

**The XIth Annual Conference of the European Association of Fisheries
Economists
Dublin 6th – 10th April 1999**

**Costs of Fisheries Management:
Theoretical and Practical Implications**

Ragnar Arnason

Department of Economics
University of Iceland
Fax: 345-552-6806
E-mail: ragnara@hi.is

Abstract

This paper considers the costs of fisheries management. In reviewing the costs of fisheries management in Iceland, Newfoundland and Norway this study, as well as information from other countries, indicates that fisheries management costs are generally quite substantial relative to the value of landed catch.

It follows that the common practice of ignoring fisheries management costs in the derivation of optimal fisheries rules and the actual design of fisheries policy is generally erroneous, perhaps seriously so. The necessary modifications of the usual fisheries optimality conditions are then derived and the quantitative implications discussed.

The existence of significant fisheries management costs obviously raises the issue of the most efficient provision of these services. How much fisheries services should be provided, by whom and who should pay the cost? The last part of the paper deals with this issue. Although not many general results seem to be readily available, it appears that efficiency would generally be served by a diminished role of central government in this area.

Introduction

The classical theory of fisheries economics from Gordon in 1954 to Clark and Munro in 1982 and to the present is *inter alia* concerned with identifying harvesting paths that maximize the present value of net benefits flowing from the fish resources. This theory has nevertheless mostly ignored the cost of implementing these harvesting paths, i.e. the cost of fisheries management.¹ This omission would be of little consequence if fisheries management costs were negligible. In the alternative case, where fisheries management costs are significant, it may lead to seriously biased fishery policy recommendations.

This paper explores these issues. It begins by reviewing the available evidence on fisheries management costs. It turns out that these are indeed quite high relative to the value of landings. Given this, the paper proceeds to examine the theoretical implications of fisheries management costs. Not surprisingly, it is found that the existence of significant management costs discourages management and consequently leads to lower optimal biomass levels and higher optimal fishing effort.

The available empirical evidence suggests wide differences in the efficiency of fisheries management services provision across fishing nations. The third and last section, of the paper is devoted to exploring this issue.

The costs of fisheries management

It is becoming increasingly more apparent that fisheries management services are far from being costless. In fact, in most countries for which data are available the cost of these services constitutes a substantial part of the gross revenues of the fishing industry. Thus, in the Commonwealth fisheries of Australia the expenditure on fisheries management has been estimated at 28 million Australian dollars in 1991/92 while the total value of landings was about ten times that (273 million).² Fisheries management costs in the United Kingdom are reported to have been about 45 million UK pounds in 1996/97, which corresponds to about 7.5% of the value of all landings

¹ Noteworthy exceptions are Sutinen and Anderson (1985) and Anderson and Lee (1986) although these papers apparently have not had much impact.

² Hundloe (1992). It should be noted that in addition to the Commonwealth fisheries there are fisheries under the jurisdiction of the individual Australian states. These are much

of fish.³ The federal and state governmental expenditure on the fisheries of the United States has been estimated at about 1 billion US dollars annually while the average annual value of landings of fish in the United States was 3.5 billion dollars in the period 1991-96.⁴ Thus, according to these estimates, which are fairly typical for major fishing nations around the world, fisheries management costs may range from 5-30% of the landed value of catch.

The above estimates are based on readily available, aggregate data. A fairly detailed examination of the cost of fisheries management services provided by the government of Iceland, Norway and Newfoundland that I have recently conducted with my collaborators, R. Hannesson and W. Schrank (Arnason et al. 1999), nevertheless broadly confirms this pattern. It reveals fisheries management costs in these countries ranging from a minimum of some 3% of landed value in the case of Iceland to some 10% in the case of Norway and up to 25% in the case of Newfoundland. Let us now briefly review the main results of this study.

The fisheries of Iceland, Norway and Newfoundland are broadly similar. All three are North-Atlantic fishing nations. They exploit very much the same species of fish of which demersals primarily cod and other gadoids are most important. They employ almost identical technology in harvesting and processing and the composition of their fishing fleets are similar. Fisheries is a major industry in all three countries. Although the Norwegian economy is much larger than that of Iceland and Newfoundland and much less dependent on fisheries, large parts of Norway, namely northern Norway⁵, is just as fisheries dependent as Iceland and Newfoundland.

Our estimates of fisheries management costs was limited to government expenditures on fisheries management. For this purpose we carefully reviewed the respective governments' expenditures on everything related to fisheries for the years 1990 to 1996. These expenditures are many and varied. For instance they include the running of lighthouses, the provision of weather forecast services, the

more important than the Commonwealth fisheries; the total landed value of Australian fisheries was 1170 million Australian dollars in 1990/91.

³ Hatcher and Pascoe (1998). It should be noted that a large part of these landings are actually by foreign vessels fishing in distant waters. So the cost of fisheries management relative to the domestic fishery would be substantially higher.

⁴ These estimates were done by Milazzo, here cited from Andersen, Sutinen and Cochran (1998). These figures may cover more a wider range of expenditures than figures cited for Australia and the United Kingdom.

⁵ The area to the north of Trondheim.

implementation of safety measures at sea, product quality control, the operation of nautical schools and other educational programmes in addition to what is usually regarded as fisheries management expenditures. Faced with this we adopted the following definition of fisheries management expenditures:

Definition: Fisheries management expenditures

Fisheries management expenditures are all expenditures on activities that are necessary to develop and operate the existing fisheries management system.

This definition clearly excludes all expenditures on fisheries that have no particular connection with the actual management of these fisheries such as the items discussed above. It includes on the other hand all research deemed necessary for the management of the fisheries including stock assessment and forecasting, economic estimation and modelling etc. It also includes the cost of designing, implementing and modifying the fisheries management system and, perhaps most importantly, the cost of enforcing the fisheries management rules.

Note that in totally unmanaged fisheries, such as were common 3-4 decades ago and can still be found around the world, the cost of fisheries management according to this definition would be zero but the government could still be spending a good deal of money on fisheries services such as harbour facilities, lighthouses, education etc. According to this definition the main categories of fisheries management costs are:

- Research
- The design and implementation of fisheries management rules.
- Enforcement

Research generates the information necessary for (a) the design and implementation of the appropriate fisheries management system and (b) fisheries management decisions under a given fisheries management system such as the setting an appropriate TAC, imposing appropriate mesh restrictions, the number of fishing licences to allocate etc. Clearly, this requires both biological and economic research. Historically, however, most fisheries management research has been biological.

The design and implementation of fisheries management rules is usually conducted (or led) by the Ministry of Fisheries or a corresponding government agency. This is essentially a political and administrative function that uses research as an input and is generally not very expensive as such, at least not compared to the research itself.

Enforcement is generally the most expensive part of fisheries management. This typically includes surveillance and enforcement activities both at-sea and on-land. The at-sea enforcement activity requires the use of patrol vessels and airplanes and sometimes even on-board-observers all of which are quite costly. On-land enforcement activities involve the assessment of the volume of catch most often at the point of landing, inspection of vessels, gear and catches, double checking at processing, retail and export points etc. In addition to at-sea and on-land monitoring, the administrative and judicial procedures necessary for the processing of violations are generally quite costly.

In assessing fisheries management costs in Iceland, Norway and Newfoundland every attempt was made to adhere to common definitions of cost categories in order to make the resulting figures comparable. Different reporting and accounting practices in the three countries make it impossible, however, to accomplish this fully. One particular problem is that the highest management level for the fisheries in Newfoundland is the federal government in Ottawa. Unfortunately, however, we did not have usable data on these administrative costs or, more precisely, the fraction attributable to the Newfoundland fisheries. Therefore, while local Newfoundland administrative costs are included, the corresponding fisheries administrative costs incurred by the Ottawa government are omitted from the Newfoundland figures.

Figure 1 shows the landed value of the catches in all three countries. During the period in question, 1990-1996, Norway had the highest landed value or over 1000 million USD on average. Iceland is next with some 800 million USD on average and Newfoundland a distant third with just over 200 million USD on average. While the landed values of Iceland and Newfoundland has been relatively steady during the period of study, the landed value in Norway shows a clear upward trend. This is explained by the strong herring and cod stocks in the Barents Sea during the period in question.

Figure 1 Landed value of the catches in Iceland, Norway and Newfoundland (US\$)

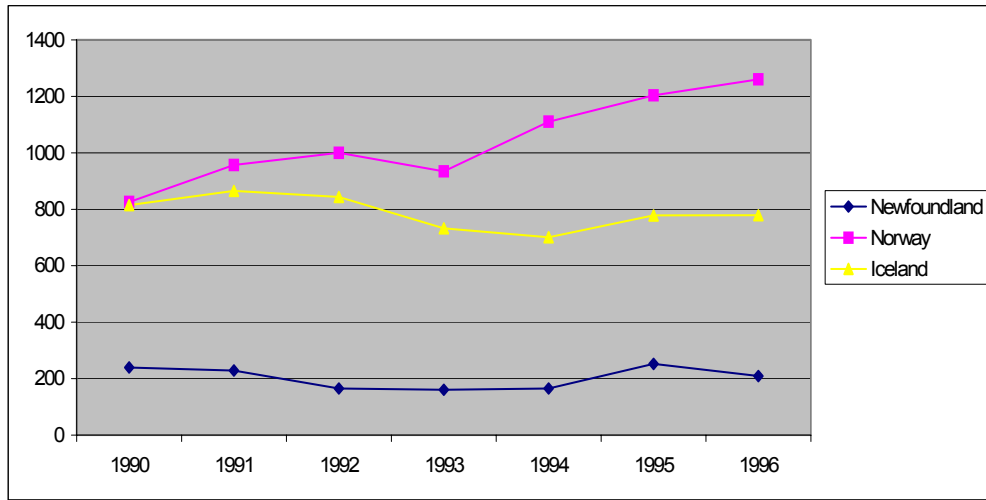
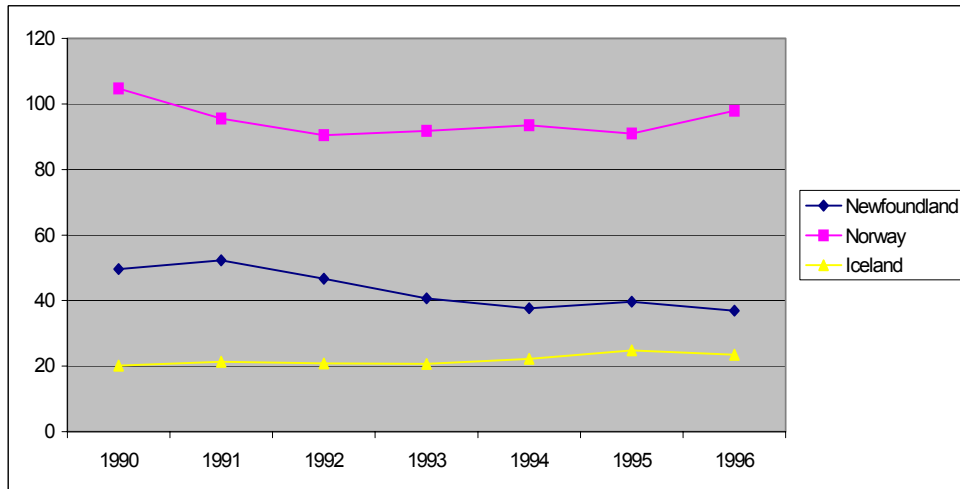


Figure 2 illustrates fisheries management costs in the three countries in million USD. The management costs are by far the highest in Norway and lowest in Iceland with Newfoundland in between.⁶

Figure 2 Fisheries Management Costs Iceland, Norway and Newfoundland (US\$)



It is interesting to note that the fisheries management costs are fairly stable over time, much more stable than the value of landings. Notice also that while the

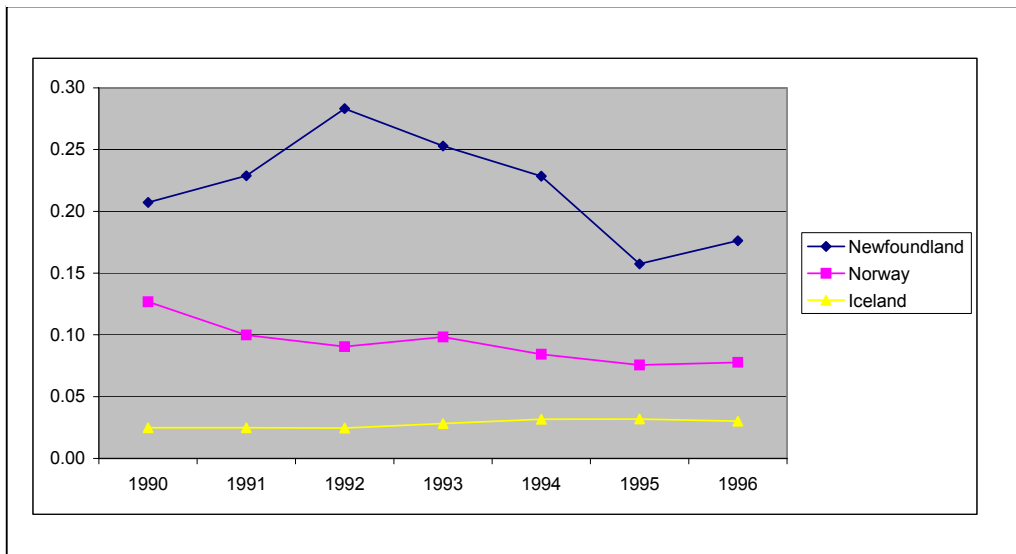
⁶ It should be noted here that the management cost data for Newfoundland are for the fiscal year that begins on April 1 every year. For this reason they are not fully comparable to the Icelandic and Norwegian figures.

Icelandic fisheries management costs exhibit a small upward tendency the Newfoundland costs show a clear downward trend. The average management costs in the three countries during the seven years in question are given in the Table 1.

Table 1 Average fisheries management costs 1990-96 (M. USD)	
Country	Costs (M.USD)
Iceland	21,9
Norway	95,0
Newfoundland	43,4

The absolute level of fisheries management costs is not very informative, however. The purpose of fisheries management is to increase fisheries rents. The pertinent comparative measure, therefore, is fisheries management costs relative to fisheries rents generated. Unfortunately, we do not have reliable estimates of fisheries rents generated in the three fisheries. What we can provide, however, is fisheries management costs as a fraction of the landed value of catch. This is illustrated in

Figure 3 Fisheries Management Costs as a Fraction of the Landed Value of Catch



Measured as a fraction of the landed value of catches, fisheries management costs are by far the highest in Newfoundland and lowest in Iceland. Norwegian fisheries management costs are in between but still more than twice as high as in Iceland. In Newfoundland fisheries management costs have ranged between 15 and 28% of the landed value of the catch and exhibit a slight downward trend over the period in question. In Norway, management costs as a fraction of the landed value of catch has declined from almost 13% to the current level of 8%. In Iceland, the corresponding fraction has been about or just under 3% with a slight increasing trend.

These high fisheries management expenditures raise the question of whether these costs are justified? The purpose of fisheries management is to increase the net economic benefits from the fisheries. Do the fisheries management in these three countries really generate fisheries rents in excess of the expenditures? In the case of Iceland who operates an efficient fisheries management system, the answer is likely to be affirmative. For Norway and in particular Newfoundland this is much more doubtful. In fact, for Newfoundland it may be questioned whether the maximum attainable fisheries rents can actually exceed the 25-30% of the landed value of the catch which the cost of fisheries management has sometimes reached.

In spite of widely different total expenditures, the relative size of the main components of fisheries management is remarkably similar in the three countries. The most expensive single fisheries management activity is monitoring and enforcement at sea in all three countries. In Iceland and Norway this is done by the coast guard while in Newfoundland the Department of Fisheries has its own enforcement and monitoring service. Norway spends the equivalent of USD 50 million annually on Coast Guard activities which is more than twice the amount spent in Newfoundland with Iceland spending only about 1/5 of the Norwegian cost. The high ocean enforcement expenditures in Norway may to some extent be explained by its much larger exclusive economic zone than that of Iceland or the Canadian zone around Newfoundland.

The second largest cost item in all three countries is marine research. In Norway the expenditure on marine research is just slightly above one half of the expenditure on enforcement at sea. In Iceland, marine research is almost as costly as the coast guard expenditures. In Newfoundland the marine research expenditures have also

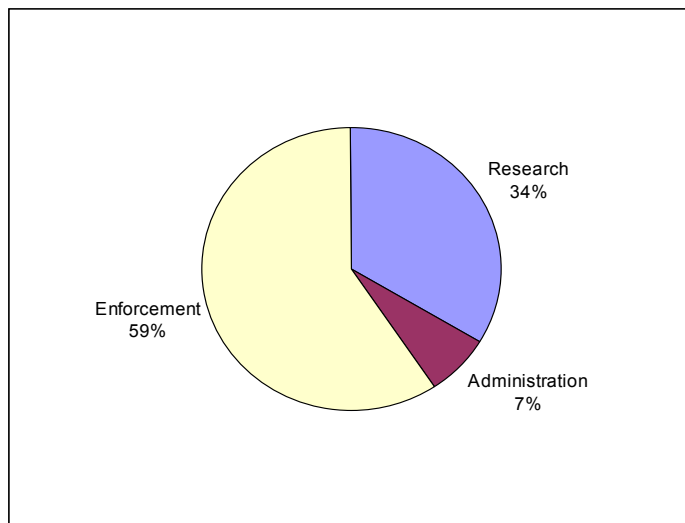
been almost as high as the coast guard expenditures but have declined in recent years.

The third most important cost category is enforcement of fisheries management rules by the Directorates of Fisheries in Iceland and Norway and the regional administration in Newfoundland. This activity covers both enforcement on land and at sea excluding coast guard activities. Again this cost is by far the highest in Norway and lowest in Iceland, where the costs are about 1/5 of the Norwegian costs.

The policy function, i.e. formulation and implementation of fisheries management, in one word the administration of the fisheries management system appears to be the least expensive in the three countries although it should be remembered that the data for Newfoundland is imperfect in this respect. Taking mainly into account the appropriate parts of the cost of the Ministries of Fisheries the costs in Norway and Iceland appear to be similar or about 3 million USD per year in each country. This corresponds to 3 and 7% of total fisheries management expenditures in each country respectively.

The following pie-chart gives the average breakdown of the fisheries management expenditures in the three countries according to main cost categories discussed above namely (i) research, (ii) Policy and administration and (iii) enforcement of fisheries management rules.

Figure 4 Fisheries Management Cost Breakdown: Iceland, Norway, Newfoundland



As already mentioned, in spite of widely different fisheries management expenditures, the expenditures on these categories as a percentage of overall fisheries management expenditures is remarkably constant across the three countries.⁷ Therefore, it may not be unreasonable to expect that in fisheries management systems of a similar nature, enforcement costs would account for about 3/5 of total expenditures, research for about 1/3 and general administration for the rest.

Fisheries models with management costs

In the preceding section it was established that fisheries management costs are indeed quite significant as a fraction of gross landed value of the catch. This suggests that in designing rent maximizing fisheries policies it is necessary to take full account of the costs necessary to implement such policies.

Traditional fisheries models⁸ from Gordon (1954) through Smith (1968), Clark and Munro (1982) and to the present derive optimal fisheries policies on the implicit assumption that management costs are zero. Since it has now been established that management costs, in fact, constitute a substantial fraction of the landed value of the catches, it follows that these models are not adequate as a basis for fisheries policy. This is all the more serious for the fact that many applied fisheries models specifically designed to provide management advice have adopted the same assumption, namely that management costs are immaterial. This certainly applies to virtually all biological models, many of which actually ignore economic considerations altogether, (see e.g. any ICES working group TAC recommendation) as well as most empirical economic models (Helgason and Olafsson 1988, Arnason 1990, Placenti et al. 1992 and Baldursson et al. 1996).

These observations suggests the need to modify fisheries models to include fisheries management costs in the appropriate way. Theoretical models are the natural place to start this revision. After all, these serve as the blueprint for most empirical models which will then have to be modified accordingly. At this stage, however, it may be in order to point out that the inclusion of fisheries management costs in empirical

⁷ Percentage standard deviation is about 10%.

⁸ Not to mention biological fisheries models.

fisheries models requires the estimation of one additional functional relationship, the fisheries management cost function that will be further discussed below.

To illustrate the modifications to the traditional fisheries models that are necessary to account for fisheries management costs we will proceed in terms of the very simplest of aggregative fisheries models.

Let instantaneous profits (rents) of the (aggregate) harvesting activity be represented by the profit function:

$$(1) \quad \Pi(y,x),^9$$

where y represents the instantaneous rate of harvest and x the level of biomass. This function is taken to be increasing in both its arguments and concave with $\Pi_{y,x} > 0$.

The biomass evolves according to the familiar rule:

$$(2) \quad \dot{x} = G(x) - y,$$

where $G(\cdot)$ is the usual dome shaped biomass growth function.

Within this modelling framework, standard fisheries economic theory characterizes competitive (unmanaged) utilization of the resource by the behavioural rule:

$$(3) \quad \Pi_y(y^c, x) = 0, \text{ all } t,$$

where y^c represents the competitive value of harvest given biomass x and t denotes time. For later use we define the competitive harvesting rule implied by expression (3) as

$$(4) \quad y^c = Y(x),$$

which on the assumptions about the shape of $\Pi(y,x)$ is monotonically increasing in biomass.

⁹ The reader will appreciate that prices and other exogenous variables are suppressed in this formulation of the profit function.

According to standard fisheries economics theory, optimal utilization of the fishery should proceed according to the set of equations:

$$(5.1) \quad \Pi_y(y,x) - \lambda = 0,$$

$$(5.2) \quad \dot{\lambda} - r \cdot \lambda = - \Pi_x(y,x) - \lambda \cdot G_x(x),$$

$$(5.3) \quad \dot{x} = G(x) - y,$$

where λ represents the shadow value of biomass and r is the rate of discount. It should be noted that provided the shadow value of biomass, λ , is nonzero, the basic optimal behavioural rule, namely (5.1), is different from the one for the competitive fishery.

The optimal equilibrium equations corresponding to the Clark-Munro (1982) conditions are:

$$(6.1) \quad G_x + \Pi_x / \Pi_y = r,$$

$$(6.2) \quad G(x) - y = 0,$$

where the term $\Lambda \equiv \Pi_x / \Pi_y$ represents what Clark and Munro refer to as the "marginal stock effect". Given that biomass contributes positively to profits, as we have assumed, this term is positive inducing more biomass conservation and therefore less fishing effort than would otherwise be the case.

Equation (6.1) is the fundamental behavioural rule in optimal equilibrium. For easier comparison with the competitive rule, i.e. (3), it is convenient to write this rule as:

$$(6.1') \quad \Pi_y = \Pi_x / (r - G_x).$$

Comparison with the competitive rule as expressed in (3) above shows that competitive utilization can only be optimal if $\Pi_x = 0$, i.e. biomass has no effects on profits.

Let us now turn our attention to enforcement costs. In this simple model the subject of enforcement can only be the rate of harvest, y . Implementing a harvest rate that is different from what individual agents would like is presumably costly. The precise relationship is, of course, a matter for empirical investigation. In the absence of such studies it seems reasonable that the cost of enforcement depends positively on the (absolute) difference between the harvest rate imposed by the management and the harvest rate desired by the fishing industry. Now, the desired level of harvest by the industry must be y^c , i.e. the competitive harvest level defined in (4) above. Given this we may define the enforcement cost function as a function of harvest rate and biomass as follows:

$$(7) \quad C_2(y-Y(x)),$$

where the notation $C_2(\cdot)$ is to remind us that this is the management cost function and not the harvesting cost function. In accordance with the above discussion the management cost function has the properties:

$$C_2(0) = 0,$$

$$(y-Y(x)) \neq 0 \Rightarrow C_2(y-Y(x)) > 0 \text{ and vice versa.}$$

Moreover, in what follows we will for mathematical convenience assume that the $C_2(\cdot)$ function is sufficiently smooth to allow differentiation and sufficiently convex to guarantee a unique profit maximum.¹⁰ An example of the management cost function is illustrated in Figure 5.

¹⁰ The alternative case where there may be multiple equilibria is interesting but will not be pursued here.

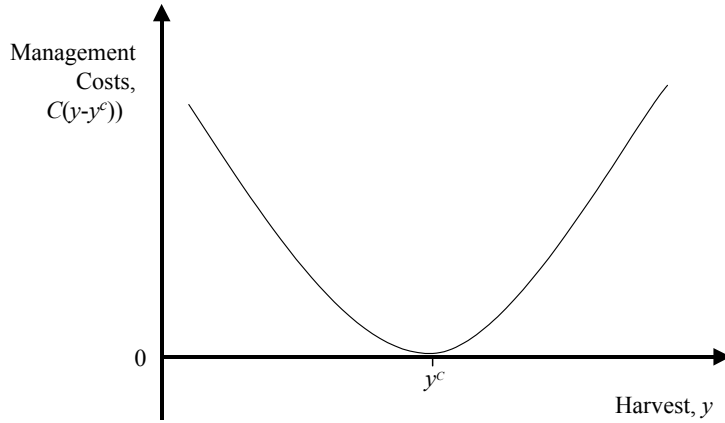


Figure 5 The Management Cost Function

Actually, it is not unlikely that the management cost function depends not only on harvest and biomass but also on the fisheries management system in which case it could be written as:

$$C_2(y-Y(x),Z),$$

where Z is an index referring to different management systems. This formulation obviously raises some intriguing possibilities that are outside the scope of the current paper.

Given the management cost function discussed above, the revised, and hopefully more realistic, instantaneous profit function is:

$$\Pi(y,x) - C_2(y-Y(x)).$$

Maximizing the present value of these profits then yields the revised necessary conditions corresponding to (5.1)-(5.3):

$$(8.1) \quad \Pi_y(y,x) - C_2'(y-Y(x)) - \lambda = 0,$$

$$(8.2) \quad \dot{\lambda} - r\lambda = - \Pi_x(y,x) - C_2'(y-Y(x)) \cdot Y_x(x) - \lambda \cdot G_x(x),$$

$$(8.3) \quad \dot{x} = G(x) - y.$$

Note that marginal management costs, $C2'$, play a role in both equations (8.1) and (8.2). Thus, it is clear that the corresponding expressions of traditional fisheries economic theory, namely (5.1) and (5.2) are not appropriate as a prescription for the optimal fisheries policy. What is the difference? The behavioural equation (8.1) includes an additional term, $C2'(y-Y(x))$ reflecting marginal management costs. This term is negative provided, of course, that enforcement is costly and the policy is to maintain the harvesting rate below the competitive level both of which seem self-evident. The impact of management costs therefore is the opposite of the shadow value of biomass. It discourages harvesting restraint and, consequently, biomass conservation and stock rebuilding. This of course is most intuitive. If there is a special cost associated with restraining harvest, this cost will, of course, work against such restraint.

The revised equilibrium conditions are:

$$(9.1) \quad G_x + (\Pi_x + C2' \cdot Y_x) / (\Pi_y - C2') = r,$$

$$(9.2) \quad G(x) - y = 0,$$

where the term $\Gamma \equiv (\Pi_x + C2' \cdot Y_x) / (\Pi_y - C2')$ is the "new" marginal stock effect when there are management costs. Notice that on our earlier assumptions, namely that the management problem is to restrain harvest, the marginal stock effect under management costs is unequivocally smaller than the traditional marginal stock effect which assumes no management costs. In other words: $\Gamma < \Lambda$, where Λ , it will be recalled is the Clark Munro marginal stock effect defined by $\Lambda \equiv \Pi_x / \Pi_y$. Thus, remembering that the marginal stock effect works in the direction of more biomass conservation and less harvesting, it is clear that when there are management costs, the optimal equilibrium biomass will be less and fishing effort greater than would otherwise be the case.

Rewriting (9.1) in the form of (6.1') above we obtain a more convenient comparison with the optimal harvesting rule under management costs, the traditional harvesting rule and the competitive harvesting rule.

$$(9.1') \quad \Pi_y = \Pi_x / (r - G_x) + C2' \cdot (Y_x + r - G_x) / (r - G_x).$$

Now, the first term on the right hand side of (9.1) is precisely the traditional harvesting rule. The second term on the right hand side of (9.1), $C_2' \cdot (Y_x + r - G_x)/(r - G_x)$, is the correction due to harvesting costs. This would be negative provided, of course, that $(r - G_x) > 0$, which is an important stability condition.¹¹ Thus, the message of (9.1') is that in optimal equilibrium the marginal profits of harvest should be less and therefore fishing effort greater and biomass smaller than that demanded by the traditional models. Moreover, as is made clear by (9.1), the difference increases monotonically with the marginal cost of management, C_2' .

This raises the question whether there exists a level of management costs such that the best equilibrium option is not to manage at all. Equation (9.1') shows that this is indeed so. According to this equation, a necessary condition for this to happen (i.e., $\Pi_y = 0$) is that:

$$(10) \quad -C_2'(0) \geq \cdot \Pi_x(G(x), x)/(Y_x(x) + r - G_x(x)),$$

where the equilibrium condition, (9.2) has been imposed. Equation (10) merely states that if in equilibrium the marginal cost of fisheries management at the zero fisheries management level, exceeds the marginal contribution of biomass to profits suitably normalized then management is not worth while.

An alternative and perhaps more transparent condition is suggested by (8.1) namely:

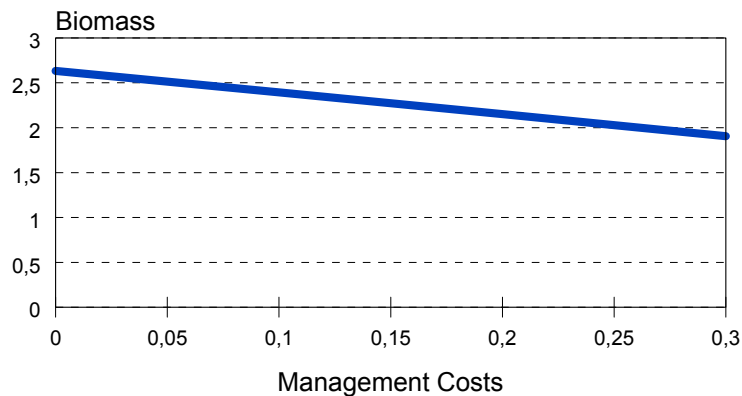
$$(11) \quad -C_2'(0) \geq \lambda,$$

i.e., the marginal cost of management exceeds the shadow value of biomass.

Now that we have seen that the traditional fisheries models, by not taking account of fisheries management costs, actually produce misleading policy recommendations we may wonder about the magnitude of the error. Is it negligible or is it significant? A general answer to this question cannot, of course, be provided. It obviously depends on the empirical facts of each fisheries situation, including the size of the management costs. However, strictly for illustrative purposes, I have calculated the impact of a range of management costs on the optimal equilibrium biomass for a very simple fishery. The results of this exercise are illustrated in Figure 6.

¹¹ Clearly, $(r - G_x) \leq 0$ could not represent an equilibrium in the traditional fishery model.

Figure 6 Optimal Equilibrium Biomass as a Function of Management Costs



The results reported in Figure 6 suggest that the impact of fisheries management costs on optimal equilibrium biomass may be quite significant. Thus, as indicated in the diagram, management costs of some 10% of landed value may lead to about 9% reduction in the optimal equilibrium biomass level. Presumably the effect on optimal adjustment paths will be of similar magnitude.

Efficient provision of fisheries management

It was established above, more precisely Section 1, that actual fisheries management costs are (i) quite substantial, (ii) vary widely between countries and (iii) there does not appear to be much relationship between the expenditures on fisheries management and the economic productivity of the fisheries. These observations raise the question of efficiency in the provision of fisheries services. Is it possible to obtain better fisheries management services at the same cost or the same quality of fisheries management services at a lower cost? The wide difference between the cost fisheries management across similar fishing nations such as Iceland, Norway and Newfoundland without any apparent corresponding impact on the quality of the management certainly seems to suggest so.

The empirical investigation into fisheries management expenditures reported in section 1 revealed that the bulk of fisheries management expenditures are allocated to three categories of management activities.

- Research
- Policy and administration
- Enforcement

Traditionally, in most fishing nations, these management services have been provided by the government¹² and paid for by public funds.¹³ The question is: what is the problem, if any, with this particular arrangement for the provision of fisheries management services and can a better arrangement be suggested?

The first thing to notice is that the above three categories of management services are have very strong public goods features. Public goods have two key characteristics: non-excludability and non-rivalry in use (Samuelson 1969). Non-excludability means that it is difficult or impossible to exclude anyone from making use of the good if it exists at all. It immediately follows that it is difficult for individual agents to collect payment for non-excludable goods. Consequently, the market system has difficulties in providing such goods. Non-rivalry means that one agent's use of the good does not diminish its availability. It follows that it is not economically appropriate to charge for the good at all.¹⁴ Therefore, in the absence of judicious intervention, the market system is by no means a desirable provider of non-rival goods.¹⁵

Few real goods are pure public goods in the above sense. However, the enforcement of institutional restrictions (policing), scientific research and policy formulation and are often mentioned as prime candidates for pure public goods. Management systems, in general, also appear to be close to pure public goods. Almost by definition, no-one, at least no-one belonging to the group to which the management system applies, can be excluded from the services of the system. Moreover,

¹² It may be noted that in most countries, the government also provides a range of other services to the fishing industry including, port facilities, communication facilities, information, education etc. . These services, however, do not come under our definition of fisheries management services and are consequently not the subject of this study.

¹³ In recent years, several fishing countries notably New Zealand, Australia, Canada, Iceland and others have taken steps toward charging the fishing industry for some of the management costs.

¹⁴ Unless, there is a charging method that does not influence the use of the commodity.

¹⁵ For a further discussion on this and related matters see (Samuelson 1969, Atkinson and Stiglitz 1980)

someone's use of the management services generally does not significantly reduce their availability to others.¹⁶

It follows that fisheries management services and whatever is required to produce them— research, administration and enforcement — come close to being pure public goods. However, fisheries management services are perhaps more aptly characterized as a subset of public goods called club goods.¹⁷ Club goods are non-rival in use but excludable in the sense that those not belonging to the club can be excluded from their use (Varian 1992). Although, usually no-one is really excluded from the use of fisheries management services, it is clear that it is first and foremost the members of the fishing industry that are in a position to make use of these services. From this perspective, fisheries management services may be regarded as club goods.

The club good nature of fisheries management services is particularly clear in the case of enforcement. It is hard to imagine those not actually in the industry making use of fisheries enforcement services. The case of research is not as clear cut. While research management purposes of course primarily benefits those in the fishing industry, the research also may have direct use outside the industry. Thus, for instance, ecological research and fish stock assessment may be of interest to other biological research, conservationists and naturalists in general. Clearly, the same applies to other research. Thus, although fisheries management services have many of the characteristics of club goods they are clearly not pure club goods.

Now, it is well known (Samuelson 1969, Atkinson and Stiglitz 1980) that the market system will not provide public goods efficiently. When it comes to public goods, the market simply fails. It follows that it is not at all advisable to simply leave fisheries management services to the vagaries of the market system. This doesn't imply, however, that it is a necessarily a good idea to entrust the government with fisheries management services. There is also such a thing as a government failure (Wolf 1988). A priori, it makes little sense to replace a market failure with a government failure.

¹⁶ There may actually be some possibility of exceeding any system's management capabilities.

¹⁷ This is discussed at some length in Anderson et al. 1998.

Government failures

The fundamental reason for government failures is inappropriate incentives made worse by certain structural and technical difficulties.

In a perfect market situation, the costs and benefits of any action are borne by the decision maker himself and no-one else. The decision maker therefore faces the appropriate incentives. In the case of the government this is generally not so. Government decision makers¹⁸ are generally allocating other people's money. They are usually not held responsible for the misuse of this money or rewarded for its prudent use, at least not fully. In addition, government decision makers are subject to political control and influence. It follows immediately that the incentives facing government decision makers are quite far from being appropriate.

This unfavourable situation is made worse by a number of things. Most importantly, the groups receiving government services is often quite different from the group actually paying for these services. Consequently, which services are provided and which are not depends very much on the political power of the respective groups. In what follows we will refer to this as the problem of asymmetric distribution of costs or benefits or, more briefly, the asymmetry problem.

The asymmetry problem can be explained with the help of the simple allocation matrix in Table 2.

Table 2			
Distribution of Benefits and Costs amongst the Population			
		Distribution of Costs	
		Narrow	Wide
Distribution of benefits	Narrow	I	II
	Wide	III	IV

¹⁸ As distinct from government employees in general which face incentives not much different from those in the private sector.

When both benefits and costs are widely distributed (box IV in Table 2), most people benefit as well as pay. Therefore, there is a fair chance that the correct action will be taken in spite of poor government incentive structures.

Box IV in Table 2, however, is basically the only situation that warrants this level of optimism. If the benefits befall a large group and the costs are borne by a small group (box III), there is little chance that the action will be undertaken, even when aggregate benefits greatly exceed aggregate costs. The reason is that the interests of the narrow group of payees is much more focussed and can be better articulated via the political process than the interest of the wide group of beneficiaries that, moreover, usually stand to gain less individually than the payees lose. Therefore, projects belonging to box III are unlikely to be undertaken by the government even when they are socially beneficial.

The opposite applies to box II. Here the benefits befall a small group of people while the costs are distributed widely. Therefore government projects in this box stand a good chance of being carried out even when aggregate costs exceed aggregate benefits. As a result one may expect the government to provide an excessive level of such services.

Finally, we have box I where both the benefits and costs fall to narrow groups. Here everything depends on who these groups are and their relative political power. If both costs and benefits fall to the same group we are essentially back in the framework of box IV and there is not much of a problem. If the groups are different, however, which of course is quite likely, there is little chance of an efficient outcome. Given the inertia of government the most likely outcome is a stand-off, i.e. no action.

Rent seeking is a much discussed cause of government failures. Rent seeking is the activity where social groups spend resources trying to convince government decision makers to undertake actions beneficial to the group. It should be noted that the government actions included in boxes I and II in Table 2 are the prime field for rent seeking.

It is interesting to note that fisheries management services tend to belong to box II in Table 2.¹⁹ This box, it will be recalled covers government actions that are relatively likely to be undertaken even when aggregate benefits do not cover aggregate costs. Since fishery participants are generally a small fraction of the taxpayers, they will usually find it in their interest to seek government management services even if they are only marginally beneficial to themselves. Since on the other hand the marginal costs to the rest of the taxpayers are virtually negligible, they will have little incentive to resist. Therefore fisheries management services provided by the government are relatively likely to be oversupplied. Moreover, the smaller the fisheries sector relative to the rest of the economy the greater is this likelihood. This is a possible explanation for the very high fisheries management expenditures relative to the value of the landings seen in many countries.

There are several other factors that contribute to government failures, i.e. inefficiency in the provision of services. One is the difficulty in measuring the value of government output. Although this problem undoubtedly stems partly from the lack of government incentives to provide and develop the appropriate measures, a significant part of the problem is quite fundamental. The government is or should primarily be providing public goods. Since public goods cannot be sold in the market there is a fundamental problem in valuing them.

How to provide fisheries management services

The problem of inappropriate incentive structure which bedevils government production in general combined with asymmetric distribution of the costs and benefits associated with fisheries management renders the government somewhat unattractive as a provider of fisheries management services. At the same time the public goods nature of fisheries management makes the market system an unsuitable provider of these services. How, under these somewhat discouraging circumstances, should fisheries management services be provided? There are several alternatives some of the more pertinent of which are listed in the following table:

¹⁹ It may be noted, however, that in some circumstances the beneficiaries of fisheries management might be the general population.

Table 3 <i>Provision of Fisheries Management Services</i>			
Arrangements		Provider	Payee
1	Current arrangement	Government	Government
2	Cost Recovery	Government	Fishing Industry
3	Contracting out	Private sector	Government
4	Self-Management	Fishing Industry	Fishing Industry

The current arrangement for the provision of fisheries management services has already been discussed. It runs afoul of both main problems of government services; the incentive problem and the asymmetric distribution of costs and benefits problem.

The second arrangement, cost recovery, is somewhat more promising. Under this arrangement the government would still provide the management services but the industry, the recipient of these services, would have to pay the cost. This arrangement thus, to a large extent eliminates the problem of asymmetric distribution of costs and benefits. The industry as a whole no longer has an incentive to ask for management services whose costs exceed the overall benefits and the political sector little or no incentive to produce such services. This arrangement, on the other hand, does not avoid the incentive problem that is the other main source of inefficiency in government services. It may even be argued that the incentive problem is exacerbated. The reason is that the government agencies providing the management services now more or less automatically receive payments for their activities from the industry and do not have to compete with other agencies for limited government funds. Counteracting this potential deterioration of proper incentives, however, would be the fishing industry that is likely to exert some pressure to receive value for its payments.

The third arrangement, the contracting out of services, is in many respects the reverse of cost recovery. The private sector would provide fisheries management services according to contractual arrangements with the government, presumably on the basis of some sort of competitive bidding. The government would, however, pay the cost. This arrangement, obviously, goes a good way toward eliminating the incentive problem, although some incentive problems may be expected to remain in

the actual contracting out and supervision of the services. It does nothing however, to alleviate the problem of asymmetric distribution of costs and benefits.

Under the fourth arrangement, self-management, the industry takes care of the management services itself. This, obviously, more or less eliminates the government incentive problem and greatly alleviates the asymmetry problem. The government incentive problem is eliminated by removing the production of management services out of the public realm. Note, however, that the management services are still a public good to the members of the fishing industry, i.e. the "club" of fishing industry members. Within the club the management services still have to be provided in a centralized manner. as a result, incentive problems will pop up again. However, presumably they will be of smaller magnitude and therefore more manageable than those under the government. Also they can be counteracted by contracting out of some or all of the management services.

The asymmetry problem is alleviated by restricting the provision and payment of the management services to the club of fishing industry members. Within this club the allocation of benefits and costs will presumably be reasonably uniform. However, to the extent that fisheries management services are not a perfect club good there will still be asymmetry problems. There may for instance be outsiders that enjoy some of the benefits of the services. Notice, however, that the government is in a position to rectify this problem by the judicious purchase of research results, perhaps by the means of allocation of research and publication grants, from the researching agency. Moreover, within the club there may also be certain asymmetry problems. For instance, some of the members are undoubtedly more law abiding than others or smaller etc. As the incentive problem, however, these asymmetry problems are probable of much smaller and manageable magnitude than under the government.

It is important to realize that for self-management to be possible, the government has to provide the necessary legal framework. Most fundamentally, this has to contain a provision for the establishment of one or more industry associations to conduct fisheries management. One additional requirement is crucial. The legal framework must provide the association(s) with the clear right to charge each industry member for his proper share in the management costs. Otherwise, due to the public goods nature of the services, the free rider problem might become very difficult to deal with.

In summary: There do not appear to be any brilliant solutions to the problem of efficient provision of fisheries management services. Therefore, we are forced to choose between several imperfect alternatives. The current arrangement where government both provides and pays for fisheries management services does not appear to be among the most efficient available. The most efficient general arrangement seems to be the one we have called self-management. Under this arrangement the industry itself is responsible for the management services and is provided with the necessary tools (mainly legal) required to make the most of this responsibility. Both contracting out of fisheries management services and, in particular, cost recovery arrangements seem clearly superior to the current arrangement.

Conclusions

Examination of the fisheries management costs in Iceland, Norway and Newfoundland shows that their fisheries management costs can hardly be characterised as trivial. For these three countries, annual fisheries management costs since 1990 have ranged between less than 3% to 28% of the value of landed catch. More recently they have converged somewhat and now range between 3% and 18% of the landed value of catch. These results are in good conformance with corresponding but less well founded estimates quoted for other countries, notably Australia, US and the UK, where fisheries management costs have been reported to range between 7.5% and 30%.

This evidence has a number of significant implications. First, the assumption implicit in most fisheries models that fisheries management costs are insignificant is no longer tenable. These models will consequently have to be revised to take account of fisheries management costs in an appropriate manner. Theoretical analysis conducted in the paper suggests that fisheries management costs will generally lead to higher fishing effort and lower optimal biomass levels than suggested by the traditional models. Preliminary numerical calculations on the basis of a very simple, aggregative fisheries model suggest that the necessary modifications in the optimal fisheries policy may be far from trivial, even for relatively modest fisheries management costs. The inclusion of fisheries management costs in theoretical

fisheries models can even lead to the somewhat startling result that unmanaged, competitive fishing may even be the optimal fisheries policy for some fisheries.

For empirical fisheries modelling, the existence of significant fisheries management costs further complicates an already formidable task. It implies that in addition to the usual biological and economic modelling parts the fisheries management aspects of the industry need to be investigated and, preferably a fisheries management cost function estimated. Without such a relationship, there is no guarantee that the policy recommendations generated by the models are sufficiently close to the mark. In fact, without the inclusion of an explicit fisheries management cost function it is almost certain the policy recommendations will be biased.

A second major implication of the observation that fisheries management costs are indeed significant, is that is clearly worthwhile to critically examine the quality and value of the fisheries management services. Is the production of fisheries management services economically efficient? Can the same level of benefits be produced at lower costs? Judging from comparative data on Iceland, Norway and Newfoundland, where the country with the lowest management costs, namely Iceland, is probably the one who also manages its fisheries most efficiently the answer seems to be unequivocally yes.

There are actually strong reasons to expect large inefficiencies in the provision of fisheries management services, even in the absence of any empirical evidence. Fisheries management services are generally provided by the government. Their provision, consequently, is not generally subject to the discipline of market forces. The beneficiary of fisheries management services, moreover, is the fishing industry, a small group of people in most societies. The costs of fisheries management services, on the other hand, are generally borne by all taxpayers. The political dynamics of the situation, consequently, work in the direction of overprovision of fisheries management services, a state of affairs which seems to be confirmed by the experience of many fishing nations.

To substantially improve on this situation, it is probably necessary to completely reorganize the way in which fisheries management services are provided. When feasible, fishing industry self-management seems to offer the most promising alternative. Fisheries management cost recovery from the industry and/or contracting out of fisheries management services are also likely to improve matters significantly.

References

- Andersen, P., J.G. Sutinen and K. Cochran. 1998. Paying for Fisheries Management. Paper presented at the IXth Conference of the International Institute of Fisheries Economics and Trade, Tromsø, Norway, July 8-11, 1998.
- Anderson, L.G. and D.W. Lee. 1986. Optimal Governing Instrument, Operatin Level, and Enforcement in Natural Resource Regulation: The Case of The Fishery. *American Journal of Agricultural Economics*. August:678-90.
- Amason, R. 1990. A numerical model of the Icelandic Fisheries. In A.G. Rodrigues (ed.) *Operations Research and Management in Fishing*. Kluwer.
- Amason, R., R. Hannesson and W.E. Schrank. 1999. The Costs of Fisheries Management. Mimeograph, unpublished.
- Atkinson, A.B. and J.E. Stiglitz. 1980. *Lectures on Public Economics*. McGraw-Hill.
- Baldursson, F.M., A.D. Danielsson and G. Stefansson. 1996. On the Rational Utilization of the Icelandic Cod Stock. *ICES Journal of Marine Science* 53:643-58.
- Clark, C.W. and G.R. Munro. 1982. The Economics of Fishing and Modern Capital Theory: A Simplified Approach. In L.J. Mirman and D.J. Spulber (eds) *Essays in the Economics of Renewable Resources*. North Holland.
- Gordon, H.S. 1954. Economic Theory of a Common Property resource: The Fishery. *Journal of political Economy* 75:274-86.
- Hatcher, A. and S. Pascoe. 1998. Charging the UK Fishing Industry. Centre for the Economics and Management of Aquatic Resources, University of Portsmouth.
- Helgason, Th and S. Olafsson. 1988. An Icelandic Fisheries Model. *European Journal of Operations Research* 33:191-99.
- Hundloe, T.J. 1992. Cost Recovery for Managing Fisheries. *Industry Commission, Report No. 17*, 3 January 1992. Australian Government Publishing Service, Canberra.
- Placenti, V., G. Rizzo and M. Spagnolo. 1992. A Bio-economic Model for the Optimization of a Multi-Species, Multi-Gear Fishery. *Marine Resource Economics* 7:275-95.
- Samuelson, P.A. 1969. Pure Theory of Public Expenditures and Taxation. In J. Margolis and H. Guitton (eds.) *Public Economics*. St. Martins.
- Smith, V.L. 1968. Economics of Production from natural Resources. *American Economic Review* 64:1-14.
- Sutinen, J.G. and Andersen, P. 1985. The Economics of Fishereis Law Enforcement. *Land Economics* 61:387-97.
- Varian, H.R. 1992. *Microeconomic Analysis*. Norton

Wolf, C. Jr. 1988. *Markets and Governments: Choosing between Two Imperfect Alternatives*.
MIT Press.