Whelk potting	Y	Y	Y	Y	Y	Y
cuttlefish potting	Y	Y	Y	Y	Y	Y
Crustacean netting	Y	Y	Y	Y	Y	Y
Fish netting	Y	Y	Y	Y	Y	Y
line	Y	Y	Y	Y	Y	Y
Seaweed	Y	Y	N	N	N	N

Table 5: Matrix of the possibility, for a given fleet, to practice a given fishing activity.

3.4 Management measures as a barrier to entry.

Different authorities, from the local level to the European level, manage the English Channel fisheries. National and European measures have mainly to do with technical measures (mesh size) and the setting of TAC and quotas. Local measures have more to do with rights to access to given areas or given activities, through licenses systems. Because they are some barriers to mobility, the latter are of interest for us. Two types of limited access measures can be distinguished : exclusive licenses (*numerus closus*) and spatial-temporal measures. If the former limits directly the practice of one activity, the spatial-temporal measures have an indirect effect. This is for example the case of the scallops dredging in the area B2, which is limited to 2 trips per week. As this activity is the more profitable, it is mainly chosen by the fishermen. However, between 2 scallop dredging trips, it's not possible to allocate the fishing effort into another area,

given the size of the boats, even if the activity practiced between the 2 scallops trip is not the most profitable. As a result, it is more relevant to compare the average of the daily margins on variable costs (given by the scallops dredging and any other activity) to the other daily margins on variable costs. One hundred fifty-seven situations of the 691 initial differences of profitability can be explained by this fourth barrier to entry.

3.5 Environmental factors as a barrier to entry.

In a complex fishery such as the English Channel, the fishermen have to make their decision under the constraint of the resource's presence. This feature has two major consequences for the current problem, as 9 situations of the 691 initial differences of profitability can be explained by this fifth barrier to entry.

1) The seasonality of the resource explains obviously that some species are only exploited during a given period of time, making the practice of less profitable activities for the rest of the year rational.
2) The impossibly of using various gear given the « tie coefficient » limits the number of days of exploitation of some activities. It is the case for crustacean pots for example. The practice of less profitable activities can be then justified during these days.

3.6 Social institution as a barrier to entry.

Among the three types of difficulties the Schumpeterain entrepreneur has to face when departing from the « routine » is the *« reaction of the social community »* (Schumpeter, 1935, p.123). Through the survey, a few cases referring to this behavior were identified. They were split into two groups. The first one concerns the practice of activities considered as « ecologically not correct », that is to say destroying for the environment, such as beam trawling. The second one concerns activities, which come in conflict with actual practices and « customs », such as netting in the area B4, traditionally dedicated to trawling[4]. Five situations can be explained by this sixth barrier to entry.

3.7 Information as a barrier to entry.

The problem of information is another of the difficulties proposed by Schumpeter (op. cit.). In the field of fisheries economic, a few works focus on the question of the flow of information, and especially the optimal size of the clubs inside which the information is shared (Gates, 1984; Wilson, 1990). Two types of informational barriers to entry are distinguished here : the question of the imperfection of the information and the question of skill.

The first one is linked to the fact that, in the field of small scale fisheries, there is a lack of official economic data. That means that there in no direct way for a fisherman to know the profitability of all the activities. His second best is then to follow the productions sold through the auction market system. However, the English Channel fishery is characterized by a high level of sales realized out of the auction market (which is perfectly legal), and this latter way of commercialization has a different impact among the activities. Yet, it is very difficult to know the economic performance of the potters, because the spider crab is accepted only in one auction. This institutional problem is completed by an information retention behavior from the operators that obtain the best results (or that believe to do so).

The second one is the problem of the skill of the fisherman, which can vary between the activities. Yet, thanks to the development of inboard electronics, it is possible to trawl without the acquisition of a specific knowledge (Le Floch, 1998). Conversely, when the human capital is important compared to the physic capital, the skill must be considered as a barrier to entry. This is for example the case of the bass liners. This question of skill can be asked at a port organization level, when it concerns the commercialization conditions. For example, the bivalve production in area B2 is only realized by a few fishermen who have a niche strategy, but has to face with a market limitation[5]. Sixty situations of the 691 initial differences of profitability can be explained by this seventh barrier to entry.

4. DISCUSSION : THE IMPORTANCE OF TAKING INTO ACCOUNT THE BARRIERS TO ENTRY.

From a theoretical point of view, the results of this research provide some new evidence in the debate concerning the economic rationality of fishermen, and further, in the knowledge of the producer's micro-behavior.

Barriers to entry, as defined above, can explain 651 of the 691 initial unexpected differences of profitability (i.e. around 90%). Without prejudging the form of the producer's objective function, this means that in most of the cases obstacles exist, justifying the current allocation of the fishing effort as if the producer acts as a profit maximisator. This result is consistent with Robinson's

[4] Or scallop diving in scallop dredging areas.

[5] It is interesting to notice that an organization of this market is actually succesfully conduct by the PO concerned.

one, when developing another methodology on the English part of the Channel (Robinson and Pascoe, 1997). Therefore, in most of the cases, the underlying assumption of profit maximization appears to be relevant when modeling producers' behavior. However, some cases remain, calling for other explanations.

A first one mobilizes the concept of « satisficing approach» (Simon, 1959), which can be defined as the research of a minimum (or *satisficing*) level of profitability, rather than the search for a maximum one. While this program remains consistent with the traditional framework of utility maximization, it requires taking into account some non-monetary arguments in the utility function, such as the leisure time or the level of the quality of life.

Yet the practice of otter trawling in area B2 is often determined by an "occupational approach", in the sense that the existence of the firm is insured by the practice of scallop dredging. The choice to practice or not this activity is then determined only by the positivity of the daily margin on variable costs. Thirty-three "unprofitable situations" can be explained by this strategy. One must precise that this number is a minimum, as a similar behavior exists, that consists for a fisherman in limiting the number of days of fishing as soon as he considers that he has earned « enough » money. The problem is that this latter behavior is more difficult to quantify. It is important to notice that this first explanation is closed to the « non monetary inertia » founded by several authors when testing the allocation choices through econometric models (e.g., see Bocksteal and Opaluch, 1983).

A second explanation refers to the concept of « satisfaction bonus », that concerns the fact that the level of pleasure provide by a fishing activity is taken into account (e.g., see Smith, 1981). Once again this behavior leads to the introduction of a non-monetary argument in the producer's utility function, while the loss of earning is compensated by a utility gain. Seven "unprofitable situations" can be explained by this strategy.

The results of this research can also be useful from a managerial point of view. As a matter of fact, some of the barriers to entry, if removed, could allow a better allocation of the inputs, even in a mid-term prospective. Thus, the regulator should pay a special attention to them. The first barrier to entry identified is the "moving" cost one. As in other economic fields, where subsidies to mobility exist (capital and labor), it could be interesting to help a firm to move from an overexploited area to a more profitable one (or to "push" it through an incentive mechanism). In the long run, such a policy will all the more justified that the reduction of the fishing pressure on the overexploited stock is expected to lead to a growth of the captures, and further to an increase of the revenue which could be taxed to finance the project. The otter trawling in area B2, which is one of the less profitable fishing activities, gives an example. It can be especially interesting from a social point of view, because this activity produce a lot of negative externalities (discarding of crustaceans, Boncoeur, Fifas, Le Gallic, 1998).

The second barrier to entry identified is the management measures one, which must be considered as endogenous. As said previously, management measures are often set up in order to limit the access of a given resource. If they can be seen as effective, when offering a better profitability, they lead to a problem of equity, in the sense that a part of the fishers are excluded from the wealth generated by the management measure.

However the most obvious barrier to entry that can be looked at by the public manager concerns the flow of the information, at both of the levels identified above (3.7). Firstly, collection and diffusion of the information should lead to a more efficient allocation of the means of production, especially when taking into account the development of new activities in some areas (fish netting in the area B4). Secondly, a financial help to the acquisition of skill, either at the production or at the commercialization level should allowed a re-allocation of the means of production to more profitable activities (Bass line).

5. CONCLUSION AND RECOMMENDATION

In any economic sector, understanding the response of producers to changes in economic and regulatory conditions is important. It is especially true in the field of multi-species, multi-gear, multi-area fisheries, such as the English Channel fisheries, where the various fishing activities are interrelated.

As a result of a bioeconomic analysis of the English Channel fisheries, permanent differences of profitability between the various fishing activities conducted by homogeneous boats were identified, bringing into question the traditional behavioral assumptions (an efficient fleet is expected to adjust in order to equalize the profitabilities).

When data are available, various econometric models can be tested to explain the behavior that conducts to this feature. However, for a large part of the fisheries around the world, the lack of data is the rule, calling for other methodologies. This paper presents one alternative

methodology to explain what we have called the *a priori* "unprofitable situations" that consists in identifying the barriers to entry, which limit the access to the most profitable activities.

From a theoretical point of view, this research outlines the fact that in few cases (10 % of the "unprofitable situations"), it is necessary to integrate non-monetary arguments in the producer' utility function (satisfacing approach or satisfaction bonus). From a managerial point of view, it helps to identify which barriers to entry could be looked at by the authorities. However the methodology used needs improvements and calls for new investigations in the field of fishers' micro-economic decisions, in order to determine the more relevant utility function as possible.

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7. APPENDIX