The impact of subsidies upon fisheries management and sustainability: the case 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 US$ 2.0–2.5 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 full-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, or are at worst, neutral. About 20% 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.

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Introduction

The impact of subsidies upon the management of fishery resources, and the surrounding aquatic ecosystem, has been a source of rapidly increasing concern and debate over the past decade and a half. The issue has been, and is being, given prominence by many international bodies, including the Food and Agricultural Organisation (FAO) of the United Nations, the *Organization for Economic Cooperation and Development* (OECD), and the World Bank (FAO 1992, 2001; Milazzo 1998; Steenblik and Munro 1999; OECD 2000). The issue has also been actively discussed by national governments, e.g. the United States (Congressional Research Services 1995), and by NGOs, such as the World Wildlife Fund for Nature (1997).

The current paper attempts to provide estimates of the level and scope of subsidies in North Atlantic fisheries. It goes beyond this, however, by entering into the debate on the impact of these subsidies on fisheries management and sustainability. There is all but universal acceptance of the fact that many fisheries subsidies undermine fisheries management and the sustainability of the resources. There does exist, however, an argument, which has broad support, that not all fisheries subsidies are damaging. An important class of subsidies, the argument continues, has a positive impact upon fisheries management and sustainability. It is this argument that provides the focus for the debate. While our contribution to the debate is made within the context of the North Atlantic, we would suggest that our conclusions are relevant and applicable to fisheries far beyond the North Atlantic.

Prior to entering into the debate and providing estimates of fisheries subsidies in the North Atlantic, we must first attempt to define and classify subsidies to be found in fisheries.

Subsidies defined and classified

The OECD, upon whose studies we draw heavily for data on North Atlantic fisheries subsidies, 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 programme that potentially permits the firm to increase its profits (through time), beyond what they would have been in the absence of the government programme' (Schrank and Keithly 1999; p. 156). We would only note that, to be included, are government programmes, which increase firm profits indirectly, as well as those that increase firm profits directly.[1]

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, relevant to the aforementioned debate, is that individual subsidies are not to be judged on an a priori basis. While some subsidies may produce socially undesirable results, others may be neutral in their effect, while yet others may produce highly desirable results (Schrank 2001).

[1]In a recent expert consultation pertaining to subsidies, the FAO includes in its definition of subsidies the impact of the absence of correcting interventions in fisheries, on the part of resource managers (FAO 2001). Later, in 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 it. 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.

The OECD study (OECD 2000) classifies subsidies/GFTs in terms of programmes, 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 programmes. The programme 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 might exceed US$ 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 US$ 15–20 billion per annum.[2] Even if one argues 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, and
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, these 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, let us next turn to an examination 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

Food and Agriculture Organisation (1992, 2001) of the US 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 over-exploitation of the fishery resources, or as economists would express it, excessive disinvestment 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.

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. Optimal economic management of capture fishery resources does, in the first instance, involve establishing of a resource investment/disinvestments programme that will (given the appropriate social rate of discount [interest rate]) yield the maximum economic returns to

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

society through time (OECD 1997; Bjorndal and Munro 1998).

Capture fisheries have in the past been characterized as being common pool, in that property rights to the resources are ill defined, or simply nonexistent (OECD 1997; NRC 1999). 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, over-exploitation is the inevitable outcome in that disinvestments in the resource(s) 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 appears to the resource manager that he/she is confronted with a fishery resource that has been over-exploited, and with a fishing fleet that has been over-capitalized. The fleet exceeds 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.

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 adds 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

We proceed by considering the consequences of subsidies under conditions of Pure Open Access. The Regulated Open Access case is discussed later.

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.

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

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

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. Then, this allows 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] Nonmalleable vessel capital is one that 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 nonmalleable vessel capital,[6] which enables us to describe the optimal resource exploitation programme, and then to examine the consequences of Pure Open Access (for a detailed discussion of the model, consult Clark *et al.* (1979) and McKelvey (1986)).

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. Then, we then have (Clark *et al.* 1979):

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

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.

[5] This is a concept analogous to that of 'liquidity' in finance.
[6] For examples of empirical/numerical fisheries models that incorporate nonmalleability fleet capital (see Charles 1983; Charles and Munro 1985; and Sumaila 1995).

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

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

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) be the unit purchase price of vessel capital, and c_s the unit 'scrap value' (re-sale value) of vessel capital. We deem vessel capital to be perfectly malleable if:

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

and to be perfectly nonmalleable 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:

$$c_s = 0; \quad \gamma > 0 \tag{5}$$
$$0 < c_s < c_1; \quad \gamma \geq 0 \tag{6}$$

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

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

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) 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:

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

where $c_{\text{var}}(x)$ denotes unit variable cost of harvesting:

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

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:

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

where δ denotes the social rate of discount and γ 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 the vessel capital be characterized by Equation (5). The capital has a re-sale value of zero, but it has a positive depreciation rate. As an aside, because this 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.

For the sake of convenience, let it be supposed, that we commence with a virgin resource stock, $x(0) = x_0$. 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:

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

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

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

$$p - c_{\text{total}}(x^*) - \frac{1}{\delta} \times \frac{\mathrm{d}}{\mathrm{d}x^*}\{(p - c_{\text{total}}(x^*))F(x^*)\} = 0 \tag{13}$$

The expression:

$$\frac{1}{\delta} \times \frac{\mathrm{d}}{\mathrm{d}x^*}\{p - c_{\text{total}}(x^*))F(x^*)\}$$

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 re-invest 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 be zero.

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

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

where

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

The remaining key question is the decision rule that should to be followed by the resource manager in investing in fleet capacity at $t_0 = 0$, $x(0) = x_0$. Once a vessel is purchased, the cost of the vessel acquisition, c_1, becomes a 'sunk' cost, which can be considered as bygone, in the sense that it cannot be recouped. From thereon, 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

[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.

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 $c_s = 0$ and $\gamma > 0$. 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 (denoted as x^0) which corresponds to Bionomic Equilibrium in fisheries economics (Gordon 1954). The Bionomic Equilibrium biomass, x^0, will be given by an equation that is similar to Equation (13), but with one fundamental difference. The second term on the LHS of Equation (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 from his/her perspective perceives the aforementioned marginal sustainable economic rent to be equal to zero. Hence, the fishers collectively deems the shadow price, itself, to be equal to zero. The biomass level x^0, corresponding to Bionomic Equilibrium, is thus given by the following equation:

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

From Equation (13), 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 be assured that $x^0 < x^*$. Pure Open Access leads, unequivocally to over-exploitation of the resource from society's point of view. McKelvey (1986) analysis also assures us, not surprisingly, that the investment in fleet capacity at $t = 0$ under Pure Open Access exceeds the optimal investment in such capacity that would be undertaken by the all-seeing resource manager.

Now return to Equation (16) and consider the impact of the introduction of subsidies. Recall that both unit-operating cost, c and the purchase price of vessel capital, c_1 enter into $c_{\text{total}}(x)$. We can then say that *any* subsidy, which (i) increases p; (ii) reduces c; (iii) reduces c_1; as perceived by the fishers results in a more intense exploitation of the resource. Let $x^{0\prime}$ be the long-run equilibrium biomass under Pure Open Access, given a subsidy, or subsidies, that lead to (i)–(iii) points cited above, or some combination of the three. Then, the case follows that: $x^{0\prime} < x^0$. 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. Equation (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 & Pitcher 1996).

Suppose then, that a full-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. Therefore, the government as resource manager while maintaining nominal control of the resource, does, to all intents and purposes, relinquish resource management rights to the 'corporation.' Although all these may sound far fetched, there are, in fact, indications that the management of fisheries in few fishing nations is evolving in 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 (Gordon 1954; Scott 1955).

Suppose, initially, that the corporation is not subsidized, and suppose, as before, that we commence with a virgin 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, Equations (1–15), would apply to the 'corporation', without modification, and not surprisingly, the results would be the same. The corporation, beginning with a virgin stock, $x(0) = x_0$, would deplete the stock and eventually stabilize at a long-run equilibrium level which shall be denoted as x^{**}, given by:

$$p - c_{\text{total}}(x^{**}) - \frac{1}{\delta} \times \frac{\mathrm{d}}{\mathrm{d}x^{**}}\{(p - c_{\text{total}}(x^{**}))F(x^{**})\} = 0 \tag{17}$$

or alternatively

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

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 d confronting the 'corporation', it will be found that $x^{**} = x^*$, the socially optimal long-run equilibrium biomass level (see Equations 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. That is to say, the government assumes, with respect to resource management and sustainability, that the impact of the subsidies will be neutral. Everything else is assumed to remain the same.

The consequences of the introduction of subsides are straightforward. Returning 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' reduces the level of x^{**}, leading to $x^{**} < x^*$. The corporation over-exploits 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 programme, 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 result in: $x^{**} < x^0$, 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.

[8]Maximum sustainable yield, in the model occurs at the biomass level, x_{MSY}, at which $F'(x_{\text{MSY}}) = 0$, 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. $x^0 > x_{\text{MSY}}$. Suppose that this is indeed the case, and now return to Equation (18), and evaluate it at $x^0 = x_{\text{MSY}}$. 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: $\frac{-c'_{\text{total}}(x_{\text{MSY}})F(x_{\text{MSY}})}{p - c_{\text{total}}(x_{\text{MSY}})} = 0.05$. Since $F'(x_{\text{MSY}}) = 0$, it will indeed prove to be the case that $x^{**} = x_{\text{MSY}}$. Hence, $x^{**} < x^0$.

If the super-cost-reducing subsidy is introduced to the corporation fishery, Equation 18 reduces 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 over 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, we have employed, is the Schaefer model. In this 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, $F'(x)$ approaches what is referred to as the intrinsic growth rate, a constant denoted by w (see Clark 1990). Clark demonstrated that under the circumstances described, there will be no solution to Equation (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 re-investing 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 modelled, 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 came to be seen 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, Porter (2001), 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.

[9] A slow-growing resource, such as whales provide a case in point (Clark 1985).

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 harvest, but in the past have exercised, or now exercise inadequate control over the fleet size. The limited harvest becomes the 'common pool'. A question that can be readily dealt with is as follows. Suppose that the authorities, while retaining control over the total harvest, remove the '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 proves 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 (see R. Hannesson 2000; Fisheries subsidies in the Nordic countries. Unpublished paper commissioned by the World Wildlife Fund for Nature).

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 harvest, 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.

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 buy-back, or decommissioning, scheme.

The purpose of a buy-back 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 buy-backs 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 buy-back purposes (Milazzo 1998). Milazzo is not alone. Schrank and Keithly (1999) point out that recent American legislation pertaining to fisheries explicitly supports the view that subsidies used for buy-back purposes are beneficial.

Decommissioning schemes have often been criticized on the grounds that they are, over the long run, ineffective. This is partly because vessel capacity, once removed from a fishery by such a scheme, tends to seep back in, over time (see, for example, Holland *et al.* 1999; Cunningham and Gréboval 2001). The implication is not that subsidies used to support such schemes are harmful. It is rather that the positive impact of these subsidies is ephemeral, or nonexistent, which would imply, in turn, that the impact is neutral. It is our contention that such subsidies can, in fact, have a markedly negative impact.

Let us 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 preventing vessel capital from seeping back into the fishery.

In our investigation, we shall draw heavily upon a recent paper by Clark and Munro (1999). In doing so, we use much the same economic model of the fishery as we did in the section on *The basic economics of the subsidies in fisheries: part one*. There are two differences. First, in that section, 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 explicitly deal with season-by-season fishery. Second, we shall be able to make our points with greater clarity by supposing that both the rate of depreciation, and the 'scrap value', are equal to zero. Finally, we also assume, for simplicity, the absence of 'crowding' externalities, that is, a vessel gear destroying other vessel gears due to overcrowding.

Now let us assume that the resource managers specify an annual Total Allowable Catch (TAC) that remains fixed for all future time. Let Q be 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 be the actual fleet size. The harvest rate is z tonnes day^{-1} vessel^{-1}. Thus, if K vessels fish for D days during the year, the fleet's total annual harvest is zKD.

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

As earlier, let p (a constant) be the price of harvested fish, and c the unit-operating profits. Thus, the fleet annual net operating profits are given by:

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

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

$$\pi_{\mathrm{An}} = \left(p - \frac{c}{z}\right)Q \tag{20a}$$

Next, let r be the annual rate of interest; K_0 be the minimum fleet required to take the allotted TAC $= Q$, i.e. $Q = zK_0D_{\max}$. Let K_{ROA} be the 'equilibrium' fleet size under Regulated Open Access. Finally, as earlier, let c_1 be 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 $[\pi_{\mathrm{An}}] \times (1 + r)/r$. We 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. $\{[\pi_{\mathrm{An}}] \times (1 + r)/r\}/K$. Thus, investment in additional fleet capital will be profitable, if it is true that:

$$c_1 < \frac{\pi_{\mathrm{An}} \times \frac{1+r}{r}}{K} \tag{21}$$

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

$$c_1 K_{\mathrm{ROA}} = \pi_{\mathrm{An}} \times \frac{1 + r}{r} \tag{22}$$

which can be re-expressed as:

$$K_{\mathrm{ROA}} = \pi_{\mathrm{An}} \times \frac{1 + r}{rc_1} \tag{22a}$$

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

$$c_1 K_0 = \pi_{\mathrm{An}} \times \frac{1+r}{r}$$

we shall certainly find that $K_{\mathrm{ROA}} > K_0$, 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:

$$\pi_{\mathrm{An}} \times \frac{1+r}{r} - c_1 K_0$$

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, the loss cannot be reversed.

Now, let us consider the economic consequences of a buy-back 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. In addition, we assume that: $Q = 10\ 000$ tonnes; $z = 1$ tonne day^{-1} per vessel; $p = \$1000$ tonne^{-1}; $c = \$500$ day^{-1} per vessel; $c_1 = \$500\ 000$ per vessel; $r = 0.10$, i.e. 10% per annum. Total annual fleet net operating profits will be:

$$\pi_{\mathrm{An}} = \left(\frac{p-c}{z}\right) Q = \$5\,000\,000\,\mathrm{year}^{-1} \tag{23}$$

while the optimal fleet size will be:

$$K_0 = \frac{Q}{zD_{\max}} = 50\ \mathrm{vessels} \tag{24}$$

Let it be supposed that 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 buy-back/license-limitation scheme, with the objective of reducing $K = 50$ and maintaining 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:

$$K_{\mathrm{ROA}} = \left(p - \frac{c}{z}\right) Q \left(\frac{1+r}{c_1 r}\right) = (\$1000 - \$500) \times \frac{10000(1.10)}{c_1 r} = 110\ \mathrm{vessels} \tag{25}$$

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' buy-back programme, 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 programme 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 programme is indeed fully effective. Henceforth, the fleet remains at $K = K_0$.

The government has thus spent \$66 000 000. Immediately prior to the buy-back, 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 enjoy unrealised gains of \$30 000 000.

The consequences of the emergence of excess capacity, under Regulated Open Access, are, we had said at an earlier point, two-fold. First, it will result in economic waste. Second, 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 programme.

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' buy-back programme 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 programme will be entirely successful.

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

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

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 continues as one of the remaining 50. Also observe that Equation (26) can be re-written as:

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

In any event, in our example, we have:

$$K'_{\mathrm{ROA}} = \$35722836 \times \frac{1}{\$75093} \approx 476 \tag{27}$$

The implication is that the eminently 'successful' buy-back programme 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 buy-back programme, the Redundancy Deadweight Loss to the economy would have been \$30 million, less than 15% of the loss brought on by the buy-back programme.

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 buy-back programme, 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 buy-back programme induces a large investment in fleet capacity is made transparent by the RHS of Equation (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, a very substantial one, equal to just under \$425 000 per vessel which is, in turn, equal to 85% of the purchase price.

With respect to economic waste, the buy-back 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 buy-back actually comes into effect. Thus, when anticipated, the 'good' buy-back 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 macro-economics is referred to as 'Rational Expectations' (see, for example, Sargent 1986; Turnovsky 2000). The argument put forth is that members of an economy, e.g. firms and households, do not react passively to changes in macro-policy, but 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 that 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 programme, can enforce it with complete effectiveness. More often than not, the 'best case' does not prevail. The consequence, as we noted earlier, is that, when a buy-back programme is implemented, and is accompanied by a limited-entry programme, capacity will tend to seep back into the fishery. Eventually, a new round of buy-backs will be called for. There is ample evidence that capacity does indeed seep back into fisheries after buy-back/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 programmes are perfectly enforceable. First, the size of the subsidies associated with anticipated buy-backs will be less. Imperfect limited-entry programmes imply lower expected future resource rents. Second, while vessel owners may be taken by surprise by a buy-back programme 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.

With the discussion of the impact of fisheries subsidies now complete, we turn to an examination of the level and scope of such subsidies in a specific region, namely the North Atlantic.

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

In this section, we shall provide estimates of the major classes of fisheries subsidies in the North Atlantic. Following this, we shall attempt to assess the potential impact of the differing classes of subsidies upon resource conservation and management. In so doing, we shall draw upon the economic analysis of the preceding section.

Estimates of subsidies

The definition of North Atlantic adopted is that used by the aforementioned Sea Around US Project (Watson *et al.* 2001), which includes 25 countries (see Table 2). For our purposes, these countries are divided into two subgroups: 16 with OECD and 9 without it.

With regards to estimates of fisheries subsidies in the North Atlantic region, 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 say, 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 and data on fisheries subsidies in the non OECD countries (e.g. APEC 2000). Our estimates of fisheries subsidies in the nonOECD countries are thus essentially educated guesses.

We, therefore adopt 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 nine country. 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 2 years (1996–1997). As 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 account for 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

[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$ in million).[a]

Country	MRE	FI	IM	TE	DLR	AOC[b]	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
UK	82.2	14.9	4.0	–	22.8	–	–	4.0	127.7	1002	13
European Union	377.7	49.4	82.7	0.6	153.6	155.0	3.6	71.2	893.9	5018	18
Iceland	18.0	–	–	18.0	–	–	–	–	36.0	877.0	4
Norway	98.0	–	14.0	34.0	–	–	3.0	14.0	163.0	1343	12
Poland	5.8	–	–	–	–	–	–	–	5.8	157.0	4
Non European Union	121.8	–	14.0	52.0	–	–	3.0	14.0	204.8	2377	9
Atlantic Canada	80.0	28.0	–	–	–	–	198.4	17.6	324.0	971.2	33
Atlantic US	292.2	4.8	13.2	66.0	1.8	–	–	7.9	385.9	1122	34
North America	372.2	32.8	13.2	66.0	1.8	–	198.4	25.5	709.9	2094	34
Total	871.7	82.3	109.9	118.6	155.4	155.0	205.0	110.7	1809	9488	19

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.

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

[b]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% 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% of the access subsidies are also accounted for by these EU members.

[c]Subsidy estimates for Canada, the USA, 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 terms of value).

(99), Denmark (94), the Netherlands (98), Ireland (21), Germany (98), France (88) and Sweden (91).

Stage 2

Value of landings for the nine non OECD 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 nine non OECD countries is the same as it is for the 16 OECD countries. Given this assumption, and the value of landings of the nine countries, we proceed to estimate subsidies for the nine (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 nine OECD countries, we recalculate using the lowest of estimates of subsidies as a percentage of value of landings for the individual OECD countries. The lowest such estimate is 4% for Iceland.

Now, consider Table 2. Total subsidies for the OECD countries for 1997 were estimated to be US$ 1.8 billion. Subsidies for the nine non OECD countries were estimated to be not less than US$ 0.2 billion, and as high as US$ 0.7 billion. Thus, we estimate that total

Table 2 Estimates of government subsidies to marine capture fisheries in countries of the North Atlantic as define by the SAUP, 1997 (US$ in 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	1343	163	12
Poland	157	6	4
Portugal	201	42	21
Spain	1722	172	10
Sweden	117	48	41
UK	1002	128	13
OECD Europe	**7395**	**1099**	**15**
Canada	971	324	33
USA	1122	386	34
OECD North America	**2094**	**710**	34
Total OECD	**9488**	**1809**	**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	**1600**	**300**	19
Non OECD	**3685**	**695**	**19**
Total	13170	2500	
Percentage	0.19		

[a]Values in bold are estimates of landed values from the SAUP project, and estimates of subsidies using the average percentage of landed values that is 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 137 000, respectively. Values appearing as zero in is because of rounding off of the values.

fisheries subsidies in the NA are in the range of US$ 2.0–2.5 billion per annum.

We now turn and consider Table 1, OECD fisheries subsidies, in detail. We first note that, of the total OECD subsidies of US$ 1810 million (excluding those from price supports), approximately 36% was accounted for by the European Union. Arnason (1999) commented that if world prizes were to be awarded to countries or entities in terms of the extent to which they subsidize their fisheries, the EU would be strong contender for top prize.

Subsidies assessed

With regards to the breakdown of total OECD subsidies by programmes, we commence by observing that approximately 48% of the subsidies are accounted for by management, research, enforcement and enhancement (MRE, US$ 870 million). There is no obvious reason why such subsidies should increase prices received by fishers for harvested fish, or lower fishers' costs. Hence, these subsides should not lead to the intensification of the exploitation of the resources. On the contrary, many of these subsidies may result in the conservation of the resources and the quality of resource management being enhanced. Thus, we agree with Flaaten and Wallis (2000) that most of these subsidies should probably be deemed to be neutral, or even positive. Hence, we do willingly concede that some subsidies used in fisheries can have a neutral or positive impact.

On the other hand, those subsidies falling into the three categories, FI, IM and TE, clearly have the effect of reducing fishers' costs. We would certainly deem to be negative in terms of their impact upon the resources. The three combined amount to approximately US$ 310 million, just over 17% of the total. The 'Other' category (OT), amounting to US$ 110 million (6% of the total) is simply unknown. This leaves three categories, namely DLR, AOC and ISU.

We choose to lump together the 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 US$ 310 million –just over 17% 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 subsidies upon the resources of those countries persuaded to grant access to fleets shifting out of NA fisheries.

As great emphasis is laid on the possible negative effects of decommissioning subsides, it behooves us to ask if we can point to any examples of such effects in the North Atlantic. An example does, in fact, exist in the form of a recent empirical study on decommissioning in the EU, undertaken by two Danish economists, Jörgensen and Jensen (1999). In Table 1, it will be seen that in 1997, of the US$ 310 million of decommissioning subsidies, broadly defined, 99% were accounted for by the EU.

Jörgensen and Jensen concluded that decommissioning subsidies in the EU do indeed act to stimulate investment in fleet capacity. Such subsidies not only affect EU investors in fleet capacity directly but also the investors' bankers. The evidence shows that decommissioning subsidies lead to the bankers offering would be investors in fleet capacity more generous credit terms, than would otherwise be the case. The authors point out that their results confirm those arising from an earlier Danish–Dutch study (Frost et al. 1996).

Jörgensen and Jensen conclude by stating that "... decommissioning, an instrument which is not considered normally under the heading of subsidization, ... could have effects, which resemble the effects of direct and indirect subsidies" (Jörgensen and Jensen 1999; p. 248). They then remark that "... the use of subsidies to solve problems in the fishing sector works as putting out a fire by using petrol" (Jörgensen and Jensen 1999, *ibid*). In many ways, our discussion of decommissioning subsidies in the previous section can be seen as providing the theoretical underpinnings for the Jörgensen and Jensen's results.

The final category of subsidies consists of income support and unemployment insurance (ISU), which amounts to US$ 210 million, approximately 11.5% 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% of the OECD subsidies in the probably neutral or benign category. We would place a further 46% in the decidedly negative, or to be viewed with deep suspicion category (FI + IM + TE + DLR + AOC + ISU). The remaining 6%, 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 WorldCatch News Network, available at http://www.worldcatch.com, issue: 9 May 2000).

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

Conclusion

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% of the NA fisheries subsidies are benign, or neutral, in terms of their impact. We also conclude that just under 50% are decidedly damaging, or are to be viewed, at best, with deep suspicion. The remainder (just over 5%) could not be classified on the basis of available information.

There is wide acceptance of the view that subsidies used in vessel decommissioning (buy-back) programmes 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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When the Fisheries Centre, University of British Columbia commenced the first phase of its Sea Around US Project (SAUP: see http://www.fisheries.ubc.ca) focused on the North Atlantic, it seemed obvious that one issue, which would have to be examined was the magnitude, and the impact of fisheries subsidies upon resource management in the region. This paper arises from the resultant SAUP study on fisheries subsidies in the North Atlantic. We would like to thank the Environment Project of The Pew Charitable Trusts, Philadelphia, for its financial support through the Sea Around US Project. We would also like to thank our colleague, Colin W. Clark, for his unstinting advice and assistance, and to thank the participants in the April 2001, Sea Around US Final Report Workshop, Nanaimo, Canada, for their insightful comments. Finally, we would like to acknowledge the many useful comments of the four referees for this paper.

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