Subsidies and Their Potential Impact on The Management of the Ecosystems of the North Atlantic

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Abstract

This paper provides both an estimate and assessment of subsidies in fisheries in the North Atlantic. The subsidies are estimated, on the basis of data taken from an OECD study and the Sea Around Us Project database, to be in the order of U.S.$ 2.0 to 2.5 billion per year. The assessment of the impact of the subsidies upon resource management and sustainability requires an examination of the underlying economics of subsidies in fisheries. There is general agreement, to which we subscribe, that fisheries subsidies do great harm by exacerbating the problems arising from the 'common pool' aspects of capture fisheries. Many economists, however, believe it that, if the "common pool" aspects of a fishery could be removed by, for example, establishing a fully-fledged property rights system, the negative impact of fisheries subsidies would prove to be trivial. This paper demonstrates that the aforementioned comfortable belief is unfounded. Fisheries subsidies can be seriously damaging, even if the 'common pool' aspects of the fishery are removed. There is also a widely held belief, among economists and government officials, that subsidies used for vessel decommissioning schemes, far from being harmful, actually have a beneficial impact upon resource management and sustainability. About twenty percent of the fisheries subsidies in the North Atlantic are directed towards these purposes. In this paper, we argue that these seemingly beneficial subsides can, in fact, be highly negative in their impact.

Introduction

The impact of subsidies upon the management of fishery resources, and the surrounding aquatic ecosystem, has been a source of rapidly increasing concern over the past decade. The Food and Agricultural Organization of the United Nations (FAO), early in the decade, maintained that a critical first step towards reversing the severe overexploitation of capture fishery resources is the removal of harmful subsidies in fisheries (FAO, 1992). The FAO continued examining the subsidy issue through the 1990's into the new millennium (see for instance, Steenblik and Munro, 1999). Along with the FAO, there has been a steadily increasing stream of studies on the impact of subsides on fisheries, that have been undertaken by national governments, e.g. the U.S.A (Congressional Research Services, 1995), by NGOs, such as the World Wildlife Fund for Nature (1997) and by other international organizations other than the FAO. Prominent studies have been undertaken for the World Bank (see Milazzo, 1998) and the Organisation for Economic Cooperation and Development (OECD). The OECD study (OECD, 2000), will be drawn upon heavily in this paper.

We commence the paper by attempting to define subsidies and provide a workable classification of subsidies. The classification adopted will be that provided by the OECD, because it is the OECD upon which we shall be most reliant for data on fisheries subsidies in the North Atlantic. Definitions and classifications will be followed by a review of the economic theory of the impact of subsidies in fisheries. With the economic theory in hand, we then attempt to provide a point estimate of the level of fisheries subsidies in the North Atlantic region as defined in the Sea Around Us Project (SAUP). In addition, we carry out an assessment of the subsidies.

Subsidies defined and classified

The OECD defines subsidies (or Government Financial Transfers – GFTs) as "the monetary value of government interventions associated with fisheries policies" (OECD, 2000, p. 129). This definition has the merit of breadth. To find a definition that is more precise, and workable, we turn to a recent article on the concept of subsidies, as applied to fisheries, by Schrank and Keithly (1999). These authors define a subsidy as "*any* government program that potentially permits the firm to increase its profits [through time], beyond what they would have been in the absence of the government program" (Schrank and Keithly, 1999, p. 156). We would only note that, to be included, are government programs, which increase firm profits indirectly, as well as those that increase firm profits directly.[1]

[1] The FAO, in a recent expert consultation pertaining to subsidies, includes in its definition the impact of the absence of correcting interventions in fisheries, on the part of resource managers (FAO, 2001). At a later point in the discussion, we shall examine the negative consequences of the "common pool" characteristics of capture fisheries. Governments can attempt to address the consequences of the aforementioned "common pool" characteristics through various management means. One approach is through the use of taxes. It can be shown easily that the fishers would collectively be better off without the taxes, than with. Consequently, if the only management option is taxes, then the government's refusal to implement taxes can be seen as constituting a positive subsidy for the fishers. However, there exist alternative management techniques that improve the profits of the fishers over the long run. A refusal on the part of government to implement such management measures could be seen as a negative subsidy to the fishers.

Schrank reiterates the aforementioned definition of subsidies in a paper prepared for a recent FAO expert consultation on subsidies (Schrank, 2001). In the paper, he goes on to make two important points. The first is that subsidies must be judged in terms of their impacts, rather than upon the intent, and objectives, of those introducing the subsidies. The second point is that, while subsidies are often condemned as being universally negative in their impacts, some subsidies may, in fact, produce socially desirable results. Some, of course, may be neutral in their effects. In any event, individual subsidies are not to be judged on an a priori basis (Schrank, 2001).

The OECD study (OECD, 2000) classifies subsidies/GFTs in terms of programs, and in terms of whether, in the authors' view, the subsidies constitute direct payments from government budgets, whether they are cost reducing transfers, or whether they constitute general services, such as research. For our purposes, we find it most useful to employ the classifications by programs. The program classifications used by the OECD are:

- Management, research, enforcement and enhancement (MRE);
- Fisheries infrastructure (FI);
- Investment and modernization of vessels and gear (IM);
- Tax exemption (TE);
- Decommissioning of vessels and license retirements (DLR);
- AOC) expenditures to obtain access to other countries EEZs;
- Income support and unemployment insurance (ISU);
- Other GFTs (OT).

Estimates of the size of such GFTs/subsidies vary widely. In 1992, the FAO reported that subsidies in world fisheries may exceed U.S. $50 billion per annum (FAO, 1992). A much more conservative estimate produced in a study, prepared for the World Bank by Matteo Milazzo (Milazzo, 1998), placed the level at between U.S. $15-20 billion per annum.[2] Even if one were to argue that the conservative estimate is more accurate, one is forced to conclude that GFTs in world fisheries are very large indeed.

We have accepted the Schrank (2001) argument that subsidies are to be judged in terms of their impacts. We can divide such impacts into two broad categories:

A. Distributional impacts

B. Impacts upon resource management and sustainability.

The subsidies will have an obvious impact upon distribution of incomes. Those receiving the subsidies are better off – temporarily, if not permanently. Those called upon to finance the subsidies, e.g., through taxes, will clearly be made worse off. The distributional impact of the subsidies will have equity consequences, which we may applaud, or condemn. Important though the distributional consequences of subsidies undoubtedly are, they shall be ignored in this paper. Rather we shall focus on the Category B impacts.

Milazzo (1998), in his detailed, and much cited, World Bank study on subsidies, discusses the many ways in which subsidies can serve to undermine fisheries conservation and management, e.g., by intensifying the over-exploitation of the resources. He also insists, however, that there exists a set of 'conservation subsidies,' which, as the name implies, have a positive impact upon fishery resource conservation and management (Milazzo, 1998, pp. 12-13). We shall examine his arguments pertaining to 'conservation subsidies' in some detail, at a later point in the paper.

With subsidies in fisheries now defined, and classified, we turn to a review of the economics of the impact of subsidies upon fisheries management and sustainability.

The basic economics of the impact of subsidies in fisheries: Part One

The FAO (1992, 1998, 2001), the United States National Research Council (NRC, 1999), the OECD (2000), and others emphasize the damaging effect that subsidies may have by exacerbating the common property, or 'common pool', problems associated with capture fishery resources. The common pool aspects of the resources will, it is argued, result in a perverse system of incentives confronting fishers, which will lead, if unchecked, to overexploitation of the fishery resources, or, as economists would express it, excessive disinvestments in the fishery resources as 'natural' capital.

Economists have now come to regard fishery resources, like all other natural resources, as natural capital. The resources are seen as assets, coming as endowments from nature, which are capable of yielding a stream of economic benefits (market and non-market) to society through time. A set of fishery resources (along with the surrounding aquatic ecosystem), in a particular region, can be viewed as a 'portfolio' of natural capital assets.

[2] The FAO and Milazzo differed in terms of their definitions of subsidies. But the differences in definitions do not fully explain the gap between the two sets of estimates, however.

These natural capital assets can obviously be subject to disinvestment. If natural capital is renewable, then one can, within limits, engage in positive investment in the natural capital assets, as well, e.g. by refraining from harvesting. The restoration of capture fishery resources in the North Atlantic, which plays an important role in the Sea Around Us Project (Pauly and Pitcher, 2000), is, from the economist's perspective, an exercise in resource investment. Optimal economic management of capture fishery resources does, in the first instance, involve establishing of a resource investment/ disinvestments program that will (given the appropriate social rate of discount [interest rate]) yield the maximum economic returns to society through time (Bjorndal and Munro, 1998; OECD, 1997).

Capture fisheries have in the past been characterized as being common pool, in that property rights to the resources are ill defined, or simply non-existent (NRC, 1999; OECD, 1997). The mobility of the fish, and their lack of observability prior to capture, has made the assignment of property rights to the resources difficult. As economists have explicitly recognized for almost 50 years, it is the absence of effective property rights that results in a system of perverse (from society's point of view) incentives confronting fishers (Gordon, 1954; NRC, 1999). The rational fisher is given every incentive to discount very heavily any future economic returns arising from investment in the resource, or any future costs arising from resource disinvestments.

The common pool problem manifests itself in two major ways. The first is what is often termed 'Pure Open Access',[3] in which there are no official regulations governing the fishery, domestic or international. High seas fisheries have, over the past decade and a half, provided prominent examples. In such fisheries, overexploitation is the inevitable outcome in that disinvestments in the resource, or resources, will go far beyond that which is optimal from society's point of view (Bjorndal and Munro, 1998). If the resource is subsequently placed under the control of the resource manager, it will appear to the resource manager that he/she is confronted with a fishery resource that has been overexploited, and with a fishing fleet that has been overcapitalized. The fleet will exceed that which would be required to harvest the resource on a sustainable basis, if the fishery resource were to be stabilized at the optimal level.

[3] The term 'Pure Open Access', and the term which we shall subsequently use, 'Regulated Open Access', were introduced by Wilen (1987).

The second manifestation of the common pool problem is often termed Regulated Open Access. In this case, the total season-by-season harvest is controlled by a resource manager. Thus, the fishery resource is, hopefully, stabilized and protected from excessive exploitation. The resource manager does not, however, exercise effective control over the fleet competing for the restricted harvest. The restricted season-by-season harvest now becomes the common pool. The almost inevitable result will be that fleet capacity will expand to the point that a significant portion can be deemed to be genuinely redundant. The fleet capacity will exceed, more often than not by a wide margin, that required to take the allowable catch, even when allowing for catch fluctuations through time. The excess fleet capacity results in certain economic waste, and may serve as a threat to resource managers' ability to control total harvests, and conserve the resource (Bjorndal and Munro, 1998). North Atlantic fisheries provide an abundance of examples.[4]

Subsidies, if they have a negative impact upon resource management, create perverse (from society's point of view) incentives, over and above those arising from the common pool nature of the resources (see: Arnason, 1999). Subsidies having a positive influence upon fisheries management can be thought of, in the first instance, as countering the perverse incentive effects of the common pool nature of the resources.

Obviously those subsidies having negative consequences will add to the perverse incentives arising from common pool fisheries, thereby making a bad situation worse. It is important to ask as well, however, whether such subsidies could have significant consequences if the common pool aspects of a fishery were effectively removed. If the answer is yes, then subsidies have to be taken very seriously indeed. If the answer is no, then, while subsidies can be seen as a significant irritant, most attention and effort should be focused on addressing the common pool aspects of capture fisheries. We shall, as have other authors, e.g. Arnason (1999), conclude that, all in all, subsidies having a negative impact are likely to do greatest damage under common pool fisheries. We shall also conclude, however, that, if the common pool aspects of the fishery are removed, these subsidies can still result in damages, which society ignores at its peril.

Impact of subsidies under conditions of pure open access

[4] The major decommissioning schemes of the European Union provide testimony to this fact. See: Hatcher (1999).

We proceed by considering the consequences of subsidies under conditions of Pure Open Access. The Regulated Open Access case will be considered in a later section of the paper.

As a first step, we shall examine the optimal management of the fishery under an all powerful resource manager, in which the state is effectively exercising its full property rights to the resource. This will provide us with a benchmark against which we can assess the consequences of Pure Open Access, with and without subsidies.

Following our assessment of the consequences of Pure Open Access, with and without subsidies, we shall suppose that, while not managing the fishery directly, the government, as resource manager, eliminates the common pool aspect of the fishery by effectively 'privatizing' the fishery. This will then allow us to ask what the consequences would be, if any, should the government at large undertake to subsidize the 'privatized' fishery.

Prior to undertaking our first step of examining the theory of optimal management of the fishery by an all powerful resource manager, we must digress to deal with a preliminary issue, which pertains to the 'malleability', or lack thereof, of conventional capital embodied in the fleet. Perfectly malleable vessel capital consists of vessel capital, which can, quickly and costlessly, be removed from the fishery.[5] Non-malleable vessel capital is vessel capital, which cannot be so removed. Most economic models of the fishery assume, explicitly or implicitly, that vessel capital is perfectly malleable. This is done on grounds of analytical ease, and most certainly not on grounds of realism. Perfectly malleable vessel capital is the exception, not the rule. One can add, moreover, that the concept of fleet overcapacity becomes essentially meaningless, if vessel capital is perfectly malleable (Gréboval and Munro, 1999). Since we can find no legitimate grounds for assuming that vessel capital is perfectly malleable, we shall not accept the assumption.

We now present the bare bones of an economic model of a fishery incorporating non-malleable vessel capital,[6] which will enable us to describe the optimal resource exploitation program, and then to examine the consequences of Pure Open Access. For a detailed discussion of the model, the reader should consult Clark et al. (1979) and McKelvey (1986).

[5] This is a concept which is analogous to that of 'liquidity' in finance.

[6] See Sumaila (1995) for a computational model that incorporates non-malleability of fleet capital.

Let us commence by denoting fishing effort by $E(t)$ and the stock of vessel capital by $K(t)$, where $K(t)$ can be thought of in terms of the number of 'standardized' fishing vessels. We then have (Clark et al. 1979):

$$0 \le E(t) \le E_{max} = K(t) \tag{1}$$

which asserts that maximum fishing effort capacity, equals the number of vessels and that actual effort cannot exceed E_{max}. Actual effort can be less than E_{max}, because some of the vessels may be used to less than capacity.

Given the initial stock of vessel capital $K(0) = K0$, adjustments in the stock of K are given by:

$$dK / dt = I(t) - \gamma K \tag{2}$$

where $I(t)$ denotes the rate of investment (gross) in vessel capital, and γ (a constant) the rate of depreciation of such capital.

Now let c_1, a constant, denote the unit purchase price of vessel capital, and c_s the unit 'scrap value' (resale value) of vessel capital. We deem vessel capital to be perfectly malleable if:

$$c_s = c_1 \tag{3}$$

and to be perfectly non-malleable if:

$$c_s = \gamma = 0 \tag{4}$$

i.e., the capital has no re-sale value, and never depreciates.

Intermediate cases – sometimes referred to as quasi-malleable capital – are given by:

$$c_s = 0; \quad \gamma > 0 \tag{5}$$

$$0 < c_s < c_1; \quad \gamma \ge 0 \tag{6}$$

Next, suppose that the fishery resource is appropriately modeled by the standard Schaefer model (see Clark, 1990):

$$dx / dt = F(x) - h(t) \tag{7}$$

where $x = x(t)$ denotes the biomass, $F(x)$ the natural growth rate of the biomass, and $h(t)$ the rate of harvest. In the Schaefer model, the natural growth function is a pure compensatory one (Clark, 1990). The harvest production function is given by:

$$h(t) = qE(t)x(t) \tag{8}$$

where q, a constant, is the catchability coefficient. We simplify this by assuming that all harvested fish is sold into the fresh fish market. The flow of net operating profits, at each point in time, can thus be expressed as:

$$\pi(t) = (pqx(t) - c)E(t) \tag{9}$$

where p, a constant, is the price of harvested fish, and c, a constant, is the cost of fishing effort (exclusive of the price of fleet capital).[7] Hence, c can also be seen as denoting unit operating costs.

For future reference, the flow of net operating profits at any point in time can also be expressed as:

$$\pi(t) = (p - c_{var}(x))h(t) \tag{9a}$$

where *c*var(*x*) denotes unit variable cost of harvesting:

$$c_{var}(x) = c / qx \tag{10}$$

Also for future reference, let us note that, if vessel capital were perfectly malleable, we could talk meaningfully of unit total cost of harvesting, which would be given by:

$$c_{total}(x) = \frac{c + (\delta + \gamma)c_1}{qx} \tag{11}$$

where δ denotes the social rate of discount. It will be recalled that γ denotes the rate of depreciation. The expression: $(\delta+\gamma)c_1$ is sometimes referred to as the 'rental' cost of vessel capital (Clark et al., 1979).

Let it now be supposed that the vessel capital is characterized by Eq. (5). The capital has a resale value of zero, but it has a positive depreciation rate. As an aside, because this point will prove to be relevant to our examination of actual subsidies in the North Atlantic, investment in 'vessels' should really also include investment in port facilities, such as piers and warehouses.

Let it also be supposed, for the sake of convenience, that we commence with an unexploited resource, $x(0) = x_0$. Finally, and also for the sake of convenience, it will be assumed that investment in vessel capital, broadly defined, can take place instantaneously.

Let it be assumed that the objective of the resource manager is that of maximizing the net economic returns from the fishery through time. The resource manager's objective functional can thus be expressed as:

$$\max J = \int_0^\infty e^{-\delta t}\left\{\pi(t) - I(t)c_1\right\}d(t),\ x(0) = x_0 \tag{12}$$

where, once again, δ is the social rate of discount (interest).

Theory tells us (see: Clark et al., 1979) that it will be optimal for the resource manager to deplete the resource, below its unexploited level, and that the resource will, in the long run, be stabilized at a level *x**, given by the following equation:

$$p - c_{total}(x^*) - \frac{1}{\delta}\cdot\frac{d}{dx^*}\left\{(p - c_{total}(x^*))F(x^*)\right\} = 0 \tag{13}$$

The expression:

$$\frac{1}{\delta}\cdot\frac{d}{dx^*}\left\{(p - c_{total}(x^*))F(x^*)\right\}$$

is the present value of sustainable profits, or economic 'rent', that would be gained (lost) by marginal investment (disinvestments) in the resource. It is sometimes referred to as the 'user cost' of, or, more commonly, as the shadow price of the resource.

The theory demonstrates that, once *x** is achieved, it will be optimal to reinvest in vessel capital to a level that will allow harvesting to take place on a sustained yield basis at *x* = *x**. In other words, while gross investment in vessel capital will be positive, net investment will equal zero.

For future reference, let it be noted that Eq. (13) can be re-written as:

$$F'(x^*) + \eta(x^*) = \delta, \tag{14}$$

[7] That is, it is being assumed that the demand for harvested fish, the supply of vessel capital, and the supplies of all other inputs constituting *E*, are perfectly elastic.

$$\text{where} \quad \eta(x^*) = \frac{-c'_{total}(x^*)F(x^*)}{p - c_{total}(x^*)}$$

The key remaining question is the decision rule that should be followed by the resource manager in investing in fleet capacity at $t = 0$, $x(0) = x_0$. Once a vessel is purchased, the cost of the vessel acquisition, c_1, becomes a 'sunk' cost, that is a cost, which can be considered a bygone, in the sense that it cannot be recouped. From thereon in, the focus must be on the operating profits to be derived from the vessel over its economic life. With this in mind, it can be stated that the optimal initial fleet size, which we can denote by K_0, will be given by the following simple investment decision rule, expressed as:

$$\frac{\partial PV^*}{\partial K} = c_1 \tag{15}$$

where PV^* denotes the present value of fleet *operating* profits, at $t = 0$, given that the harvesting strategy, which will lead to the resource eventually being stabilized at $x = x^*$, is followed. The decision rule states: invest in vessel capital up to the point that the resultant marginal present value of operating profits is equal to the unit cost of vessel capital.

With the benchmark case of optimal resource management, by an all seeing, all powerful resource manager in place, we can proceed to examine the consequences of Pure Open Access. We shall suppose, as before, that we commence with a virgin biomass, $x(0) = x_0$, and that vessel capital is quasi-malleable, in that $c_s = 0$; $\gamma > 0$. Finally, we assume that we commence with an unsubsidized fishery, and that the p, c and c_1 confronting the fishers are identical to the p, c and c_1 facing the resource manager in our benchmark case.

McKelvey (1986) has demonstrated that a pattern will emerge which is similar in nature to that to be found in the optimal management case. The resource will be depleted and then stabilized at a level, which we shall denote as x^o, which corresponds to what is referred to in the fisheries economics literature as Bionomic Equilibrium (Gordon, 1954). The Bionomic Equilibrium biomass, x^o, will be given by an equation that is similar to Eq. (13), but with one fundamental difference. The second term on the left hand side of Eq. (13), it will be recalled, is the *shadow price* of the resource, which is, in turn, the present value of sustainable profit, or economic rent, that will be gained (lost) as a result of a marginal investment (disinvestments) in the resource. Under Pure Open Access, the rational fisher will, from his/her perspective, perceive the aforementioned marginal sustainable economic rent to be equal to zero. Hence, the fishers collectively will deem the shadow price, itself, to be equal to zero. The biomass level x^o, corresponding to Bionomic Equilibrium, is thus given by the following equation:

$$p - c_{total}(x^o) = 0 \tag{16}$$

Return to Eq. (13). From this equation, one can infer that there are two 'brakes' on exploitation of the resource confronting the all-seeing resource manager. The first is that the unit cost of harvesting steadily increases as x is depleted. The second brake is contained within the *shadow price* of the resource. The resource manager must be constantly aware of the impact of resource depletion today, upon the economic returns from the resource tomorrow.

Under Pure Open Access, the second of the two brakes upon exploitation is eliminated. We can, therefore, with confidence, be assured that $x^o < x^*$. Pure Open Access will lead, unequivocally, to overexploitation of the resource from society's point of view. The McKelvey (1986) analysis also assures us, not surprisingly, that the investment in fleet capacity at $t = 0$, under Pure Open Access, will exceed the optimal investment in such capacity that would be undertaken by the all-seeing resource manager.

Now return to Eq. (16) and consider the impact of the introduction of subsidies. Recall that both unit operating costs c and the purchase price of vessel capital, c_1 enter into $c_{total}(x)$. We can then say that *any* subsidy, which

i) increases p, as perceived by the fishers;
ii) reduces c, as perceived by the fishers;
iii) reduces c_1, as perceived by the fishers.

will result in a more intense exploitation of the resource. Let $x^{o\prime}$ denote the long run equilibrium biomass under Pure Open Access, given a subsidy, or subsidies, that lead to i, ii, iii, or some combination of the three. Then, it will certainly be the case that: $x^{o\prime} < x^o$. Thus, a bad situation will indeed be made worse.

To emphasize the point, consider an extreme case, in which the government introduces a super cost-reducing subsidy, which effectively reduces c and c_1 to zero. The consequence would be that the one brake on resource exploitation would be removed. Eq. (16) would have no solution, implying that the resource would be sent hurtling towards extinction.

Impact of subsidies in an effective private property rights fishery

Next consider the following. Instead of permitting the development of a Pure Open Access fishery, and instead of direct management of the resource by the resource manager, the 'authorities' succeed in creating effective private property rights to the resource. While the resource is not directly managed by the resource manager, the common pool aspects of the fishery are eliminated, and thus good resource management should be expected to prevail. The question then to be asked is what effect, if any, would the introduction of subsidies have upon resource management and resource sustainability.

Various means have been suggested for attempting to create property rights among fishers (OECD, 1997). Individual transferable harvest quotas (ITQs) provide one such example (see, for example, Munro and Pitcher, 1996).

Suppose then, that a fully fledged ITQ system is established, and suppose further that the ITQ holders coalesce and begin to act and to behave as a 'corporation,' which effectively owns, not just the harvest shares, but the resource itself. The government, as resource manager heretofore, while maintaining nominal control of the resource, does, to all intents and purposes, relinquish resource management rights to the 'corporation.' While all of this may sound far fetched, there are, in fact, clear signs that the management of fisheries in at least one fishing nation, New Zealand, is evolving in just this direction (Munro et al. 1999). We would, in any event now have a fishery, effectively privately owned, in which all vestiges of the common pool had been removed, and which closely resembled the mythical 'sole owner' fishery described by the pioneering fisheries economists, H. Scott Gordon and Anthony Scott (Gordon, 1954; Scott, 1955).

Suppose, initially, that the corporation is not subsidized, and suppose, as before, that we commence with an unexploited stock, $x(0) = x_0$. Suppose, as well, that the p, c, and c_1 facing the corporation are identical to the p, c, and c_1 facing the resource manager in our benchmark case. Finally suppose that the rate of discount (interest rate) used by the corporation is identical to the social discount rate, and that the objective of the corporation is to maximize the net economic returns from the fishery over time.

The problem facing the corporation would be exactly the same as that facing the resource manager in the benchmark case. The economic model of the fishery established for the benchmark case – Eqs. (1) to (15) – would apply to the 'corporation,' without modification, and, not surprisingly, the results would be the same. The corporation, beginning with an unexploited stock, $x(0) = x_0$, would deplete the stock and eventually stabilize at a long run equilibrium level which we shall denote as x^{**}, given by:

$$p - c_{total}(x^{**}) - \frac{1}{\delta} \bullet \frac{d}{dx^{**}}\left\{(p - c_{total}(x^{**}))F(x^{**})\right\} = 0 \tag{17}$$

or alternatively

$$F'(x^{**}) - \frac{c'_{total}(x^{**})F(x^{**})}{p - c_{total}(x^{**})} = \delta \tag{18}$$

Equations (17) and (18) appear to be identical to Equations (13) and (14), and indeed they are. Given our assumptions about the p, c, c_1 and δ confronting the 'corporation,' it will be found that $x^{**} = x^{*}$, the socially optimal long run equilibrium biomass level (see Eqs. 13 and 14). The 'corporation', as private sole owner of the resource, would follow a socially optimal policy, as has been predicted by fisheries economists from Gordon (1954) and Scott (1955) onwards.

We can now consider the impact of the introduction of subsidies. The government, we might suppose, introduces subsidies for distributional purposes (fishers' incomes are seen as being 'unfairly' low), while assuming that, since the fishery is 'well-managed', the subsidies can be counted upon to have no negative resource consequences. Everything else is assumed to remain the same.

The consequences of the introduction of subsides are straightforward. Return to Equations (17) and (18). It is clear that *any* subsidy which has the effect of increasing the p, perceived by the 'corporation,' or of reducing either c or c_1, or both, as perceived by the 'corporation,' will reduce the level of x^{**}, leading to the result that $x^{**} < x^{*}$. The corporation will overexploit the resource, as seen from the point of view of society, and do so in an unequivocal manner.

The introduction of subsidies does not make a bad situation worse, as is the case in Pure Open Access. Rather, the introduction of subsidies undermines, what would otherwise be socially optimal resource management program, by introducing a new set of perverse incentives.

While the introduction of subsidies will, admittedly, have a negative impact upon the resource, perhaps the impact will prove to be trivial. One has, in fact, no justification for assuming that this must necessarily be the case. It takes no great skill, or imagination, to construct a scenario in which the introduction of subsidies into the 'well managed' fishery would lead to the result: $x^{**} < x^{o}$, i.e., a scenario, in which the introduction of subsidies would lead to an outcome that was, from society's point of view, worse than an unsubsidized Pure Open Access fishery.[8]

In our discussion of subsidies under Pure Open Access, we attempted to drive home our points by taking the extreme example of a super cost- reducing subsidy that effectively reduced both c and c_1, as perceived by the fishers to zero. The consequence was resource extinction. Let us apply the extreme example to the corporation fishery, for comparative purposes.

If the super cost-reducing subsidy is introduced to the corporation fishery, Equation (18) will reduce to:

$$F'(x^{**}) = \delta \tag{19}$$

As in the case of Pure Open Access, the subsidy would eliminate the brake on exploitation arising from the fact that unit harvest costs rise, as the resource is depleted. The second brake, however, arising from the 'corporation's' concern about the impact of resource exploitation today upon economic returns from the resource tomorrow, appears to remain in place. Thus, we are protected from the threat of resource extinction, or so it would seem. Clark (1990), however, presents us with a stern warning.

The underlying biological model, which we have employed, is the Schaefer model. In the Schaefer model, we have $F''(x) < 0$, which implies that $F'(x)$ will steadily increase as x is diminished. In the limit, as x approaches 0, $F'(x)$ will approach what is referred to as the intrinsic growth rate, which we denote by w, a constant (see: Clark, 1990). Clark has demonstrated that, in circumstances such as we have described, there will be no solution to Eq. (19), if $\delta > w$.[9] The second 'brake' would prove to be inoperative and the resource would, in fact, be driven to extinction (Clark, 1990). In other words, it would pay the corporation to mine the resource to extinction, perhaps with the objective of reinvesting the proceeds from the fishery in some other form of capital investment. Thus, while extinction would not be assured, as it would be in the case of a Pure Open Access fishery, it remains an uncomfortable possibility.

Of course, the assumption of the super cost - reducing subsidy is extreme. So are the assumptions that the resource is perfectly understood, and can be perfectly modeled, however. The introduction of less extreme subsidies to the corporation-run fishery could still result in the resource being driven down to a level which could be seen after the fact as dangerously low.

In conclusion, we agree with all those who argue that the introduction of subsidies under conditions of Pure Open Access can be very damaging. We also conclude, however, that to assume that the impact of subsidies introduced to a fully privatized, 'well run', fishery can safely be dismissed as trivial is folly. In a recent paper, Gareth Porter argues that "it would be unwise ... to base the international policy toward the fisheries subsides regime on the theoretical proposition that well-managed fisheries can neutralize the negative impacts of subsidies" (Porter, 2001, p. 14). We would agree, and would offer the counter theoretical proposition that, under the right set of circumstances, the introduction of subsides to an apparently 'well-managed' fishery can lead to the destruction of the resource.

The basic economics of the impact of subsidies in fisheries: Part Two

In this section, we consider the impact of subsidies under Regulated Open Access, in which the resource managers control the annual catch, but have in the past exercised, or do now exercise, inadequate control over the fleet size. The limited harvest becomes the 'common pool.'

One question, which can be dealt with readily, is the following. Suppose that the authorities, while retaining control over the total catch, remove the

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[8] Maximum sustainable yield, in the model occurs at the biomass level, x_{MSY}, at which $F'(x_{MSY}) = 0$, by definition. Depending upon the level and nature of harvesting costs, it is quite possible that Bionomic Equilibrium will occur at a stock level above the MSY level, i.e. $x^{o} > x_{MSY}$. Suppose that this is indeed the case, and now return to Eq. (18), and evaluate it at $x^{o} = x_{MSY}$. Suppose, for the sake of argument, that $\delta = 0.05$, and suppose that the subsidies affecting p, c and c_1 lead to the result that: $\left[\frac{-c'_{total}(x_{MSY})F(x_{MSY})}{p - c_{total}(x_{MSY})}\right] = 0.05$

Since $F'(x_{MSY}) = 0$, it will indeed prove to be the case that $x^{**} = x_{MSY}$. Hence $x^{**} < x^{o}$.

[9] A slow growing resource, such as whales, provides a case in point (Clark, 1990).

'common pool' aspects of the fishery through the granting of individual harvest quotas, or some other scheme, and that the ITQ scheme, or alternative, works well. What then would be the consequence of introducing subsidies? The answer is that the subsidies should have very limited negative consequences, and, in many cases, will prove to be neutral. Consider, as an example, a well managed ITQ scheme. The individual quota holder cannot influence the size of his/her quota, except by buying quotas from others. He/she will attempt to harvest the assigned quota in the most efficient manner possible, in order to maximize profits. A subsidy affecting some inputs, but not others, would cause the quota holders to substitute, where possible, the subsidized input, or inputs, for the unsubsidized ones. This could be inefficient from society's point of view. Be that as it may, the consequences of subsidies should be far less severe than in our case of the 'corporation,' which was enabled to assume the full rights of resource management (Hannesson, 2000).

A cautionary note is in order, however. The discussion in the previous paragraph rests critically upon the assumption that the 'authorities', as resource manager, retain iron control over the total catch, and thus over the management of the resource itself. Should the ITQ fishery evolve in a manner, such that more and more of the power of resource management becomes vested in the ITQ holders, then we shall move towards a 'corporation' type of fishery described in the previous section, with all that that implies

Be that as it may, the key subsidy question pertaining to Regulated Open Access arises when the 'common pool aspects remain, and the resource manager reacts to the emergence of excess capacity by introducing a buyback, or decommissioning, scheme.

The purpose of a buyback scheme is quite simply to persuade a given number of fishers to sell their boats and licenses, and retire from the fishery, thereby eliminating the excess capacity.

The expenditures on buybacks constitute subsidies, and are clearly designated as such by the OECD (2000). At an earlier point, we noted that Milazzo, in his study on subsidies for the World Bank (Milazzo, 1998), argued that some subsidies had a positive impact upon resource management, and that he designated such subsidies as 'conservationist' subsidies. His prime example of a 'conservationist' subsidy is a subsidy used for buyback purposes (Milazzo, 1998). Milazzo is not alone. Schrank and Keithly, in the article already cited, point out that recent American legislation pertaining to fisheries explicitly supports the view that subsidies used for buyback purposes are beneficial (Schrank and Keithly, 1999).

Decommissioning schemes have often been criticized on the grounds that they are, over the long run, ineffective. Vessel capacity, once removed from a fishery by such a scheme, tends to seep back in, over time (see, for example, Holland, Gudmundsson, and Gates, 1999). We will commence by assuming, initially at least, a 'best case' outcome for the decommissioning scheme. Once the vessel capacity is removed, the resource manager proves to be entirely effective in blocking all seepage.

In our examination of this issue, we shall draw heavily upon a recent paper by Clark and Munro (1999). In so doing we shall use much the same economic model of the fishery as we did in Section III. There are two differences. In Section III we found a continuous time model to be more convenient. In this section, we find that a discrete time model is more appropriate. We shall, after all, have to deal explicitly with season-by-season fishery. Secondly, we shall be able to make our points with greater clarity by supposing that the rate of depreciation, and the 'scrap value,' are equal to zero. Finally, we also assume, for simplicity, the absence of 'crowding' externalities.

Now let us assume that the resource managers specify an annual Total Allowable Catch (TAC), which remains fixed for all future time. Let Q denote this fixed annual TAC in tonnes. Assume, initially, that entry into the fishery is unrestricted. Thus, we commence with true Regulated Open Access. As before, let K denote the actual fleet size. The harvest rate is z tonnes/day/vessel. Thus, if K vessels fish for D days during the year, the fleet's total annual harvest is: zKD .

Let $D_{\max}$ denote the maximum length of the annual fishing season. If the fleet size is such that $zKD_{\max} \le Q$ the fishing season will be at its maximum length. If $zKD_{\max} > Q$, then the actual number of days fishing must be: $D < D_{\max}$, if the TAC is not to be exceeded.

As before, let p, a constant, denote the price of harvested fish, and c, unit operating profits. Thus Fleet Annual Net Operating Profits are given by:π_{An}

$$\pi_{An} = (pz - c)KD \tag{20}$$

If the TAC is fully taken, then we have $zKD = Q$ and Eq. (20) can be re-written as:

$$\pi_{An} = (p - c/z)Q \tag{20a}$$

Next let r denote the annual rate of interest, let K_0 denote the minimum fleet required to take the allotted TAC = Q, i.e. $Q = zK_0D_{max}$. Let K_{ROA} denote the 'equilibrium' fleet size under Regulated Open Access. Finally, as before, let c_1 denote unit price of fleet capital.

Given that Q is taken year in, and year out, the present value of fleet operating profits will be equal to: $[\pi_{An}] \bullet (1+r)/r$. We shall assume that the vessels (and crew) are identical. Consequently, an owner of a unit of fleet capital (a vessel) can expect to enjoy an average share of the aforementioned present value, i.e., $\{[\pi_{An}] \bullet (1+r)/r\}/K$. Thus investment in additional fleet capital will be profitable, if it is true that:

$$c_1 < \{[\pi_{An}] \bullet (1+r)/r\}/K \tag{21}$$

Hence, we would predict that the 'equilibrium' fleet size, K_{ROA}, would be given by

$$c_1 K_{ROA} = [\pi_{An}] \bullet (1+r)/r \tag{22}$$

which can be re-expressed as:

$$K_{ROA} = [\pi_{An}] \bullet (1+r)/rc_1 \tag{22a}$$

Unless, it should be the case that the fishery is strictly a 'break even' fishery, i.e.

$$c_1 K_0 = [\pi_{An}] \bullet (1+r)/r$$

we shall certainly find that $K_{ROA} > K_0$, and we can argue that Regulated Open Access will lead, as standard fisheries economics would predict (see, for example, Bjorndal and Munro, 1998), to the complete dissipation of net economic returns (resource 'rent') from the fishery. The magnitude of the dissipated resource rent is given simply by:

$$\{[\pi_{An}] \bullet (1+r)/r - c_1 K_0\}$$

We shall refer to the above measure as the Redundancy Deadweight Loss arising from excess fleet capacity emerging under Regulated Open Access. Let it be noted that the Redundancy Deadweight Loss is incurred the *instant* that the excess, redundant, capital is acquired. Once incurred, this loss cannot be reversed.

Now, let us consider the economic consequences of a buyback scheme. The scale of the impact will depend critically upon whether the scheme is, or is not, anticipated by the vessel owners. We illustrate with the aid of a simple numerical example.

Let it be supposed that D_{max} = 200 days. We assume in addition, that:

Q = 10,000 tonnes;
z = 1 tonne per vessel per day;
p = $1,000 per tonne;
c = $500 per vessel per day;
c_1 = $500,000 per vessel;
r = 0.10 – i.e., 10% per annum.

Total annual fleet net operating profits will be:

$$\begin{aligned}\pi_{An} &= (p - c/z)Q \\ &= \$5{,}000{,}000 \text{ per year}\end{aligned} \tag{23}$$

while the optimal fleet size will be:

$$K_0 = Q/zD_{max} = 50 \text{ vessels} \tag{24}$$

Let it be supposed that the fishery commences at time period t = 0. It is not unknown for resource managers to react to an 'excess' capacity problem, only after the problem has emerged. Therefore, let it be supposed that, if 'excess' capacity does emerge, the resource managers will react at, say time period t = 10, by introducing a buyback/license limitation scheme, with the objective of reducing K to 50 and of maintaining that fleet level thereafter.

Let us commence by also assuming that, at t = 0, the resource manager's future responses are wholly unanticipated by vessel owners. They assume, incorrectly, that regulated open access fishery will continue forever. We can thus anticipate that at t = 0, investment in capital capacity will be given by:

$$\begin{aligned}K_{ROA} &= (p - c/z)Q\left(\frac{1+r}{c_1 r}\right) \\ &= (\$1000 - \$500) \bullet \frac{10{,}000(1.10)}{c_1 r} \\ &= 110 \text{ vessels}\end{aligned} \tag{25}$$

Thus there is excess capacity of 60 vessels, representing a Redundancy Deadweight Loss of $30 million.

At t = 10, the resource managers do introduce a 'sudden death' buyback program, to the surprise of the vessel owners. The vessel owners are, however, convinced that the authorities will do whatever is necessary to reduce the fleet to 50 vessels and are further convinced that the accompanying limited entry program will be effective forever.

The present value of the operating profits of the remaining 50 vessels, discounted back to t = 10 will be $1,100,000. Thus, we can be assured that the resource managers cannot offer less than $1,100,000 per vessel. We shall assume, somewhat unrealistically, that the authorities are able to achieve their goal by offering a purchase price of $1,100,000 and the accompanying limited entry program is indeed fully effective. The fleet remains at $K = K_0$ from henceforth.

The government has thus spent $66,000,000. Immediately prior to the buyback, each vessel was worth its original purchase price, $500,000. Those who sold out received $1,100,000, a windfall gain of $600,000. Those who remained in the fishery found that the value of their vessels had appreciated by $600,000 to $1,100,000. Both those who leave the fishery and those who remain have benefited from the subsidy. Those who left the fishery collectively receive $36,000,000, while those who remain collectively receive $30,000,000.

The consequences of the emergence of excess capacity, under Regulated Open Access, are, we had said at an earlier point, twofold. First it will result in economic waste. Secondly, it will act as a threat to the ability of the resource managers to control the total harvest. Up to this point, we have implicitly assumed that the resource managers are able to exercise full control over the total harvests. This is a very strong assumption, which we must be prepared to relax. With regards to the elimination of economic waste, the subsidy, in the example developed to this point, does no good. The Redundancy Deadweight Loss remains unaffected.

In terms of the threat to the resource managers, should the managers in fact lack full control, the subsidy will indeed ease the pressure, and can be seen as having a positive or 'conservationist,' impact. This outcome, however, rests upon the vessel owners being caught by surprise, and rests as well upon the assumption that the resource manager can introduce, and maintain, a wholly effective limited entry program.

Now let us change the example by supposing that, at t = 0, the vessel owners have perfect foresight. They anticipate, correctly, that, at the inception of the fishery, the resource manager will initially do nothing about the possible emergence of 'excess' capacity. They anticipate further that, by t = 10, the resource managers will react to the appearance of excess capacity by introducing a 'sudden-death' buyback program and that the resource manager will, moreover, offer a price of $1,100,000 per vessel. The vessel owners also know that the fleet will be stabilized at 50 vessels, and that the accompanying limited entry program will be entirely successful.

We can now calculate the level of investment in vessels at t = 0, which we shall denote by K'_{ROA}. Equilibrium will be achieved when:

$$c_1 K'_{\text{ROA}} = \sum_{i=0}^{10} (p - c/z) \frac{Q}{(1+r)^i} + \frac{c_3}{(1+r)^{10}} \bullet K'_{\text{RO/}} \tag{26}$$

where c_3 denotes the resource manager's offer price at t = 10. Observe that it is a matter of indifference whether an individual vessel owner sells his/her vessel at t = 10, or whether his/her vessel continues on as one of the remaining 50. Also observe that Eq. (26) can be re-written as:

$$K'_{\text{ROA}} = \left[\sum_{i=0}^{10} (p - c/z) \frac{Q}{(1+r)^i} \right] \bullet \frac{1}{c_1 - c_3/(1+r)^{10}} \tag{26a}$$

In any event, in our example, we have:

$$K'_{\text{ROA}} = \$35{,}722{,}836 \bullet \frac{1}{\$75{,}093} \approx 476 \tag{27}$$

The implication is that the eminently 'successful' buy-back program would lead to a Redundancy Deadweight Loss of $500,000 • (476-50) = $213 million. Recall that, if the 'authorities' had done nothing, i.e., had foregone a buyback program, the Redundancy Deadweight Loss to the economy would have been $30 million, less than 15 per cent of the loss brought on by the buyback program.

Note as well that, what we might term the 'do nothing' policy, results in the net economic returns from the fishery being reduced to zero – the usual result from the standard fisheries economics model. The present value (at t = 0) of net operating profits from the fishery is $55 million, while total expenditure on vessel capital would be $55 million. In our example of the anticipated buyback program, the net economic benefits from the fishery to the economy at large (discounted back to t = 0) will be equal to *minus* $158 million.

The reason that the anticipated buyback program induces a large investment in fleet capacity is made transparent by the right hand side of Eq. (26a). The effective purchase price of vessel capital, for would be vessel owners, at $t = 0$ is: $c_1 - [c_3/(1+r)^{10}]$, which carries with it the implication that the vessel owners would be receiving a subsidy, indeed a very substantial subsidy equal to just under $425,000 per vessel, which is equal, in turn, to 85 per cent of the purchase price.

With respect to economic waste, the buyback subsidy, when anticipated, is a disaster. In terms of a threat to the resource manager's ability to control the total harvest, the anticipated subsidy, obviously intensifies the threat, until the buyback actually comes into effect. Thus, when anticipated, the 'good' buyback subsidy is, in fact, a very bad subsidy indeed.

The anticipated subsidy case can best be thought of as a fisheries example of what in macroeconomics is referred to as 'Rational Expectations.' (See, for example, Sargent 1986, and Turnovsky 2000). The argument put forth is that members of an economy, e.g. firms and households, do not react passively to changes in macropolicy, but will rather take into account all relevant information about the future course of macro-policy. From this follows the famous proposition that Monetary Policy, for example, will be effective in terms of having an impact upon the level of national income, only to the extent that it is unanticipated. Fully anticipated Monetary Policy will have no impact upon the level of national income (Turnovsky, 2000).

Our last example is, of course, exaggerated in that we assume perfect foresight. Vessel owners always remain uncertain about the course of future government policy. Nonetheless, the point remains. It is foolish to suppose that vessel owners will simply ignore the knowledge they have acquired about the behaviour of resource managers, and, thus neglect to incorporate such knowledge in their investment decisions.[10]

To this point, we have assumed a 'best case' outcome, namely that the resource managers, upon introducing a limited entry program, can enforce the limited entry program with complete effectiveness. More often than not, the 'best case' does not prevail. The consequence, as we noted earlier, is that, when a buyback program is implemented, and is accompanied by a limited entry program, capacity will tend to seep back into the fishery. Eventually a new round of buybacks will be called for. There is ample evidence that capacity does indeed seep back into fisheries after buyback/decommissioning programmes (see, for example: Holland et al. 1999).

There are two consequences for our analysis, arising from the relaxation of the assumption that limited entry programs are perfectly enforceable. The first is that the size of the subsidies associated with anticipated buybacks will be less. Imperfect limited entry programs imply lower expected future resource rents. The second is that, while vessel owners may be taken by surprise by a buyback program the first time around, one cannot expect them to go on being taken by surprise. Once future decommissioning schemes come to be anticipated, the trickle of capacity back into a fishery can be expected to turn into a flood.

In a recent paper, Jorgensen and Jensen (1999) report on an empirical study, which they undertook on European Union vessel decommissioning (buyback) programs. They argue that EU fishers, and, in particular, their bankers, are not at all myopic with respect to investment in vessel capital. Decommissioning schemes, if repeated, will come to be anticipated and will influence investment decision making. The authors then argue, on the basis of a simulation model, that decommissioning schemes are likely to destabilize, rather than stabilize, the fishery (Jorgensen and Jensen1999).

Estimates of fishing sector subsidies in countries of the North Atlantic region

We now turn to estimates of fisheries subsidies in the North Atlantic region (NA). The definition of North Atlantic adopted by the SAUP (see Watson et al., this volume) includes 25 countries (see Table 2). For our purposes, these countries are divided into two sub-groups, those within the OECD – 16 – and those without- 9.

The OECD has recently published a thorough study on fisheries subsidies within the OECD region, to which we have repeatedly referred (OECD, 2000). Our estimates of fisheries subsidies in the OECD countries are, needless to stress, drawn from that study. As a consequence, we have a reasonably high degree of confidence in these estimates. By way of contrast, we have very limited sources of information about, and data on, fisheries subsidies in the non-OECD countries

[10] Nobel Laureate Robert Lucas, one of the founders of the Rational Expectations School, is famous for the comment that you do not find 50 dollar bills lying on the sidewalk.

Table 1. Estimates of Government subsidies to marine capture fisheries in OECD countries that are also member of the North Atlantic: 1997 (US $Million)[a]

Country	*MRE*	*FI*	*IM*	*TE*	*DLR*	*AOC*[c]	*ISU*	*OT*	*Total*[c]	*Landed value (LV)*	*Subsidy as % of LV*
Belgium	2.0	-	3.0	-	-	-	-	-	5.0	99.0	5
Denmark	46.1	2.8	11.3	-	7.5	-	-	9.4	77.1	489.7	16
Finland	21.0	-	1.0	-	1.0	-	-	3.0	26.0	29.0	90
France	65.1	5.3	11.4	-	4.4	-	-	36.1	122.3	665.3	18
Germany	45.1	5.9	2.0	-	2.0	-	-	7.8	62.7	190.1	33
Ireland	19.3	0.4	0.6	0.6	-	-	-	-	21.0	46.2	45
Netherlands	24.5	6.9	1.0	-	2.9	-	-	-	35.3	456.7	8
Portugal	15.8	4.4	5.7	-	13.2	-	-	2.5	41.6	201.0	21
Spain	18.5	8.0	40.0	-	98.0	-	-	7.5	172.0	1722	10
Sweden	38.2	0.9	2.7	-	1.8	-	3.6	0.9	48.2	117.4	41
United Kingdom	82.2	14.9	4.0	-	22.8	-	-	4.0	127.7	1,002	13
European Union	*377.7*	*49.4*	*82.7*	*0.6*	*153.6*	*155.0*	*3.6*	*71.2*	*893.9*	*5,018*	*18*
Iceland	18.0	-	-	18.0	-	-	-	-	36.0	877.0	4
Norway	98.0	-	14.0	34.0	-	-	3.0	14.0	163.0	1,343	12
Poland	5.8	-	-	-	-	-	-	-	5.8	157.0	4
Non European Union	*121.8*	-	*14.0*	*52.0*	-	-	*3.0*	*14.0*	*204.8*	*2,377*	*9*
Atlantic Canada	80.0	28.0	-	-	-	-	198.4	17.6	324.0	971.2	33
Atlantic United States	292.2	4.8	13.2	66.0	1.8	-	-	7.9	385.9	1,122	34
North America	*372.2*	*32.8*	*13.2*	*66.0*	*1.8*	-	*198.4*	*25.5*	*709.9*	*2,094*	*34*
Total	**871.7**	**82.3**	**109.9**	**118.6**	**155.4**	**155.0**	**205.0**	**110.7**	**1,809**	**9,488**	**19**

Notes to Table 1

a) Sources: OECD (2000); Flaaten and Wallis (2000).

b) MRE: management, research, enforcement and enhancement;
FI: fisheries infrastructure;
IM: investment and modernization;
TE: tax exemption;
DLR: decommissioning of vessels and license retirements;
AOC: access to other country's waters;
ISU: income support and unemployment insurance;
OT: other.

c) Subsidies under the heading of access to other countries' waters are relevant to the EU only. The data source, the OECD, does not provide a breakdown of these subsidies on a country by country basis. Consequently, the totals shown for some EU members are certainly understated. The authors deem the access subsidies to be similar in nature to decommissioning subsidies in that they are used to deal with 'excess' vessel capacity. About 54 per cent of total EU landed values is accounted for by the adjusted landed values of EU members in Table 1. It is assumed, for want of a better assumption, that 54 per cent of the access subsidies are also accounted for by these EU members.

d) Subsidy estimates for Canada, the U.S.A. Spain, Poland, and Portugal, UK, Denmark, Netherlands, Ireland, Germany and Sweden were estimated by the OECD for the entire countries. It was assumed that the percentage of subsidies in each country devoted to the Atlantic region was proportional to that region's share of the national harvest (in value terms).

(e.g., APEC, 2000). Our estimates of fisheries subsidies in the non-OECD countries are thus essentially educated guesses.

We adopt, therefore, a two-stage approach in our estimation of fisheries subsidies in the North Atlantic (NA). In the first stage, we make an estimate of subsidies for the 16 OECD countries. In the second stage we deal, as best we can, with the remaining 9. Details of the steps taken are presented below.

Stage 1:

We use data on the different types of subsidies and the value of landings for each of the 16 OECD countries in the North Atlantic region (OECD, 2000) (see Table 1). The OECD presents subsidy estimates for two years, 1996 and 1997. Since there are negligible differences between the two sets of estimates, we confine our attention to the estimates for 1997. Not even the OECD data are complete, however. The OECD estimates exclude subsidies arising from price supports (OECD, 2000, p.129). We shall comment on this omission at a later point.

Not all of the landings of the 16 OECD countries are taken in the NA, and consequently, not all of the fisheries subsidies reported by the OECD are relevant to the NA. We are thus required to adjust the OECD estimates, and do so by a process of pro-rating. If, for example, half of the value of landings (1997), of a particular OECD country is found to be accounted for by NA fisheries, then it is assumed that one half of the subsidies reported by the OECD are attributable to the NA. The subsidy estimates of 12 of the 16 OECD countries have to be adjusted in this fashion. The percentage of total value of landings (1997) accounted by NA fisheries are as follows for the 12: Canada (80), USA (44), Spain (50), Poland (73), Portugal (63), UK (99), Denmark (94), Netherlands (98), Ireland (21), Germany (98), France (88) and Sweden (91).

Stage 2:

Value of landings for the non-OECD 9 countries are obtained from the SAUP catch database (Watson et. al., 2001).

We calculate the total OECD subsidies, attributable to the NA, as a percentage of the value of landings of the 16 OECD countries from NA fisheries (19%). We then assume, to begin with, that subsidies as a percentage of the value of landings for the 9 non-OECD countries is the same as it is for the 16 OECD countries. Given this assumption, and the value of landings of the 9 countries, we proceed to estimate the fisheries subsidies for the 9 (See Table 2). We readily concede that this method of estimating subsidies suffers the usual criticisms and caveats that apply when a mean is used to estimate values for a given population. Our justification lies in our claim that no superior method is known to us. Non- OECD data sources, e.g., APEC (2000), provided scant assistance.

To provide a lower bound for an estimate of the fisheries subsidies for the 9, we re-calculate using the lowest of estimates of subsidies as a percentage of value of landings for the individual OECD countries. The lowest such estimate is the percentage for Iceland, 4%.

Now, consider Table 2. Total subsidies for the OECD countries for 1997 were estimated to be U.S.$1.8 billion. Subsidies for the 9 non-OECD countries were estimated to be not less than U.S.$0.2 billion, and as high as U.S.$0.7 billion. Thus, we estimate that total fisheries subsidies in the NA are in the range of U.S. $2.0 – 2.5 billion per annum.

Is it the lower or upper end of the estimate that is likely to be correct? According to a recent report (World Wildlife Fund for Nature 2001), subsidies to the fishing industry globally amounts to about 20 per cent of the total landed value of fish catch. Our upper estimate of US$2.5 billion for the North Atlantic is about 19 per cent of the landed value of fish caught in this region in 1997, while the lower estimate is much lower than 20 per cent. Hence, if one were to give weight to the recent estimate, US$ 2.5 billion is more likely to be closer to the actual amount of subsidies in the North Atlantic than U$ 2.0 billion. In fact, one may argue that even this estimate is low for the North Atlantic because the 20 per cent estimate is a global mean. Thus, some regions of the world would contribute more than this percentage, while other regions would contribute less. One would expect countries in the North Atlantic region to be one of the regions that would contribute a higher percentage to the global mean, simply because this is one region of the world that can most afford subsidies to its fishing sector. Furthermore, our estimate looks conservative if compared to the estimate of subsidies of about US$ 50 billion at the global level reported by FAO (1992).

We now turn and consider Table 1, OECD fisheries subsidies, in detail.

We first note that, of the total NA subsidies of U.S.$2,500 million (excluding those arising from price supports), approximately 36 % was accounted for by the European Union. Arnason (1999) commented that, if prizes were to be awarded to countries or entities in terms of the extent to which they subsidize their fisheries, the E.U. would be strong contender for top prize.
With regards to the breakdown of total OECD subsidies by programs, we commence by observing that approximately 48 per cent of the subsidies are accounted for by MRE (management, research, enforcement and enh-ancement) (U.S. $870 million). We agree with Flaaten and Wallis (2000) that most of these should probably be deemed to be neutral, or even positive. On the other hand, those subsidies falling into the three categories FI (fisheries infrastructure), IM (investment and mod-ernization) and TE (tax exemptions) we would certainly deem to be negative in terms of their impact upon the resources. The three combined amount to approximately U. S. $310 million, just over 17 per cent of the total. The 'Other' category (OT), amounting to U.S. $110 million (6 per cent of the total) is simply unknown. This leaves three categories, namely:

Table 2. Estimates of Government Subsidies to marine capture fisheries in countries of the North Atlantic as defined by the SAUP: 1997 (US $Million)

Country	**Landed value**	**Subsidies**	**Subsidy as % of landed value**
Belgium	99	5	*5*
Denmark	490	77	*16*
Finland	29	26	*90*
France	665	122	*18*
Germany	190	63	*33*
Iceland	877	36	*4*
Ireland	46	21	*45*
Netherlands	457	35	*8*
Norway	1,343	163	*12*
Poland	157	6	*4*
Portugal	201	42	*21*
Spain	1,722	172	*10*
Sweden	117	48	*41*
UK	1,002	128	*13*
OECD Europe	**7,395**	**1,099**	**15**
Canada	971	324	*33*
USA	1,122	386	*34*
OECD North America	**2,094**	**710**	*34*
Total OECD	***9,488***	***1,809***	**19**
Bahamas	**45**	**10**	*19*
Bermuda	**0**	**0**	*19*
Estonia	**0**	**0**	*19*
Faeroe Island	**665**	**125**	*19*
Greenland	**600**	**115**	*19*
Latvia	**140**	**25**	*19*
Lithuania	**35**	**5**	*19*
Morocco	**600**	**115**	*19*
Russia	**1,600**	**300**	*19*
Non-OECD	***3,685***	**695**	***19***
Total	*13,170*	*2,500*	
Percentage	*0.19*		

Notes to Table 2

(a) Numbers in bold are estimates of landed values from the SAUP project, and estimates of subsidies using the average percentage of landed values that are paid out as subsidies in countries in the North Atlantic that are also members of the OECD, that is, 19%. (see also Table 1). To calculate the low conservative estimate of $2.0 billion reported in the text we used 4% instead of 19%.

(b) Landed values (and subsidies) for Bermuda and Estonia are US$ 10,000 and US $ 137, 000, respectively. They appear as zero in the table only because of rounding off.

decommission subsidies (DLR), access to other countries' waters (AOC), and income support and unemployment insurance (ISU).

We choose to lump together decommissioning subsidies and subsidies to obtain access to other countries' waters, since both are designed to eliminate fleet capital from NA fisheries. The two categories of subsidies together amount to U.S. $310 million –just over 17 per cent of the total. It will be recalled that such subsidies are widely believed to be positive in terms of resource conservation. Our preceding arguments indicate that the positive impact of these subsidies is likely to be fleeting, and that, in many cases, the subsidies will prove to be decidedly negative in their impact. We might add in passing that we do not even consider in this paper the possible negative impact of AOC subsides upon the resources of those countries persuaded to grant access to fleets shifting out of NA fisheries.

The final category of subsidies consists of income support and unemployment insurance (ISU), which amounts to U.S. $210 million, approximately 11.5 per cent of the total. The question that has to be raised with regards to ISU subsidies is whether or not they are linked to fishing activities. If they are linked, e.g., subsidies depend inter alia on the amount of fishing undertaken, and then the impact is unquestionably negative. The impact is basically not different from a subsidy designed to artificially raise the price of harvested fish. These subsidies, in 1997, were accounted for almost entirely by Canada. There is overwhelming evidence that most of these Canadian subsidies are directly related to fishing activities (see, for example, Poole, 2000).

In summing up, we would, for the year 1997, place 48 percent of the OECD subsidies in the probably neutral or benign category. We would place a further 46 percent in the decidedly negative, or to be viewed with deep suspicion, category (FI + IM + TE + DLR + AOC + ISU). The remaining 6 percent we would place in the unknown category.

It should be noted that, the OECD estimates do not include subsidies arising from price supports, with the consequence that our estimates do not, as well. Our previous analysis indicates that such subsidies should, without question, be placed in our negative category. We have, at this stage of the research, no means of determining whether the missing subsidies are large, or small. Thus our subsidy estimates for the relevant OECD countries should be seen as a lower bound. Further research will be required to allow us to establish a reasonable upper bound.

It is also worth noting that we provide only a point estimate, which means that we do not provide information on trends in subsidies. However, country case studies reported in OECD (2000) tended to show that subsidies to the fishing industry in OECD member countries appear to have been falling in recent years. This may mean that subsidies are likely to decrease into the future, but it has been recently reported that fuel subsidies to the fishing sector have been rampant in certain EU member countries. This is said to be because of political pressure from the fishing industry, due to the recent fuel price increases (see the May 9, 2000 issue of WorldCatch News Network: www.worldcatch.com).

Finally, with respect to the breakdown of fisheries subsidies of the 9 non-OECD countries by programs, we can do no better than to assume that the breakdown mirrors that reported for the 16 OECD countries.

Conclusions

In this paper, we have, with the assistance of economic theory, made an attempt to examine subsidies in fisheries in the North Atlantic. Such subsidies can be expected to have both an impact upon the distribution of income, and upon fishery resource management and sustainability. We have chosen to confine our attention solely to the second impact. Subsidies can have a positive, as well as negative or neutral, impact upon fisheries management and sustainability. Our primary source of data on subsidies in the North Atlantic is the recently published study by the OECD. We conclude, tentatively, that just under 50 per cent of the NA fisheries subsidies are benign, or neutral, in terms of their impact. We also conclude that just under 50 per cent are decidedly damaging, or are to be viewed, at best, with deep suspicion. The remainder, just over 5 per cent, we cannot classify on the basis of available information.

There is wide acceptance of the view that subsidies used in vessel decommissioning (buyback) programs also have a positive impact upon fisheries management and sustainability. By reducing fleet capacity such subsidies will reduce economic waste in the fisheries and reduce pressure on the resource, or so the argument goes. We take sharp issue with this widely held view. Such subsidies, if they come to be anticipated by industry, can, and will, have a decidedly negative impact.

Subsidies in fisheries, to the extent that their impact is negative, are seen as exacerbating the problems arising from the ‘common pool’ nature of many capture fisheries. We do not question this claim. We do, however, raise the question of whether the subsidies would continue to have a negative impact if the characteristics of the fishery were removed, e.g. by the establishment of effective property rights. The answer is unquestionably yes. Under the right set of circumstances, subsidies could drive a fishery resource, supporting a fishery free of all ‘common pool’ characteristics, to extinction.

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