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Shared Fish Stocks and High Seas Issues

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A. INTRODUCTION

The management of world capture fishery resources, which currently yield annual harvests in the order of 85 million tonnes (Normura, 2004), has been plagued by the fact that, historically, the resources have been “common pool” in nature, i.e. open to all. It is easy to demonstrate that, when commercially valuable fishery resources have the characteristic of being “common pool,” the consequences are overexploitation of the resources, from society’s point of view, and economic waste (Bjørndal and Munro, 1998).

An international attempt to mitigate the “common pool” aspect of world capture fishery resources was undertaken through the 1973-1982 UN Third Conference on the Law of the Sea, which brought forth the UN Convention on the Law of the Sea (UN, 1982), which did, in turn, come into force in 1994. Prior to the 1982 UN Convention, the fisheries jurisdiction of coastal states (states with significant marine coastlines) extended out to a maximum of 12 miles (19 km) from shore. Under the 1982 UN Convention, coastal states have been enabled to establish Exclusive Economic Zones (EEZs) out to 200 nautical miles from shore. The coastal states do, to all intents and purposes, have property rights to the fishery resources contained within their respective EEZs (McRae and Munro, 1989). Vast amounts of hitherto international “common pool” fishery resources became coastal state property, as a consequence. It has been estimated that as much as 90 per cent of the world’s capture fishery resources are encompassed by EEZs (Eckert, 1979).

The EEZ regime has, however, brought with it its own set of fishery resource management problems, one of the most important of which arises from the mobility of fish encompassed by the EEZs. The typical coastal state, upon establishing an EEZ, found that some of the fishery resources, encompassed by the EEZ, crossed the EEZ boundary into neighbouring EEZs, the adjacent high seas, or both, where they were subject to exploitation by other states. Such fishery resources are deemed by the FAO to be “shared,” i.e. subject to exploitation by two or more states. It is estimated that as much as one third of the world capture fishery harvests are based upon shared fishery resources (Munro, Van Houtte and Willmann, 2004). This paper is concerned with the economic management of such shared capture fishery resources.

The FAO sets our four non-mutually exclusive categories of shared fish stocks, these being:

1. transboundary stocks – fishery resources moving from one EEZ to one, or more neighbouring EEZs.
2. highly migratory stocks (tuna primarily), which because of their nature cross the EEZ boundary into the adjacent high seas, where they become subject to exploitation by so called

distant water fishing states (DWFSs). A DWFS is a fishing nation, some of whose fishing fleets operate far beyond that state's home waters

3. straddling stocks – all other fish stocks crossing the EEZ boundary into the adjacent high seas.
4. discrete high seas stocks – those few stocks remaining wholly in the high seas (Munro, Van Houtte and Willmann, 2004).

We shall, in this paper, have nothing to say about Category 4 stocks, which, currently, are of minor economic importance. Categories (2) and (3) stocks can, for our purposes, be safely merged. We shall, from hereon in, refer to the merged categories, simply as straddling fish stocks.

In light of the small percentage of capture fish stocks estimated to lie outside of the EEZs, it might seem reasonable to suppose that the management of straddling fish stocks would present only a minor resource management problem. Such was the view at the close of the UN Third Conference on the Law of the Sea in 1982 (Kaitala and Munro, 1993). This view proved to be wholly unfounded, however. So serious a problem did the management of these resources become that the UN found it necessary to mount an international conference devoted solely to the management of these stocks, a conference popularly referred to as the UN Fish Stocks Conference, 1993-1995. The Conference produced an agreement, popularly referred to as the UN Fish Stocks Conference,[1] which came into force in 2001 (UN, 1995). The 1995 UN Agreement serves, not to supplant any part of the 1982 UN Convention, but rather to supplement and buttress the Convention (Munro, et al., *ibid.*).

In proceeding to examine the economics of the management of shared fish stocks, we shall first consider the relatively simple case of transboundary fish stocks, and then deal with the more complex case of straddling fish stocks. We conclude with a case study of the cooperative management of a major straddling fish stock, namely the Norwegian Spring Spawning Herring stock, and of a highly migratory fish stock, the East Atlantic Bluefin Tuna fishery..

The economics of the management of transboundary and straddling fish stock consists of a blend of the dynamic economic model of fishery resources confined to a single EEZ – unshared fish stocks – and the theory of games. To set the stage, then, let us first review the economics of the management of unshared fish stocks:

[1] The full names of the Conference and the Agreement are: United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, 1993-1995; Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, (UN, 1995).

B. THE BASIC ECONOMICS OF THE MANAGEMENT OF UNSHARED FISH STOCKS: A REVIEW[2]

In this review, we look first at the "ideal," the management of an unshared fish resource under an all-powerful social manager, in which all "common pool" aspects of the resource are eliminated. We then turn to the polar opposite of a pure open access fishery, in which the "common pool" aspects of the resource are unchecked.

The All-Powerful Social Manager

We assume a deterministic world, and suppose that the relevant underlying biological model is the general production model of M.B. Schaefer (see: Clark, 1990). The resource dynamics are described by the following differential equation model.

$$\frac{dx}{dt} = F(x) - h(t), \quad x(0) = x_0 \tag{1}$$

$$h(t) = qE(t)x(t) \tag{2}$$

where $x(t)$ is the non-negative state variable representing the biomass at time t, $F(x)$ is the growth function of the biomass, $h(t)$ is the harvest rate, q, a constant, is the catchability coefficient, hereafter assumed to equal 1, and $E(t)$ is fishing effort, defined as the flow of labor and capital serviced devoted to harvesting fish. The usual assumptions made are that $F(x) > 0$ for $0 < x < K$. The biomass K is often referred to as the carrying capacity. In the analyses below, it is assumed that E is of the feedback form, such that $E(t) = E(x(t))$. Furthermore, we assume that $0 < E(x) < E^{max}$.

Now let us assume that the demand for harvested fish and the supply of fishing effort are both perfectly elastic. Let p and a, both constants, denote the price of harvested fish, and the unit cost of fishing effort respectively. The net revenue from the fishery, or resource rent, at time t is given by:

$$\pi = (px - a)E \tag{3}$$

or alternatively:

$$\pi = (px - c(x))h \tag{4}$$

where $c(x)$, the unit cost of harvesting, is given by $c(x) = a/x$ (recall our assumption that $q = 1$).

[2] Parts B and C of this chapter draw heavily upon Bjørndal , Kaitala, Lindroos and Munro, 2000.

The objective of management, from society's point of view, is to maximize the present value of the resource rent:

$$\max J(x_0, E) = \int_0^\infty e^{-\delta t}[px(t) - a]E(t)dt \qquad (5)$$

such that Eq. (1) holds, and where δ is the social rate of discount.

Consider next the optimal strategy for the All-Powerful Social Manager, in managing the resource. The problem has a unique optimal solution in which the harvesting strategy $E(x)$ is discontinuous in the state variable x. There is an optimal steady state x^* (that is, an optimal resource stock level x^*) that is determined by the following equation (see: e.g. Clark and Munro, 1975):

$$F'(x^*) + \frac{\partial\pi / \partial x^*}{\partial\pi / \partial h\big|_{h=F(x^*)}} = \delta \qquad (6)$$

The second term on the L.H.S. of Eq. (6) is the so-called Marginal Stock Effect, which reflects the impact of marginal investment in the resource on harvesting costs.

Given that the capital employed in harvesting is perfectly malleable, the optimal approach path is the most rapid one. Denoting the optimal fishing effort by $E^*(x)$ we have the following most-rapid-approach rule:

$$E^*(x) = \begin{cases} E^{\max} & \text{for} \quad x(t) > x^* \\ F(x^*)/x^* & \text{for} \quad x(t) = x^* \\ 0 & \text{for} \quad x(t) < x^* \end{cases} \qquad (7)$$

In other words, when the stock level exceeds the optimal steady state level x^* then the maximum fishing effort is applied until the stock level reaches the level x^*. On the other hand, if the stock level is sub-optimal, then $E(x)$ is set equal to zero, and the stock is allowed to recover at the most rapid rate, until the level x^* is reached. If it should have been the case that our model was non-linear, e.g. if we had $p = p(h)$, or that the capital employed in harvesting was not perfectly malleable, the most rapid approach path would not have been optimal (see Clark, 1990).

A "Common Pool" Fishery à Outrance

The polar opposite to the case of an All-Powerful Social Manager is that, in which, the fishery is a pure open-access one, subject to no government regulations of any form. In this case, the biomass will be driven below the social optimum, x^*, to a point where the resource rent is fully dissipated.

The founder of modern fisheries economics, H. Scott Gordon, referred to the resultant equilibrium as Bionomic Equilibrium (Gordon, 1954), which can be seen as a benchmark of fisheries exploitation undesirability. Denote the Bionomic Equilibrium biomass as x^{∞}, which is given by:

$$p - c(x^{\infty}) = 0 \qquad (8)$$

It can be shown that $x^{*} = x^{\infty}$, if and only if, $\delta = \infty$ (Clark and Munro, 1975). The implication is that, under pure open access, fishermen are given the incentive to discount wholly all future returns from the fishery.

C. THE MANAGEMENT OF TRANSBOUNDARY FISH STOCKS

Now let it be supposed that the resource in question, rather than being confined to the waters of a single EEZ, crosses the EEZ boundary into the EEZs of one or more neighbouring coastal states, and, as such, is a shared stock. Let us suppose, initially, that the resource is shared by two neighbouring coastal states only, which we shall designate as coastal states I and II.

The Two Coastal State Case

Under the terms of the 1982 UN Convention on the Law of the Sea, the two coastal states I and II, are called upon to enter into negotiations over the cooperative management of the resource (UN, 1982, Article 63(1)). Having said this, however, the two states are not required to establish a cooperative resource management arrangement. If the two states do not establish a cooperative arrangement, then each is to manage the segment of the resource within its EEZ in accordance with the other provisions of the 1982 UN Convention (Munro, et al., 2004). Let us refer to this as the default position.

The default position, non-cooperative management, is modeled theoretically as an infinite horizon non-cooperative game (Kaitala 1986; Mesterton-Gibbons 1993). We shall employ Nash's model of a two player non-cooperative game (Nash, 1951). It is assumed that there is strategic interaction between the coastal states, in the sense that I's harvesting of the resource will have an impact on II's harvesting activities, and vice-versa. If there was no strategic interaction between the two, there would be no basis for a non-cooperative, or a cooperative, game, and considerations of cooperative management would largely be beside the point.

Let us now assume that the fishing effort costs of the two coastal states differ, such that $a_{\mathrm{I}} < a_{\mathrm{II}}$, i.e. I is a more efficient harvester than II. It can be easily shown, in the context of our model, that: $x_{\mathrm{I}}^{*} < x_{\mathrm{II}}^{*}$; $x_{\mathrm{I}}^{\infty} < x_{\mathrm{II}}^{\infty}$. We shall assume that $x_{\mathrm{II}}^{\infty} < x_{\mathrm{I}}^{*}$.[3]

We know from game theory analysis, that when the two coastal states act non-cooperatively, the Nash non-cooperative feedback equilibrium solution (Nash, *ibid*.) is such that the resource will be depleted in a most rapid approach manner until x_{II}^{∞} has been reached (Clark, 1980). Then, the non-cooperative feedback strategies of the two coastal states can be defined as:

$$E_{\mathrm{I}}^{N}(x) = \begin{cases} E_{\mathrm{I}}^{\max} & \text{for } x > \min(x_{\mathrm{I}}^{*}, x_{\mathrm{II}}^{\infty}) \\ F(x)/x & \text{for } x = \min(x_{\mathrm{I}}^{*}, x_{\mathrm{II}}^{\infty}) \\ 0 & \text{for } x < \min(x_{\mathrm{I}}^{*}, x_{\mathrm{II}}^{\infty}) \end{cases} \tag{9a}$$

$$E_{\mathrm{II}}^{N}(x) = \begin{cases} E_{\mathrm{II}}^{\max} & \text{for } x > x_{\mathrm{II}}^{\infty} \\ 0 & \text{for } x < x_{\mathrm{II}}^{\infty} \end{cases} \tag{9b}$$

Given our assumption that $x_{\mathrm{I}}^{*} < x_{\mathrm{II}}^{\infty}$, the transboundary resource will be subject to overexploitation. Clark (1980) demonstrates that, if $a_{\mathrm{I}} = a_{\mathrm{II}}$, i.e. the two players are symmetrical, the resource will be driven down to the common Bionomic Equilibrium. Thus, other than in exceptional circumstances, cooperation does indeed matter.

The payoffs to I and II in the noncooperative game can be seen as the present value of the net economic return, or resource rent, accruing to I and II, respectively. Let us denote the payoffs to I and II, arising from the solution to the non-cooperative game as: $J_{\mathrm{I}}(x(0), E_{\mathrm{I}}^{\mathrm{N}}, E_{\mathrm{II}}^{\mathrm{N}})$ and $J_{\mathrm{II}}(x(0), E_{\mathrm{I}}^{\mathrm{N}}, E_{\mathrm{II}}^{\mathrm{N}})$. In our following discussion of a cooperative fisheries game, these payoffs are seen to constitute the Threat Point payoffs.

Having determined the consequences of non-cooperation, we investigate opportunities for cooperative management. In so doing, we seek to measure the economic benefits of cooperation, and to address the question of the sharing these cooperative benefits in an equitable manner. We turn to Nash's two player model of a cooperative game for guidance (Nash, 1950; 1953).

[3] If $x_{\mathrm{I}}^{*} < x_{\mathrm{II}}^{\infty}$, the case would be uninteresting. Coastal state I would drive II out of the fishery and manage it optimally as an unshared fishery.

The two minimum conditions, which must be met if the solution to the cooperative fisheries game is to prove to be stable, are as follows. First the solution must be Pareto optimal. Secondly, the Individual Rationality constant must be satisfied, in that each player must be assured a payoff at least as great as its Threat Point payoff, which we have defined as arising from the solution to a non-cooperative game.

Now let us examine the details of cooperative resource management arrangements of the transboundary stock by the two coastal states. We assume that cooperative arrangements, upon being achieved, are binding (but see Kaitala and Pohjola, 1988), and that side payments between the players are a feasible policy option. Kaitala and Munro (1993) show that in this particular game setting I will buy out II. Furthermore, the cooperative arrangement will be focused on the sharing of the total net returns from the fishery between the two.

Let $\omega(x(0))$ denote the present value of the global net economic returns from the fishery, commencing at $x = x(0)$, following the optimal harvest strategy of I. Let $\omega_{\mathrm{I}}(\mathrm{x}(0))$ and $\omega_{\mathrm{II}}(x(0))$ denote the share of I and II respectively of the global net economic returns from the fishery under a cooperative resource management arrangement. We have:

$$\omega(x(0)) = \omega_{\mathrm{I}}(\mathrm{x}(0)) + \omega_{\mathrm{II}}(x(0)) \tag{10}$$

The shares, defined by Eq. (10), are Pareto optimal. If I(II) receives additional benefits from the fishery, it can only do so at the expense of II(I).

Given that the Individual Rationality Constraint is satisfied, we can define the Cooperative Surplus, $e(x(0))$ as the difference between $\omega(x(0))$ and the sum of the Threat Point payoffs. Thus, we have:

$$e(x(0)) = \omega(x(0)) - \left[\sum_{i=\mathrm{I}}^{\mathrm{II}} \mathrm{J_i}(x(0), E_{\mathrm{I}}^{N}, E_{\mathrm{II}}^{N} \right] \tag{11}$$

An application of the bargaining scheme of Nash (1950) leads to the outcome that, under the side payments regime, the cooperative Surplus will be divided evenly between I and II (Kaitala and Munro, 1997). The cooperative solution payoffs to I and II can be expressed as follows:

$$\omega_i(x(0)) = e(x(0))/2 + \mathrm{J_i}(x(0), E_{\mathrm{I}}^{N}, E_{\mathrm{II}}^{N}), \quad i = \mathrm{I, II} \tag{12}$$

This result will hold true, even though I and II are, in economic terms, quite different. The rationale in applying the Nash bargaining scheme is that, upon joining the agreement each coastal state can be seen to make equal contribution to reaching the agreement and to generating the subsequent economic benefits.

A recent empirical application of the model described is to be found in the article of Bjørndal and Lindroos on the North Sea herring resource (Bjørndal and Lindroos, 2004). The transboundary resource is managed cooperatively by a coastal state, Norway, and by what we might call a coastal state entity, the EU. The authors' best estimates show Norway's fishing effort costs to be significantly below those of the EU. Political considerations prevent Norway from ''buying out" the EU in this case. Even though the *optimum optimorum* is not achievable, the Cooperative Surplus is substantial, as a consequence of the fact that the resource is highly vulnerable to overexploitation (Bjørndal and Lindroos, *ibid*.).

The Case of Three or More Coastal States

Now let it be supposed that the resource, rather than being shared between two neighbouring coastal states, is shared among three such states, I, II and III. When three, or more, players are involved in the cooperative fishery game, the possibility of sub-coalitions arising between, or among, the players must be recognized. Therefore, an approach, which explicitly recognizes the existence of coalitions, is preferred. We shall review the results obtained by Kaitala and Lindroos (1998), when using a coalitional bargaining approach, namely the characteristic function game approach. Our discussion will be restricted to the Shapley value (Shapley, 1988).

The characteristic function game (*c*-game) approach (Mesterton-Gibbons, 1993) assumes a rather different perspective from the Nash bargaining approach, in that the coastal states are seen as having no bargaining power on their own. It is the coalitions, which the coastal states can form with one another that define their contribution in the cooperative agreement, and consequently their bargaining strengths. Thus, it is natural that the result of the two-player game coincides with the Nash bargaining solution. In our three-player game, we assume that there is only one two-player coalition that has bargaining power during the negotiations, and that the value of this coalition determines the sharing of total benefits from cooperation for all three players. In addition, we continue to assume transferable utility, i.e. we allow for side payments.

Let it be supposed, as before, that the coastal states differ only in terms of fishing effort costs, and that we have:

$$a_{\mathrm{I}} < a_{\mathrm{III}} < a_{\mathrm{II}} \tag{13}$$

and

$$x_{\mathrm{III}}^{\infty} < x_{\mathrm{II}}^{\infty} < x_{\mathrm{I}}^{*} \tag{14}$$

The two player coalition, having the bargaining power, obviously consists of I and III, the two most efficient coastal states. The two most efficient players will always have veto power in any cooperative fisheries game, involving more than two players (see, for example: Arin and Feltkamp, 1997), since their presence is necessary for any coalition to have positive bargaining strength. The second most efficient player has the ability, if it chooses to exercise it, of harvesting the resource down to the non-cooperative level.

In our three player game, the Shapley value gives I and III each more than one third of the Cooperative Surplus (unlike the Nash bargaining solution).

Let $v(\{\mathrm{I,III}\})$ denote the value of the I-III coalition, when playing non-cooperatively against II. Let us normalize the Cooperative Surplus, $e(x(0))$ to 1, and assume that $v(\{\mathrm{I,III}\}) < 1$. Let z_i^s, i = I, II, III, denote the cooperative game payoffs dictated by the Shapley value. We have

$$z_{\mathrm{I}}^{s} = z_{\mathrm{III}}^{s} = \frac{v(\{\mathrm{I,III}\})}{6} + \frac{1}{3} \tag{15}$$

$$z_{\mathrm{II}}^{s} = \frac{1}{3} - \frac{v(\{\mathrm{I,III}\})}{3} \tag{16}$$

The fairness of the Shapley value arises from the equal treatment of coastal states in the coalition formation process, as well as the difference of the bargaining strengths with respect to the coalitions of which a given coastal state is a member, and those of which it is not. While our example is of a three player game, the results extend to any cooperative games with the number of players, n, greater than two. The veto players always receive equal shares, while all others receive shares, which vary according to their relative efficiency, but which are always less than the shares of the veto players.

In the n > 2 player games described, the players are distinctly asymmetrical. Lindroos, in a paper written a number of years after his 1998 paper with Kaitala, warns that, if the players are symmetric, the number of players, which full cooperation - the Grand Coalition – can support, in the absence of strong legal constraints, is small, maybe no more than two (Lindroos, 2002). It becomes too attractive for individual players to attempt to defect and to enjoy the cooperative benefits of the other players.

The probability of a stable full cooperative solution, with $n > 2$ players, is much enhanced, if the players are asymmetrical – given that side payments are feasible (Lindroos, *ibid.*). Fortunately, asymmetry among states sharing fishery resources appears to be the rule, not the exception. Nonetheless, Lindroos' concerns about the stability of cooperative fisheries arrangements in the face of large numbers is of great relevance when one considers the management of straddling fish stocks, to which we now turn.

D. THE MANAGEMENT OF STRADDLING FISH STOKCS

Straddling type of fish stocks, those to be found both within the EEZ and the adjacent high seas, are subject to exploitation by both coastal states and distant water fishing states (DWFSs). The 1982 UN Convention is vague and imprecise, regarding the rights and duties of coastal states, on the one hand, and those of DWFSs on the other, with respect to the high seas portions of straddling stocks (Bjørndal and Munro, 2003). As a consequence, in the years following the close of the UN Third Conference on the Law of the Sea, non-cooperative management of the resources was all but guaranteed. The economic model of non-cooperative management of transboundary stocks applies, without modification, to straddling stocks. As this model would have predicated, case after case of straddling stock overexploitation occurred in the mid to late 1980s, and early 1990s. The UN responded by convening the UN Fish Stocks Conference, 1993-1995.

The 1995 UN Fish Stocks Agreement, which emerged from the Conference (UN, 1995), calls for the management of straddling type stocks to be undertaken on, a region basis by region basis, through Regional Fisheries Management Organizations (RFOs), the members of which are to consist of the relevant coastal states and DWFSs. The Northwest Atlantic Fisheries Organization (NAFO), and the newly emerging Western Central Pacific Fisheries Convention (WCPFC) are examples of RFOs (Munro et al., 2004).

In analyzing the economics of cooperative management of straddling fish stocks through RFOs, economists employ the economics of the cooperative management of transboundary fish stocks and introduce modifications where required. The cooperative management of straddling fish stocks differs from that of transboundary fish stocks in two respects. The first is in terms of the number of participants, or "players." While examples of transboundary stock cooperative arrangements involving large numbers can be found, these are the exceptions. RFOs, since they include both coastal states and DWFNs can involve very large numbers indeed. Admittedly, however, this is a difference in degree, rather than in kind.

There is nothing particularly new in the analysis required here. The cooperative transboundary fish stock game models, involving $n > 2$ players, apply, essentially without modification. We have the usual problem of the threat of non-compliance – defections – steadily increasing with the number of players (Lindroos, 2002).

The second difference, which we shall refer to as the New Member problem, is a difference in kind. In the cooperative management of transboundary fish stocks, the players, both in nature and number, can be expected to be invariant over time, in other than exceptional circumstances. Such is not the case in the cooperative management of straddling stocks. Some of the participants will be DWFSs, the fleets of which are nothing, if not mobile.

Conceivably, an initial, or "charter," DWFS member of a RFO might withdraw. More importantly DWFSs, which were not among the founders of a RFO, may demand admission to the "club". The 1995 UN Agreement maintains explicitly that any state wishing to exploit a straddling stock, under RFO management, must become a member of the RFO, or agree to abide by the RFO's management provisions. In an effort to be fair to latecomers, the Agreement also explicitly states that "charter" members of a RFO cannot bar would be new members, or entrants, outright (UN, 1995; Munro et al., 2004).

The New Member provision carries with it definite risks. Kaitala and Munro (1997) demonstrate that, if all New Members agree faithfully to abide by the management provisions of the RFO, but demand full pro rata shares of the allowed harvest, "free of charge" as it were, the RFO could be undermined. "Charter" members, anticipating a swarm of New Members, could calculate that their expected payoffs from cooperation would be less than their Threat Point payoffs (Kaitala and Munro, *ibid*.), and the RFO would be stillborn.

If prospective New Members are offered less than full pro rata shares, "free of charge", however, they may be strongly tempted to ignore the provisions of the 1995 UN Agreement, by refusing to join the RFO, and then by becoming free riders in the adjacent high seas. Obviously, a RFO faced with rampant, and uncontrollable, free riding would cease to be stable.

This points to an outstanding legal issue, which must be resolved, if the RFO regime is to prosper. Under current international law, vessels of a state, not party to a RFO, which are found to be operating without authorization in the EEZ of a coastal state member of the RFO, are deemed to be engaged in illegal fishing. The coastal state can take vigorous action to repel the vessels. If the same vessels are, however, found to be exploiting the high seas portions of the straddling stock(s) being managed by the RFO, contrary to RFO management provisions, the vessels are deemed to be engaging in *unregulated* fishing. It is much less clear what measures RFO members can take to deal with unregulated fishing.

The FAO currently has underway a plan of action to address the problem of Illegal, Unreported and Unregulated (IUU) fishing (FAO, 2001). What clearly is required is that the FAO initiative must succeed, and that customary international law – state practice – should evolve in such a manner that unregulated fishing achieves the status – de facto if not de jure – of illegal fishing.

E. CASE STUDIES.

The Norwegian Spring Spawning Herring Fishery

In the 1950s and the 1960s, Norwegian spring-spawning herring (*Clupea harengus L.*) was a major commercial species, harvested by vessels from Norway, Iceland, Faroe Islands and the former Soviet Union. During the 1950s, the fishable component of the Norwegian spring-spawning herring stock measured about 10 million tonnes. However, the stock was subjected to heavy exploitation by the above mentioned parties, employing new and substantially more effective fishing technology. The annual harvest peaked at 2 million tonnes in 1966. By this time, however, the stock was in serious decline and a complete stock collapse occurred by the end of the decade.

Prior to stock depletion, the species was a straddling stock migrating through several coastal states and the high seas. The migratory pattern and number of components to the stock changed between 1950 and 1970. In its depleted state, however, the adult population ceased migration and while adults remained in Norwegian waters year round, their offspring also were distributed in the Barents Sea[i].

Recruitment remained weak throughout the 1970s and it was not until the strong year class of 1983 joined the adult population in 1986 that the stock began to recover. In 1993/1994 after spawning along the coast of Norway, the adult herring of this growing stock began a westerly migration into the international waters called the "Ocean Loop" and occasionally into the Exclusive Economic Zones of the European Union, Faroe Islands and Iceland, on their way to the summer feeding area near Jan Mayen Island.

The new migration pattern (as from 1993/1994) of the Norwegian spring-spawning herring takes on importance since, as a straddling stock the herring are exposed to territorial and possibly distant water fleets with strong incentives to harvest the population before it moves elsewhere (Bjørndal *et al.*, 1998). If a co-operative management policy, with an equitable distribution of harvest, cannot be agreed upon, Norway, Iceland, Faroe Islands, countries of the European Union, Russia and possibly distant water vessels fishing in the Ocean Loop, may resort to 'strategic over fishing' that could jeopardise continued sustainability of the stock.

During the first years of the new migration pattern the situation was quite chaotic. There was no comprehensive regional agreement about the utilisation of the stock. It followed that Norway, Russia, Iceland and Faroe Islands were able to harvest the stock at will within their own jurisdictions. Moreover, in international waters the stock could be harvested legally by any interested fishing nation.

In 1995, the Advisory Committee on Fishery Management (ACFM) of the International Council for the Exploration of the Sea (ICES) recommended a total allowable catch (TAC) for the Norwegian spring spawning herring of 513,000 tonnes. Norway ignored the recommendation and announced an individual TAC of 650,000 tonnes of which 100,000 tonnes would be allocated to Russian vessels. Iceland and Faroe Islands followed suit and announced their own combined TAC of 250,000 tonnes. In total, the collective harvest of Norway, Russia, Iceland, Faroe Island and the EU was approximately 902,000 tonnes of herring, almost twice the quantity recommended by ACFM (Bjørndal *et al.*, 1998). Nevertheless, in spite of these high catch levels, the herring spawning stock continued to increase, due to high recruitment in 1991 and 1992.

There was, however, some progress towards co-operation. In 1996, Norway, Russia, Iceland and Faroe Islands reached an agreement for a combined TAC. The agreement was reached by increasing the quota levels for each country and setting a total maximum limit of 1,267,000 tonnes. Nevertheless, the European Union did not take part in a TAC commitment and continued fishing at near capacity. In 1997, the EU became a signatory to an agreement, limiting the maximum total catch to 1,498,000 tonnes. The significance of this agreement is that the EU in a commitment to international fisheries co-operation agreed to reduce their total catch levels from the previous period, whereas the four other countries again increased individual TACs (Bjørndal *et al*., 1998). Notwithstanding, the stock of spring-spawning herring was robust and continued to increase[ii].

The countries involved agreed to continue co-operation and in 1998 the total TAC was set at 1.3 million tonnes. The new quotas for 1998 were allocated between the parties with the same key as in 1997. As a part of the agreement, bilateral access quotas were granted. For example, for fishing spring-spawning herring Russia, the EU, Iceland and Faroe Islands are all granted limited access to Norwegian fishing waters and vice versa. For 1999, the TAC was 1.3 million tonnes and for 2000 the TAC was set at 1.25 million tonnes.

The five-party cooperative agreement broke down in the autumn of 2002, so that as of the 2003 season there has been no agreement. The main reason for the breakdown is that the Norwegian claims, much based on zonal attachment of the herring to the Norwegian EEZ, is much higher than the Norwegian quota of 57%. As a consequence, Norway has demanded a higher share of the TAC, a demand that has not been met by the other parties. For 2005, Norway has unilaterally set a national quota that represents a Norwegian share of 65% of the TAC recommended by ICES, an increase of its national quota by 14%. Iceland has similarly increased its national quota with 14%. If all parties increase their quotas, the sum of the nationally determined quotas will exceed the TAC recommended by ICES. To what degree total catches in 2005 will be higher than the TAC recommended by ICES , cannot be said until the end of the fishing season. As a consequence of the breakdown of the agreement, the other parties, with the exception of Russia, no longer have access to the Norwegian EEZ and the fishery zone around Jan Mayen, which is under Norwegian jurisdiction.

According to the UN Fish Stocks Agreement, the management of straddling and highly migratory fish stocks is to be carried out through Regional Fisheries Management Organisations (RFMOs). For Norwegian spring-spawning herring, which is classified as a straddling stock, management takes place through the North East Atlantic Fishery Commission.

The recovery of the Norwegian spring-spawning stock offers the opportunity for substantial annual harvests on a sustainable basis for the benefit of all nations involved. It is clear that if, as a consequence of the breakdown of the co-operative arrangement among the countries, there is a return to competitive harvesting and open access condition, this will result in increased international competition for harvest shares that will be biologically, economically and politically damaging. Eventually, this could threaten a new stock collapse for the fishery and result in substantial economic damage for all nations concerned in terms of lost revenue and employment as catch levels decline.

The East Atlantic Bluefin Tuna Fishery

The East Atlantic bluefin tuna stock is distributed from the east of the Canary Islands to Norway, in the North Sea, in Ireland, in the whole of the Mediterranean and in the south of the Black Sea. Occasionally, it goes to Iceland and Murmansk. The Bluefin tuna moves according to food abundance and water temperature. Spawning is located in the warm waters (around 24º C) of the Mediterranean around the Balearic Islands and in the south of the Tyrrhenian Sea, starting in June and continuing until July. In the beginning of this season, a great flow of Bluefin tunas can be observed. Afterwards, some specimens remain in the Mediterranean throughout the year, and others, either young or adult, leave these waters and go to Morocco, the Viscaya Gulf, the Canary Islands and the Madeira Islands. The larger Bluefin tuna can be found in the North Sea and along the Norwegian coast, since they are more resistant to colder waters. In the winter they return to the tempered waters of the African coast.

Bluefin tuna is the most valuable fish in the ocean. High quality tuna fetch a price premium in the Japanese sushi market, where a single fish can command a price of up to US $ 100,000. Moreover, the price has been increasing in recent years due to a world wide decline in catches of high quality tuna.

The Bluefin tuna fisheries are characterised by a variety of vessel types and fishing gears operating from many countries. Different circumstances – economic, biological, geographical, political as well as traditional - dictate the actual gear choice. The most important fishing gears in the Northeast Atlantic are the purse seine, the long line, the trap and the bait boat.

Throughout the years, the importance of each gear has changed. Certain fisheries, such as trap, go back to ancient times. Other gears, such as the long line and the Mediterranean purse seine, reached full development in the mid 1970s. The spatial distribution of the different gears has changed through the years. The most important change in this respect has been the relocation of the long line fishery to latitudes above 40º and longitudes between 20º and 50º west, i.e., to fishing grounds on the high seas outside coastal state 200 mile EEZs.

Historically, more than 50 countries have participated in the fishery for Bluefin tuna; currently, 25-30 participate. European countries such as Italy, France and Spain use bait boat, long line, purse seine and trap. Distant water fishing nations (DWFNs) such as Japan come to the high seas of the North Atlantic to catch Bluefin tuna using long line. The large number of countries harvesting Bluefin tuna imposes a severe pressure on the stock. In the 1970s, annual catches varied between 10,500 tonnes in 1970 and 22,300 tonnes in 1976. Subsequently, catches increased to a maximum of about 53,000 tonnes in 1997. Thereafter, there has been a decrease to 28,000 tonnes in 2000, mainly due to lower stock levels.

The lower number of participants in the fishery is primarily due to reduced stock levels as compared to historical figures. This has been compounded by the fact that as the stock declines, the distribution area of the stock is reduced. This explains why countries like Norway, Iceland and Russia are not currently active in the fishery. Nevertheless, the situation points to a potential threat to the stock: if and when the stock recovers, there are many potential entrants to the fishery. This is compounded by the high value of the fish.

Bluefin tuna is classified as a highly migratory fish stock. According to the 1995 UN Fish Stocks Agreement, both coastal states and high seas fishing states are required to cooperate directly or through the establishment of sub-regional or regional fisheries management organisations (RFMO) to this end.

The management of the Northern Atlantic Bluefin tuna falls under the aegis of the International Commission for the Conservation of Atlantic Tunas (ICCAT). ICCAT was established in 1969 with two main functions: to provide scientific assessments of Atlantic tunas and tuna-like fish and to give management recommendations that will permit a sustainable fishery. At present, there are 23 contracting parties to ICCAT. These include coastal states in Europe and Africa as well as DWFNs such as Korea and Japan.

As early as 1974, ICCAT recommended limiting the bluefin tuna catch in both the Atlantic and the Mediterranean. In spite of the recommendations being officially implemented in 1975, they had no or little impact, as they were not respected. Present regulations include catch limits (quotas for each member country), prohibition of juvenile landings and closed seasons. So far, the regulations have proved to be rather ineffective. This is due to the inability of ICCAT to monitor and enforce its regulations, which is compounded by the large number of participants in the fishery, members as well as non-members of ICCAT. Therefore, to a large extent many of the characteristics of an open access fishery still prevail.

Stock size decreased from 210,000 tonnes in 1971 to 133,000 tonnes in 1981. Thereafter, the stock remained fairly stable, experiencing a slight increase in 1993-94 to about 150,000 tonnes, which was also the stock level in 2000. As noted, in the 1990s catches have remained at fairly high levels, especially in the Mediterranean, causing a decline in stock size.

The situation is very grave. If the current trend is maintained, a complete stock collapse is expected within a few years (Brasão *et al, 2*001). On the other hand, according to Bjørndal and Brãsao (2005), a cooperatively managed fishery bears the promise of generating very substantial rents.

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[i] The issue of migration is controversial (Patterson 1998). Patterson argues that the causes of migration include changes in water temperature and availability of zooplankton. However, there are studies that suggest that migration may be genetically linked and it is possible that in a small non-migratory stock of herring there is a risk that the migratory genes may disappear and migration would stop.

[ii] The continued recovery of the herring stock even under heavy fishing pressure was due to good growth conditions, conceivably partly due to the reduced stocks of predatory fish species.