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Regulation of the Uses of the Marine and Coastal Resources and Ecosystems

AMURE PUBLICATIONS

Working Papers Series

N° D-16-2006

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Working Papers Series

www.gdr-amure.fr

ISSN 1951-641X
AMURE Publications. Working Papers Series.
Online publications : www.gdr-amure.fr

SUMMARY

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A typology of fisheries management tools[1]

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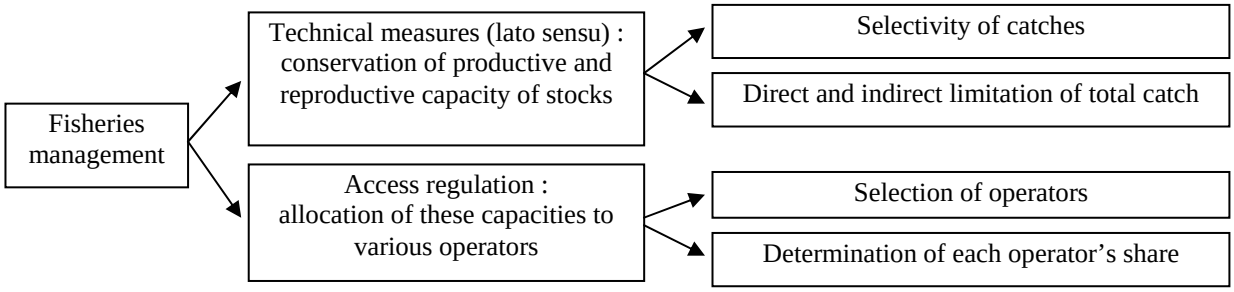
This paper proposes a classification of fisheries management measures which is based a typology developed by Boncoeur et Troadec (2003). This typology was discussed as part of the TECTAC research project, and amended to provide the following conceptual framework. Fisheries management tools may be classified according to their purpose, to the regulation method on which they rely, and to the control variable(s) which they use. The typology presented in this paper relies on these three criteria

[1] This paper was prepared as part of the final report of the "*TECTAC*" European Research Project (Q5RS-2002-01291

1 The purpose criterion

Fisheries management relies on two major sets of regulations, differing from each other in purpose. These two purposes are *i*) conservation of the productivity of fish stocks, and *ii*) adjustment of fishing capacity to the replacement potential of fish stocks (fig. 1).

Figure 1. The two main components of fisheries management



Source: Boncoeur (2003)

The first set of tools basically corresponds to the classical tasks of fisheries management. The aim is to maintain fish stocks productivity at a high level, by controlling two factors: production per recruit, and the relation between spawning stock biomass and average long period recruitment. Two types of tools may be considered in this category:

- some tools are mainly aimed at preventing excess catches of juveniles ; they usually consist in norms concerning gear selectivity (e.g. mesh size), minimum landing sizes, and fishing operations (fishing time and zone closures, focused on periods and areas where high concentrations of some critical resource components call for a specific protection);
- others intend to limit the total fishing mortality on a given stock, in order to keep a level of biomass high enough to maintain the reproductive capacity of the stock; they usually consist in the setting of total allowed catches (TAC) or/and global size of the fleet (e.g. number of vessels, total engine power, etc), fishing time limitations (e.g. yearly, weekly or daily fishing time). These norms are periodically adjusted to the changing level of fish stocks.

According to the usual terminology, only measures of the first type are called « technical ». However, as TACs or fishing time limitations do not deal with the question of resource allocation between fishers, it seems relevant to classify these regulations in the set of « technical measures » as well. Technical measures, in this broad sense, normally apply to all fishers operating under similar conditions, and are traditionally implemented by administrative ("command and control") methods (see below).

The second set of fisheries management tools is concerned with the regulation of individual access to fish stocks. The aim here is to allocate the limited productive capacity of these stocks between fishing firms. This operation has itself two sides: selecting firms which are allowed to fish a given stock (or group of stocks), and fixing the share each one is allowed to fish.

The attention of authorities in charge of fisheries management is increasingly focused on the search for efficient regulations controlling individual access to fish stocks. The need for such regulations is mainly the result of the weaknesses of traditional fisheries management, mainly based on technical measures (lato sensu), and which become more conspicuous as anthropic pressure on fish stocks increases. This is so because technical measures, though in principle adapted to stock conservation, are unable to prevent the development of overcapacity in fisheries[2], which is nothing but the natural consequence of negative mutual externalities accompanying the harvesting of a common-pool resource[3], and generates a gap between individual and collective (or social) optima[4]. The negative consequences of overcapacity are economic, but also social and biological:

- in economic terms, overcapacity means inefficiency in the harvesting of a given resource, because too many scarce resources (capital, labour) are devoted to this operation, which induces a loss of net wealth for society ;
- socially, overcapacity is harmful in different ways, notably because it strongly boosts use conflicts between fishers ;
- overcapacity is also harmful as regards resource conservation, because the social pressure resulting from overcapacity generally leads public authorities to give priority to short term considerations, whatever the caveats given by fisheries biologists concerning the long term consequences of exceedingly high fishing mortality rates; this often results in a free-and-easy attitude in fixing the levels of conservation policy parameters, as well as in their enforcement policy.

The following developments will deal in more detail with access regulation tools.

2 The control method criterion

It is also possible to classify fisheries management tools according to the control method on which they rely. In this field, it is usual to distinguish so-called “administrative” or “command and control” methods, based on the implementation of norms, from so-called “economic” methods, based on incentives. This distinction may apply to both sets of tools presented in the former section of this paper. In the field of technical measures for instance, economic methods can be implemented through the use of such tools as taxation of poorly selective

[2] In some cases they may even contribute to worsen the situation in this field, for instance when the setting of a TAC increases the phenomenon of “race for fish ” (OECD, 1997).

[3] An externality, or external effect, appears when the activity of a firm modifies the production conditions of other firms, or the welfare of consumers, without counterpart on the market. Several firms harvesting a common-pool scarce resource generate towards each other negative cross-externalities, due to the fact that an increase in the harvesting effort of each firm makes the resource scarcer for the others, both in the short run (crowding externalities) and in the long run by influencing the resource dynamics (stock externalities).

[4] Due to negative cross-externalities, individual marginal product of fishing effort (i.e. the increase in catches which a fisher gets from slightly increasing his own effort) is higher than social marginal product of fishing effort (i.e. the result for the whole fishery of a slight increase in fishing effort) : when a fisher increases his effort, *caeteris paribus*, it results in deteriorating the fishing conditions of other fishers fishing the same stock, and as a consequence, the increase in his own catches is partly (if not wholly) balanced by a decrease in catches of other fishers. In a competitive unregulated fishery, each fisher aiming at maximising his own personal income will ajust his effort according to its marginal private, rather than social marginal product (the maximising condition is the equality between marginal product and real unit cost of effort). This will result in an overall excess effort at the scale of the fishery, i.e. an inefficient situation where fish rent is lost because too much effort is devoted to the fishing of a given stock. In the long run, overcapacity is a major factor of stock depletion.

gears, subsidising of highly selective gears, or eco-labelling[5]. However, in the fishing industry, most technical measures pertain with to the category of administrative methods, and the debate concerning the use of administrative v. economic methods is mainly focused on the question of access regulation.

Administrative methods, which for long have been used to protect the productive and reproductive capacity of fish stocks, have often been extended to the regulation of individual access to the resource. In this field, administrative methods usually consist in implementing limited entry non-transferable licenses. These licenses are generally accompanied by limitations concerning individual fishing power and / or fishing time, or sometimes individual catches. In this last case, individual catch quotas may be the same for all licensed boats, or may be based on individual boat capacity, historical catch records, or a combination of these criteria (for examples of use of these criteria in Icelandic and Dutch fisheries prior to the introduction of ITQs, see Arnason 1995, and Davidse 2000).

The philosophy of economic methods is to prompt fishers to take into account the externalities they generate towards each other when fishing a common stock, in order to reconcile collective and individual optima. Economic methods may be divided into two groups:

- taxations methods;
- so-called "rights-based" methods (methods based on the implementation of individual transferable rights of access to the resource).

Taxation methods, frequently used in the field of environmental management, are based on the theory of social cost (Pigou, 1920). According to this theory, taxing an activity that generates a negative externality will lead the producer of this externality to incorporate in his own economic calculation the cost it induces for other economic agents (provided the level of the tax is related to this cost); the expected result is a decrease in the level of the negative externality, either because the activity is itself reduced, or because the production method is changed (shift to "cleaner" techniques for instance)[6]. In the fishing industry, taxation increases the unit real cost of fishing effort, which is expected to prompt fishers to decrease their effort. If the tax rate is fixed at the appropriate level, fishing effort may be reduced to the point where its social marginal product becomes equal to its unit real cost (exclusive of tax), i.e. where the fish rent (net income generated by fishing) is maximum. In this system, the fish rent is channelled through the tax, a feature which leaves open the determination of the ultimate beneficiary of this net income. However, taxation is seldom used as a management tool in fisheries. In many countries, fishing effort is subsidised, which means a negative taxation, thus favouring an increase rather than a decrease in fishing effort (OECD, 1997).

Payments offered to vessel owner to decommission their fishing unit are often thought of as a way to rationalise the size of fishing fleets. In addition, it can also be thought of as a form of subsidizing of the industry. The use of subsidies for vessel decommissioning was questioned by Munro (1998) as they may alleviate the overcapacity problem in the short term, but only at

[5] The efficiency of an eco-label as a fisheries management tool depends *inter alia* on the product differenciation it generates on the market, i.e. on its recognition by consumers and on their willingness to pay for the characteristics which it certifies.

[6] Symmetrically, according to the theory of social cost, the producer of a positive externality should be subsidised. This theory provides the theoretical background for ths subsidising of "environmental friendly" farming methods which protect the quality of a landscape for instance.

the cost of intensifying the problem in the longer term if the incentives to invest are not resolved. Weninger and McConnell (2000) and Guyader, et al. (2003, 2004) support the notion that decommissioning schemes fails to address the underlying externalities in fisheries that create overcapitalisation. Clark, Munro and Sumaila (2004) further conclude that decommissioning schemes can benefit conservation, provided that the schemes are unanticipated by the vessel owners. Hannesson (2004) considered that since the justification of vessel decommissioning lies in the realisation of expected future benefits, it may be a reasonable condition that programmes are ultimately funded by those remaining in the fishery (i.e. no public subsidies should be involved). Some form of cost recovery structure should therefore be implemented to justify the use of public funds for this purpose (Schrank et al., 2003). The proceedings of the NMFS workshop (forthcoming) on the buyback programs concluded that they are only a second-best solution to fishery management where defined property rights or other economic instruments are not in place and that access regulation are needed. It should not be a long-term application (e.g. use for short-term recovery plans, or to deal with problems of sunk costs during a shift in a management system) and industry participation is vital to improve transparency and legitimacy, and lower the cost of programmes.

Just like administrative methods of access regulation, rights-based methods consist in issuing a limited number of fishing permits. The specific feature of rights-based methods relies in the so-called “transferability” of these individual permits, which means that they may be traded on a market at prices fluctuating according to supply and demand. This possibility conveys an explicit money value to the fishing permits, which thus become an asset in the account books of the fishing firms, just like fishing boats. These assets may be used, for instance, as a security in case of a bank loan (Davidse, 2000). Rights-based methods in fisheries management belong to the same family of management tools as pollution permits in environmental management. Their doctrinal background may be found in Coase’s critical analysis of the pigovian theory of social cost, which stresses the fact that externalities are merely a consequence of incomplete and loosely defined use rights concerning production factors (Coase, 1960).

At a microeconomic level, transferability enables each firm to adjust its level of activity according to its own interests: a firm may increase or diminish its share in the total rights of access to the resource by buying or selling rights[7], just like a firm in the farming industry may change its production possibilities by trading cultivable land. Just as the equilibrium value of a cultivable land is normally equal to the capitalisation of land rent generated by its cultivation, the equilibrium value of fishing rights is normally equal to the capitalisation of fish rent (corresponding to the period of validity of the right). Therefore, the opportunity cost of fishing rights leads their owners to integrate resource scarcity in their fishing behaviour: just as in the case of taxation, a fishing firm will normally develop its fishing effort (and buy the corresponding volume of rights) up to the point where the social marginal cost of fishing effort is equal to its real cost (exclusive of rights opportunity cost). In this case, fish rent is incorporated in the price of rights, a feature which means that the conditions of first allocation of rights are critical as regards wealth distribution[8].

Rights-based methods are often considered as more conform to economic liberalism than taxation methods. While the immediate consequence of a tax for fishers is mainly an

[7] Or eventually by renting them.

[8] But not as regards economic efficiency, according to Coase (1960).

additional fishing cost without any clear individual counterpart[9], introducing transferable fishing rights allows each fisher to incorporate into his personal heritage rights of access to the resource which are socially recognised, have a value fixed by the market and are freely tradable[10]. However, in such a mechanism, public authorities still have a lot to do. Their job is to define clearly the rights of access, to adjust their total volume, as well as the time-and-space schedule of their emission to the productivity of fish stocks, to enforce them, and possibly to regulate their market.

As regards the debate between administrative and economic methods of management, the main pros and cons may of each method are summed up in the following table (the cons of one method being pros of the alternative method):

Tableau 1. administrative v. economic methods of regulation of access to fish stocks

Administrative methods: main critics	Economic methods: main critics
• do not provide satisfactory criteria for the selection of operators, specially as regards efficiency	• expected results in terms of economic efficiency will not be reached if market signals are inadequate (price distorsions), or if operators do not respond to these signals
• unable to adapt the share of each operator to its specific production conditions	• often charged of negative social consequences (loss of jobs, capital concentration, uncontrolled distributional consequences).
• do not adapt easily to technical innovations	

Source: Boncoeur (2003)

3 The control variable criterion

Fisheries management tools, and more specifically access regulation tools, may also be classified according to the control variable on which they rely.

The problem of the control variables in the fishing industry is complicated by the nature of the resource. Contrasting with the situation that prevails in farming or forestry industries, fish resources usually have a “fugitive” character, i.e. are mobile and difficult to quantify. As a result, in most cases stocks cannot be directly control variables, and access rights cannot be directly defined in terms of stocks. in the case of sedentary species such as shellfish or seaweeds, controlling individual access to the resource may be based on territorial use rights. In other situations (i.e. the most frequent case in sea fisheries), control of individual access relies on an input basis (control of individual fishing effort), or on an output basis (control of individual catches[11]). The use of the word “licences” is frequently limited to the case of input-based controls of individual access; while output-based controls are usually termed individual quotas (see for instance Copes, 1997).

[9] However, if the tax is introduced in a free access fishery, the additional cost borne by fishers because of the tax will be only temporary: after a new equilibrium position is reached, total fishing cost (exclusive of tax) will be equal to the total value of landings, just as in the former tax-free equilibrium (but at a lower level of effort, and a higher level of biomass).

[10] In practice, some restrictions may be imposed to the trade of fishing rights.

[11] Or more often, in practice, of individual landings, which may create a serious bias in case of the use of poorly selective gears (problem of discards).

The main problems met in implementing these two methods are summarised in the table below:

Table 2. Input controls v. output controls

Input control : main problems	Output controls : main problems
• Multidimensional character of fishing effort, and usually high substituability between inputs.	• Controlability of landings
• Permanent evolution of parameters of fishing effort due to technical progress.	• Possible increase in discards in case of poor interspecific and intraspecific gear selectivity

Source: Boncoeur (2003)

The relative importance of these problems varies according to the specific conditions of each fishery. As a consequence, the optimal control method is not necessarily the same in all fisheries.

4 Access regulation instruments: a synthesis.

The table below combines the classification of access regulation tools according to both criteria of control method (administrative v. economic methods) and control variable (input v. output).

Tableau 3. Typology of fisheries management tools regulating individual access to fish stocks

Control method		Control variable	
		A. Fishing effort	B. Catches
1. administrative (command and control)		Non transferable limited entry licenses	Non transferable individual quotas
2. economic (incentives)	2.1. Taxes	Inputs taxes (Payments to decommission vessels)	Landings taxes
	2.2. Rights-based methods	Transferable limited entry licenses	Transferable individual quotas

Glossary :

- Transferable = tradable on a market.
- Limited entry licenses = individual fishing permits accompanied with a *numerus clausus* and limitations concerning individual fishing power and fishing time.
- Individual quotas = individual shares of a TAC.
- Inputs taxes = taxes based on various components of fishing effort (such as gasoil consumption, time at sea...).

The six possible cases described by the table are not equally met in practice. As noted before, taxation is seldom used as a management tool in fisheries. Concerning licenses and quotas, it appears that in the majority of real world cases, limited entry licenses are non transferable, while individual quotas are transferable - or become so after a transitional period - (OECD, 1997).

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