

The conservation and management of shared fish stocks: legal and economic aspects



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by

Gordon Munro

Department of Economics and Fisheries Centre

University of British Columbia

Vancouver, Canada

Centre for Research in Economics and

Business Administration (SNF)

Bergen, Norway

Annick Van Houtte

Legal Officer

FAO Legal Office

Rome, Italy

and

Rolf Willmann

Senior Fishery Planning Officer

Fishery Policy and Planning Division

FAO Fisheries Department

Rome, Italy

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ISBN 92-5-104836-3

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PREPARATION OF THIS DOCUMENT

This paper explores both the legal and the economic aspects of the management of each of the several different categories of shared stocks, namely transboundary, highly migratory, straddling and discrete high seas stocks. In so doing, the paper draws heavily upon the results of the October 2002 Norway-FAO Expert Consultation on the Management of Shared Fish Stocks, and in particular upon those results arising from the many case studies, from both developed and developing States, presented at the Consultation.

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ABSTRACT

The effective management of shared fish stocks stands as one of the great challenges towards achieving long-term sustainable fisheries. These resources account for as much as one third of world marine capture fishery harvests. This paper explores both the legal and the economic aspects of the management of each of the several different categories of shared stocks, namely transboundary, highly migratory, straddling and discrete high seas stocks. In so doing, the paper draws heavily upon the results of the October 2002 Norway-FAO Expert Consultation on the Management of Shared Fish Stocks, and in particular upon those results arising from the many case studies, from both developed and developing States, presented at the Consultation. The legal foundation for the management of these resources is seen to rest upon the 1982 United Nations Convention on the Law of the Sea, and upon the 1995 United Nations Fish Stocks Agreement, which focuses specifically on highly migratory and straddling stocks. The Agreement came into force in 2001, and is now in the process of being implemented. The economics of the issue points to the conclusion that, with few exceptions, effective cooperation between/among States sharing a given fish stock, of any of the four categories, is a fundamental pre-requisite for the sustainable management of the resource. Non-cooperative management of shared stocks leads almost invariably to overexploitation. Experience has demonstrated that effective long run cooperation demands that cooperative resource management arrangements have the resiliency to withstand unpredictable shocks, which in turn requires that the scope for bargaining among the members of the arrangements be as broad as possible. Effective cooperation also requires the full implementation of the FAO International Plan of Action to Prevent, Deter and Eliminate International Unreported and Unregulated Fishing. This is particularly true in the case of highly migratory and straddling stocks. Finally, the paper warns that achieving effective cooperative management of discrete high seas stocks, which have hitherto received little attention, is likely to prove to be exceptionally challenging. If the challenge is not met, these resources will unquestionably remain vulnerable to overexploitation.

Munro, G.; Van Houtte, A.; Willmann, R.
The Conservation and Management of shared fish stocks: legal and economic aspects.
FAO Fisheries Technical Paper. No. 465. Rome, FAO. 2004. 67p.

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ACKNOWLEDGEMENTS

It will be clear to all readers that this paper draws heavily upon the results of, and the papers presented at, the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks, Bergen, Norway, 7–10 October 2002. The authors wish, therefore, to express their deep gratitude to all of the participants in the Expert Consultation, and to say that they feel particularly indebted to the Norwegian hosts and co-organizers of the Expert Consultation, Peter Gullestad, Sigmund Engesaeter and Terje Lobach.

ACRONYMS/ABBREVIATIONS

AFZ	Australian fishing zone
DWFSs	Distant water fishing States
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
IBSFC	International Baltic Sea Fishery Commission
ICES	International Council for the Exploration of the Sea
IPOA	International Plan of Action
IPOA-IUU	International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing
ITQ	Individual transferable quota
MCS	Monitoring, control and surveillance
MOU	Memorandum of Understanding
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	Northeast Atlantic Fisheries Commission
OECD	Organisation for Economic Co-operation and Development
PNG	Papua New Guinea
RFOs	Regional or subregional fisheries management organizations or arrangements
TACs	total allowable catch
UN	United Nations
UNFSA	United Nations Fish Stocks Agreement
VMS	vessel monitoring system
WCPFC	Western and Central Pacific Fishery Convention

1. Introduction

In October 2002, the Government of Norway, in cooperation with the FAO, convened an Expert Consultation on the Management of Shared Fish Stocks¹. The rationale for the Norway-FAO Expert Consultation lay in the recognition of the fact that the management of these resources stands as one of the great challenges on the way towards achieving long-term sustainable fisheries.

This paper, in exploring the legal and economic aspects of the management of shared fish stocks, draws heavily upon the conclusions of the Norway-FAO Expert Consultation, as set forth in the Expert Consultation's report, and upon the extensive set of papers presented at the Expert Consultation². The papers provide overviews of the legal and economic components of shared fish stock management and do, as well, provide a wide range of case studies on shared fish stock management from many regions of the world, both developed and developing.

There are, as will be seen, four categories of shared fish stocks. The Norway-FAO Expert Consultation, by design, restricted itself to two of the four categories. This paper will attempt to extend the analysis, arising from the Expert Consultation, to cover all four categories.

¹ The Norway-FAO Expert Consultation on the Management of Shared Fish Stocks, Bergen, Norway, 7-10 October 2002.

² Both the Report of the Norway-FAO Expert Consultation and the papers presented at the Expert Consultation have been published. See: FAO, 2002a and FAO, 2003a. The Report and the Expert Consultation papers were presented to the Twenty-fifth Session of the FAO Committee on Fisheries, February 2003.

2. Shared fish stocks: an overview

The term “shared fish stocks” is understood by FAO (see, in particular, the FAO, *Code of Conduct for Responsible Fisheries*, Article 7 (FAO, 2003b)) to include the following:

- (a) fish resources crossing the EEZ boundary of one coastal State into the EEZ(s) of one, or more, other coastal States – transboundary stocks;
- (b) highly migratory species, as set forth in Annex 1 of the 1982 UN Convention on the Law of the Sea (UN, 1982), consisting, primarily, of the major tuna species (being highly migratory in nature, the resources are to be found, both within the coastal State EEZ, and the adjacent high seas);
- (c) all other fish stocks (with the exception of anadromous/catadromous stocks) that are to be found, both within the coastal State EEZ and the adjacent high seas – straddling stocks;
- (d) fish stocks to be found exclusively in the high seas – discrete high seas fish stocks³.

Clearly, these categories are not mutually exclusive. One can find many examples of fish stocks that fall into Category (b), or Category (c), which also fall into Category (a).

John Caddy (1997) provides a definition of transboundary stocks, which, with minor modification, can be extended to cover straddling and highly migratory (but not discrete high seas) stocks. The modified Caddy’s definition is as follows:

...a group of commercially exploitable organisms, distributed over, or migrating across, the maritime boundary between two or more national jurisdictions, or the maritime boundary of a national jurisdiction and the adjacent high seas, whose exploitation can only be managed effectively by cooperation between the States concerned...

There is not universal agreement, by the way, that cooperation between and among relevant States/entities is required for the conservation and management of all of these resources. Be that as it may, a fundamental issue pertaining to shared fish stocks, which will be the recurrent theme throughout this paper, is the development of appropriate management and conservation regimes (which could include non-cooperative regimes as an option) for these resources.

The 1982 UN Convention on the Law of the Sea (1982 UN Convention, hereafter) (UN, 1982), which came into force in 1994, and the 1995 UN Fish Stocks Agreement (UN, 1995)⁴, which came into force in 2001, will be seen to provide the basic legal framework for such regimes. The 1982 UN Convention calls upon States, be they coastal States or distant water fishing States (DWFSs), to cooperate, or at the very least to negotiate, with respect to the management and conservation of all categories of shared stocks. In so doing, the 1982 UN Convention sets forth the basis upon which States are to negotiate or cooperate. Such negotiation and cooperation may be

³ There is not uniform agreement on the categorization of these fish stocks (see: Van Houtte, 2003, for a thorough discussion). While there is no disagreement on the definitions of straddling, highly migratory and discrete high seas stocks, what we might refer to as a second school of thought prefers to use the term “transboundary stocks” as the generic term, and to use the term “shared stocks” to denote those fish stocks crossing the EEZ boundary of one coastal State into the EEZ(s) of one, or more, other coastal States.

⁴ The full title of the Agreement is: 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.

effected through bilateral or other agreements, or may be effected through appropriate subregional and regional organizations.

2.1 SOME CHARACTERISTICS OF SHARED FISH STOCKS

One of the earliest analyses of the problems of managing and conserving shared fishery resources was that prepared by John Gulland of the FAO, prior to the close of the UN Third Conference on the Law of the Sea (Gulland, 1980). In his paper, Gulland focuses on transboundary stocks, because of their then perceived importance. His analysis can, however, be readily extended to straddling and highly migratory stocks⁵.

In any event, Gulland presents a biological/geographical categorization of transboundary fish stocks, which is useful in setting the stage for the discussion of the problems of managing the resources. He makes the following distinctions:

- I. stocks occurring within two or more EEZs, but showing no clear migratory pattern;
- II stocks occurring within two or more EEZs, and displaying a clear pattern of movement:
 - 1) resulting from seasonal migration
 - 2) according to development stages.

Change *stocks occurring within two or more EEZs*, in I and II, to *stocks occurring within the EEZ and the adjacent high seas*, and one has a description of straddling and highly migratory fish stocks.

In the case of (I), Gulland contends, it is not always clear that exploitation on one side of the relevant boundary will necessarily have a significant effect upon harvesting opportunities on the other side of the boundary (Gulland, *ibid.*). Munro (1987) provides such an example in the form of the rich Georges Bank scallop fishery, shared by Canada and the United States. The resource was, and is, clearly a transboundary fish stock. It was, however, questionable whether Canadian (American) harvesting of scallops would have any significant impact upon American (Canadian) harvesting opportunities. Adult scallops are more or less stationary. Moreover, while there is some transboundary movement at the larval stage, there were, in 1987, extensive beds of larvae producing scallops, which were free from exploitation due to the sea bed terrain.

These facts led to the argument that, since Americans and Canadians could harvest the resource without affecting one another's harvest opportunities, cooperative fisheries management of this shared resource was largely beside the point (Munro, 1987). Whether the situation, which prevailed in 1987, continues to prevail today is not known to these writers. Nonetheless, the point remains, and leads to our first conclusion, namely that cooperative fisheries management of a shared fishery resource is not, in all cases, necessarily required, or desirable. The conclusion is reinforced by the fact that establishing a cooperative fisheries management regime is not a costless undertaking. As the Report of the Norway-FAO Expert Consultation points out, realizing the benefits of cooperation will require a significant investment in the form of financial resources. The investment should properly be assessed in a cost/benefit framework (FAO, 2002a). If the assessment reveals that the expected net benefits from the investment will be negative, then obviously the case for cooperation collapses.

The implication is that, in the case of a Georges Bank scallop type of resource, the relevant States could, in keeping with the 1982 UN Convention, enter into negotiations and conclude that a satisfactory conservation and management regime would consist of each State managing its segment of the resource to the best of its ability, without

⁵ Although admittedly not discrete high seas stocks, which we shall, at a later point, refer to as "orphan" stocks.

reference to the other State(s). It will be seen that the 1982 UN Convention does, in fact, allow for just such an outcome.

2.2 LEVELS OF COOPERATION IN RESOURCE MANAGEMENT AND CONSERVATION

Suppose now that the harvesting activities of one State, sharing a fishery resource, do impinge significantly upon the harvesting opportunities of the one, or more, other States sharing the resource, so that a *prima facie* case for cooperation does, in fact, exist. The question, which then arises, is the appropriate level of cooperation. There are, as Gulland points out, at least two levels of cooperation (Gulland, 1980). The first level, or what we might term the *primary level*, consists of cooperation in research alone, without reference to coordinated management programmes. Since all parties should stand to benefit from improved information and data, the cooperation should be relatively easy to achieve. The emphasis is on the word relative, however. It is still possible that one or more parties may suspect that research information, which it shares, will serve to benefit its rival exploiters of the resource, at its own expense.

In any event, if it is not possible to achieve cooperation at this primary level, it certainly will not be possible to achieve cooperation in active management of the resource. In actual cooperative management regimes, which have proven to be successful, cooperation in research alone is often seen, in retrospect, to have been the precursor to cooperation in active management.

The significance of this primary stage of cooperation was made apparent at the Norway-FAO Expert Consultation. Scientific cooperation, although not cooperation in active management, was seen to exist between Kuwait and Iran in the Persian Gulf, between and among the Pacific Latin American states of the Southeast Pacific, and among the coastal states of Northwest Africa (Al-Hussaini, 2003; Zuzunaga, 2003; Samb, 2003). In each of these cases, there are prospects that cooperation at the scientific level will provide the foundation for more extensive cooperation in resource management, in the future.

The Norway-FAO Expert Consultation also provided evidence that inadequate scientific cooperation can serve to undermine the development of cooperation in active resource management. Although there are clear benefits to South Africa, Namibia and Angola in cooperating in the management of a major shared hake stock, lack of scientific knowledge of the resource is acting as a barrier to the development of an effective cooperative arrangement (Sumaila, Ninnes and Oelofsen, 2003). On the other side of the South Atlantic, a decline in cooperative scientific research, due to lack of funding, is serving as a hindrance to effective cooperation in the management of fishery resources shared by Argentina and Uruguay (Chaluleu, 2003).

What we might call cooperation at the *secondary level* – “active management” – involves, almost by definition, the establishment of coordinated joint management programmes. As Gulland (1980) informs us, this will require:

- (a) allocation of harvest shares among the participating states (or entities);
- (b) determination of an optimal management strategy through time, including *inter alia*, the determination of optimal global harvests over time;
- (c) implementation and enforcement of coordinated management agreements.

The Report of the Norway-FAO Expert Consultation maintains that, in order to achieve all of this, it will be necessary to have:

- a cooperative management authority;
- a detailed joint management plan;
- a set of agreed upon common objectives;
- agreed upon tools for managers, including indicators and reference points to monitor performance;
- a joint scientific body to provide advice.

The detailed joint management plan should be expected, at a minimum, to contain: (i) a description of the fishery, (ii) objectives of management, (iii) measures to achieve the objectives, (iv) indicators and reference points to be used to measure actual performance against objectives, (v) decision rules on how to change management, when the objectives are not being reached, and (vi) information needs and research required to support management (FAO, 2002a).

Obviously, establishing cooperation in shared stock management at the secondary level is a much more formidable undertaking than is establishing such cooperation at the primary level. Outside of the expense and administrative complexities involved in establishing a mechanism for secondary level cooperation, numerous other problems and difficulties emerge. To begin, even cooperation in research may lose its benign character. Research findings can influence harvest allocations, and thus can easily become “tools of combat” in negotiations between and among relevant states.

Secondly, consider (b), in the Gulland list, optimal management strategies. While we shall come to talk, for ease of exposition, in terms of the management of single shared stocks, the reality in many, if not most, cases is likely to be far less simple. In many cases, what will be shared might better be referred to as ecosystems, in which there are sets of shared stocks interrelated in ways, both complex and intricate (e.g. through predator-prey relations).

Next, under the heading of optimal management, is the fact that there is no assurance that the relevant states will have identical resource management goals. The FAO recognized this fact, as early as 1979, with reference to transboundary stocks, through its Advisory Committee on Marine Research (FAO, 1979). The Committee pointed out that, if two coastal States share a fishery resource, one might favour low long run TACs, but a large stock and high catch rates, while the other might favour large long run TACs, and accept with good grace low catch rates. If management goals are not identical, then one is faced with the burden of developing a mutually acceptable compromise resource management programme, or so it would seem (FAO, *ibid.*).

Thus, establishing cooperative conservation and management at the secondary level can prove to be frustrating and costly. One can add that the anticipated cost might appear not only in economic terms, but may also appear, as far as coastal States are concerned, in the form of perceived loss of sovereignty. If, the net economic benefits from cooperative management appear not to be substantial, the relevant states, with the possible loss of sovereignty in mind, may conclude, to use an old English expression, that “the game is not worth the candle.”

Certainly in the case of transboundary stocks, each relevant coastal State could, upon assessing the benefits of cooperation, conclude the following. If it were to manage alone its segment of the resource in a rational manner, and if its fellow states sharing the resource were to do the same, the overall resource management results, while not ideal, would be adequate, even though the coastal State’s harvesting opportunities are affected by the harvesting activities of its fellow coastal State(s). One of the central questions to be addressed is whether or not this comfortable view of the world is, in fact, reasonable.

2.3 THE SIGNIFICANCE OF SHARED FISH STOCKS IN WORLD CAPTURE FISHERIES

Difficulties of achieving effective cooperation in resource management to one side, the significance of the issue of cooperative management of shared fishery resources is dependent ultimately upon the importance of shared fishery resources in terms of world fisheries. No precise measures exist, but there is enough evidence to indicate that the significance of shared fish stock in world capture fisheries is decidedly non-trivial.

To commence, John Caddy (1997) has undertaken a thorough investigation of transboundary stocks. Caddy first observes, in his 1997 paper (Caddy, 1987), that,

in 1982, as the world Exclusive Economic Zone (EEZ) regime was emerging, he had pointed out that a significant proportion of fishery resources then being encompassed by EEZs would be found to be shared with other coastal States. He subsequently proceeds, with the aid of the Geographical Information System database, to estimate the number of contiguous EEZ maritime boundaries. Then, making a very conservative estimate of the number of fishery resources crossing these boundaries on average, he comes forth with an estimate of 1 000 to 1 500 transboundary fishery resources (Caddy, *ibid.*). In short, transboundary fish stocks are ubiquitous, worldwide.

As a contribution to the UN Fish Stocks Conference, the FAO prepared a survey of world highly migratory stocks, and of straddling stocks, both actual and potential (i.e. Categories (b) and (c)) (FAO, 1994). In the publication, the FAO presents estimates of the total annual harvests of the two categories of stocks, as of 1991. Upon updating these estimates to the year 2001, we conclude that the total annual harvests of highly migratory, plus actual and potentially straddling stocks, may be as high as 15 million tonnes. This, in turn, is roughly equal to one fifth of the total harvests from world marine capture fisheries for that year (FAO, 2002b; 2003a)⁶. One can only guess at what the proportion would be, if it were possible to add in harvests of transboundary stocks, which are not also straddling or highly migratory stocks, and harvests of discrete high seas stocks. For example, many important small pelagic stocks (e.g. Southeast Pacific, West and South Africa) are transboundary, but not straddling, in nature. Including such stocks could raise the total catches from shared fish stocks to close to one third of global marine capture fishery harvests.

As well, we shall point out (and as should come as no surprise), the management of transboundary fish stocks is, by and large, a considerably easier undertaking than is the management of highly migratory, straddling and discrete high seas stocks. Nonetheless, John Caddy, on the basis of his survey, argues that only a small percentage of the 1 000–1 500 relatively easy to manage transboundary fish stocks are subject to effective cooperative management (Caddy, 1997). To this, we can add the observation that the UN Fish Stocks Agreement emerged in response to the manifest inadequacy of the management of many of the world's highly migratory and straddling fish stocks (as well as the limited guidance offered by the 1982 UN Convention on the Law of the Sea with respect to the management of these stocks).

The information, which we have at our disposal, is, admittedly incomplete, and somewhat fragmentary. It does, nonetheless, allow us to advance the following propositions. If it is indeed the case that cooperative management is important for the long term stability and productivity of most shared fish stocks, then the scope for improved management of these resources is immense. Secondly, the potential significance of such improved management for the sustainability of world capture fisheries in general is indeed very high.

With the overview of shared fish stocks complete, we turn to the question of the conservation and management of these stocks, commencing with Category (a), transboundary fish stocks.

⁶ The authors are grateful to Mr Luca Garibaldi, FAO Department of Fisheries (FIDI), for his assistance in preparing these estimates.

3. The conservation and management of transboundary fish stocks

In examining the management of transboundary fish stocks, we proceed as follows. We commence with an overview of the relevant legal regime, and then turn to a discussion of the basic economics of the management of such resources. We conclude with a discussion of questions of surveillance and enforcement, and of institutional matters pertaining to cooperative resource management arrangements in practice.

3.1 THE LEGAL REGIME

The 1982 UN Convention contains but one provision pertaining to the management of transboundary fish stocks, namely Article 63(1), which reads as follows:

Where the same stock or stocks of associated species occur within the exclusive economic zones of two or more coastal States, these States shall seek, either directly or through appropriate subregional or regional organizations, to agree upon the measures necessary to coordinate and ensure the conservation and development of such stocks without prejudice to the other provisions of this Part [V] (UN, 1982, Article 63(1)).

The Convention imposes a duty on the relevant coastal States to negotiate over arrangements for the management of transboundary stocks. Importantly, however, it does not impose a duty on the States to reach an agreement. If the States are unable to reach an agreement, then each State shall manage that segment of the transboundary stock occurring within its EEZ. It shall do so in accordance with the rights and duties relating to fisheries management and conservation by a coastal State within its EEZ, as set forth by the Convention. We might refer to this as the default option.

Beyond this, the 1982 UN Convention says little. The Convention does not elaborate on management and conservation objectives, on principles of allocation of the catch among the relevant States, nor, more generally, on how cooperation is to be achieved. Indeed, the American legal expert on Law of the Sea issues, William Burke, comments (somewhat caustically) that “the substantive obligation imposed by Article 63(1) cannot fairly be described as awesome, imposing, or, even perhaps, very consequential” (Burke, 1983, p. 36).

We can, however, at least offer an interpretation of the duty to negotiate, implied in Article 63(1), and of the term “development” appearing in that article. In the *North Seas Continental Shelf* cases⁷, the International Court of Justice dealt with the duty to negotiate in the context of maritime boundary limitations:

... the parties are under the obligation to enter into negotiations with a view to arriving at agreement, and not merely to go through a formal process of negotiation ... they are under the obligation so to conduct themselves that the negotiations are meaningful, which will not be the case when either of them insists upon its own position without contemplating any modification of it⁸.

These observations on the substantive standards, which negotiations must meet, are in fact applications of the principle of good faith to specific circumstances (Molenaar, 2000).

⁷ International Court of Justice, *Reports 1964*, p.3.

⁸ International Court of Justice, *Reports 1964*, p. 3.

With regards to the term “development,” Nandan, Rosenne and Grandy (1993, p. 647) state that:

The reference to “development” ... relates to the development of those stocks as fishery resources. This includes increased exploitation of little-used stocks, as well as improvements in the management of heavily-fished stocks for more effective exploitation. Combined with the requirement in Article 61 of not endangering a given stock by overexploitation, this envisages long-term strategy of maintaining the stock as a viable resource.

Next, we can note that, while the 1982 UN Convention provisions directly pertaining to transboundary stocks appear to be limited, there are provisions of the 1982 UN Convention, which, at the very least, are potentially relevant to the management of transboundary stocks. These include the provisions relating to the settlement of disputes (Part XV), the “Good Faith and Abuse of Rights,” Article 300, those pertaining to marine scientific research, *inter alia* Articles 246(3), 246(5)(a) and 249, and the articles relating to coastal State rights (UN, 1982).

Finally, we should also take note of the FAO *Code of Conduct for Responsible Fisheries* (FAO, 2003b), even though it is not a binding instrument. The Code’s provisions on fish stocks are generally relevant, along with those more specifically aimed at shared stocks (see: paragraphs 7.1.3, 7.3.2 and 12.17 [FAO, 2003b]).

3.2 THE ECONOMICS OF THE MANAGEMENT OF TRANSBOUNDARY FISH STOCKS

The economics of the management of transboundary fish stocks, as well as addressing transboundary stock issues, provides the foundation for the economics of the management of the other three categories of shared fish stocks. In part, this is due to the history of shared fish stock management. The significance and importance of the problems of managing transboundary stocks was recognized well before the close of the UN Third Conference on the Law of the Sea, while the importance of the problems of managing straddling and highly migratory stocks did not gain recognition until the late 1980s. Only limited recognition has been given to date to the problems of managing discrete high seas stocks. Thus, the development of the economics of the management of transboundary stocks can be traced back to the late 1970s (Munro, 1979), while the development of the economics of the management of straddling and highly migratory stocks only dates back to the early 1990s (Kaitala and Munro, 1993). At the time of writing, there is nothing in the academic literature on the economics of the management of discrete high seas stocks, although one can draw certain conclusions from the economics of the management of the other three categories of shared fish stocks.

The fact that the economics of transboundary stock management precedes that of the management of the other categories of shared fish stocks is also a reflection of the relative difficulty in managing transboundary, as opposed to straddling/highly migratory, and discrete high seas stocks. The management of transboundary stocks is a considerably less complex task than that of managing the other three categories of stocks. In the case of transboundary, as opposed to the other categories of shared fish stocks, the states involved are, with few exceptions, fixed through time, and the shared, or joint, “property” rights to the relevant resources are reasonably straightforward (McRae and Munro, 1989). Furthermore, the number of states involved is usually relatively small. In the economic analysis of the management of these transboundary stocks, one can often make do with models of just two countries.

The basic economics of the management of transboundary fish stocks, which is now reasonably well developed, has moved well beyond the realm of academic economists. It is finding its way into official publications, as exemplified by the 1997 OECD publication, *Towards Sustainable Fisheries* (OECD, 1997), and the study, *Managing Transboundary Stocks of Small Pelagic Fish*, prepared by M. Agüero and E. Gonzalez

for the World Bank (Agüero and Gonzalez, 1996). It is also being discussed by specialists in fisheries, from disciplines other than economics. The 1997 paper by John Caddy (Caddy, 1997), which has been, and which will be, cited extensively, provides a case in point.

The economic model, which is used in the analysis of the management of transboundary fishery resources, is a blend consisting of two components. The first consists of the now standard bioeconomic model, used in the analysis of fisheries confined to the waters of a single coastal State (see: for example, Clark, 1990; OECD, 1997; Bjørndal and Munro, 1998), while the second consists of the theory of strategic behaviour, more popularly referred to as the theory of games.

Fisheries economics is, in the context of capture fishery resources confined to the waters of a single coastal State, concerned with the inherent open access, or “common pool,” nature of such resources, which is, in turn, a reflection of the absence of, or the inadequate implementation of, “property” rights to the resources. The “common pool” nature of the resources can lead easily to serious overexploitation of the resources, and to substantial economic waste. Much of fisheries economics is concerned with means of countering the baleful effects of this “common pool” nature of these resources.

One useful concept, dating back to the advent of modern fisheries economics, is that of Bionomic Equilibrium (Gordon, 1954). This is the equilibrium, which the resource and the industry achieve simultaneously, when the fishery is a “common pool” fishery, *à outrance*, with a complete absence of both clearly defined “property” rights to the resource and national, or international, fisheries regulations. Bionomic equilibrium is characterized by overexploitation of the resource from society’s point of view⁹, and by fleet capacity, far in excess of that which would be required, if the resource were exploited optimally. As such, Bionomic Equilibrium can be seen as a benchmark of undesirability in fisheries management.

While the standard bioeconomic model of capture fisheries is reasonably well understood, the theory of strategic behaviour – theory of games – is not. On the assumption that most readers are not familiar with this second component of the economic model of transboundary fisheries, we turn now to a review of the essentials of the theory of games.

3.2.1 The theory of games: a brief review

The theory of strategic behaviour is concerned with situations in which the wellbeing of an “individual” depends, not only on the actions of the “individual” itself, but also on the actions of other “individuals,” with which the “individual” in question is interacting. The “individuals” may be persons, firms, political parties, states, et cetera. In any event, the “individual” is compelled to take into account that its wellbeing will be affected by the actions of others, and vice-versa. The theory is popularly referred to as the theory of games, because games (e.g. card games) provided convenient examples, in the early stages of the development of the theory.

One field of economics, where game theory has come to play a major role, is Industrial Organization, which is generally devoted to the study of industries dominated by a few large firms. Let the airline industry serve as an example. The fare structure, and other policies, implemented by a major airline, such as Lufthansa, are bound to have an impact upon rival airlines. The rivals can be expected to react. Lufthansa will, of course, anticipate such reactions, and will factor these expected reactions into its planning.

Industrial Organization is only one of numerous fields, in which one can anticipate interactions between and among “individuals.” Many fields of economics are influenced by game theory, as now are many areas outside of economics, such as international

⁹ In the case of some fishery resources, there will be no Bionomic Equilibrium this side of extinction.

relations and legal studies. The use of game theory is also to be found in some natural sciences. Game theory does, for example, play a major role in evolutionary biology.

Cooperative resource management between, or among, coastal States sharing a fishery resource becomes worthy of consideration, we have now argued, if the harvesting activities of one coastal State have a significant impact upon the harvesting opportunities of the other State(s) sharing the resource. If this condition is met, then strategic interaction between “individuals,” in the form of coastal States sharing the resource, becomes inescapable. Early attempts by economists to analyse the management of transboundary fisheries, without the aid of game theory, quickly degenerated into incomprehensibility. Little progress in the development of the economics of the management of transboundary fish stocks was made, until the analytical tools provided by the theory of games were brought to bear. It might be noted, in passing, that natural resource/environment economists studying other transboundary resource management issues, e.g. water resources, global warming, find themselves compelled to employ game theory (see, for example: Barrett, 2003).

Perhaps the greatest drawback, from which the theory has suffered, is its popular name – the theory of games, which creates the impression that the theory is frivolous. It is not. In recognition of the theory’s rapidly growing application, the 1994 Nobel Prize in Economics was awarded to a trio of game theorists, one of whom, John Nash, can be seen as the founder of modern game theory, as applied to economics.

In the terminology of game theory, the “individuals” are referred to as “players.” The “players” are assumed to be rational and to have various courses of action open to them, which are referred to as “strategies.” The expected return to a player, in following a particular strategy, is then referred to as a “payoff.” The size of the expected return or “payoff” will, needless to say, be dependent upon the known, or expected, reactions of other “players.” The interaction between, or among, the players, as they execute their strategies, is the game. The stable outcome of a game, if it exists, is termed the “solution” to the game. Finally, the game may be a “once only” affair, or it may be repeated.

There are two broad categories of games, these being competitive, or non-cooperative, games, and cooperative games. In a cooperative game, the players are assumed to be motivated entirely by self interest, but have some incentive to endeavour to cooperate. Of prime importance is the fact that players are able to communicate with one another effectively. In competitive, non-cooperative games, the lines of communication between and among the players are, more often than not, faulty, or are simply non-existent.

Having said all of this, however, it must be emphasized in passing that open lines of communication, between and among players, do not, in of and by themselves, guarantee a stable solution to a cooperative game. As we shall see, effective communication among players is a necessary, but not sufficient, condition for a stable outcome (solution) to the cooperative game.

In analysing the economics of management of transboundary fishery resources, economists have asked themselves two fundamental questions. The first is what the consequences will be, if coastal States claim that they are unable to cooperate in the management of the resource. The implication is that the States would adopt the default option, which we discussed with reference to Article 63(1) of the 1982 UN Convention. That is to say, each coastal State would go its own way and manage the segment of the resource within its EEZ, as best it could. If the answer to the question is that the negative consequences of non-cooperation will prove to be trivial, then one need proceed no further.

If, on the other hand, the answer to the question is that the negative consequences of non-cooperation are severe, then cooperation does matter and the second fundamental question must be asked. The second question is: what requirements must be met for

a cooperative resource management regime to be stable and sustainable over the long run? It might be mentioned, in passing, that the second question raises the issue of equity. Cooperative management regimes, perceived, by one or more players, to be inequitable are, by definition, unstable.

3.2.2 Non-cooperative management of a transboundary fishery resource

The first question, that of the consequences of non-cooperative management of a shared fishery resource, is addressed, not surprisingly, by bringing to bear the theory of non-cooperative games. Consider a two “player” (coastal State) game. Those who have investigated the question usually assume that each of the two players has full and effective resource management powers within its own waters, although we shall want to comment on this at a later point.

One must concede, from the outset, that there do exist cases in which the default option is perfectly acceptable. The 1980s Georges Bank scallop fishery, shared by Canada and the USA, provides a case in point (Munro, 1987). The chief characteristic of the fishery, however, was that economic benefits Canada extracted from the fishery were essentially independent of American harvesting activities, and vice-versa. Hence, there was no effective strategic interaction between the two coastal States, as far as the fishery was concerned. Thus, the theory of strategic behaviour (games) was simply irrelevant in this case.

Let us then turn to the many transboundary stock cases in which the harvesting activities of any one coastal State do affect the economic wellbeing of the other coastal State(s) sharing the resource, and in which the theory of non-cooperative games is indeed relevant. A stable solution to a non-cooperative game was defined by John Nash (1951) as a situation in which each player has no incentive to change, given the strategies being followed by the other player. Two independent investigations of the non-cooperative fisheries game were published in 1980 (Clark, 1980; Levhari and Mirman, 1980). Both came to the same conclusion. A stable solution to the game would involve, except in unusual circumstances, mismanagement of the resource from society’s point of view. Clark (1980) argues that, if the players are symmetric, i.e. identical in all respects, the outcome will be similar to that encountered in an unrestricted open access domestic fishery, i.e. Bionomic Equilibrium (Gordon, 1954), which we have characterized as a benchmark of undesirability in fisheries management. The overall outcome to the fisheries game is an example of what is probably the most famous of all non-cooperative games, known as the “Prisoner’s Dilemma.”

The point of the “Prisoner’s Dilemma” game is that the players in the non-cooperative game will be driven to adopt strategies, which each recognizes as being undesirable. The name comes from a story told by the author of the game to illustrate the point (Tucker, 1950). Two men are arrested on suspicion of having committed a major theft. The suspicions are, in fact, entirely valid. The two suspects, A and B, are kept completely separate from one another. The impossibility of communication between the two acts as a perfect barrier to cooperation.

Prisoner A is interviewed by the chief prosecutor, who admits that the evidence, which he has, is limited. A is told that if both he and B plead not guilty, they can each expect to receive a six month sentence on a lesser charge. If both A and B plead guilty, they will each receive a five year sentence. If A pleads guilty, but B pleads not guilty, A will be released for having assisted the prosecution. If A pleads not guilty, but B pleads guilty, then it will go very hard with A, and A will get ten years. The chief prosecutor holds exactly the same interview with B.

A and B are the players. Each player has two alternative strategies: to plead guilty, or to plead not guilty. If A and B could communicate, and importantly, could enter into a binding agreement (i.e. an agreement in which each would be assured that the other could not, and would not, cheat), they would both plead not guilty, and would

look forward to being out of prison in six months time. They cannot communicate, however. The best strategy for A, regardless of which of the two strategies B might choose, is to plead guilty. What is true for A is true for B. Hence, both plead guilty and end up with the decidedly inferior outcome of serving five year sentences¹⁰.

Now let us apply the concept of the “Prisoner’s Dilemma,” to a somewhat different fisheries situation. Let A and B be two “symmetric” coastal States sharing a resource. Assume that neither A nor B had, in the past, engaged in serious management of its respective share of the resource. The resource is, consequently, overexploited, at the common Bionomic Equilibrium level, a fact which is recognized by both A and B. A and B are now admonished by an outside international body to undertake meaningful management of their respective portions of the resource. There is, however, no thought of cooperation between A and B.

Consider A, which has two “strategies” before it: undertake and incur the cost of a management programme, or do nothing. Suppose that A does incur the cost of a serious management programme, and that the resource, for a time, rises above the Bionomic Equilibrium level. In the absence of cooperation, the outcome is not stable, and the resource will be driven back down to where it started. B would have the pleasure of enjoying some temporary benefits from A’s management efforts, at no cost to B. We would refer to B, in these circumstances, as a “free rider.” For A, undertaking the cost of management, is likely, at best, to be little more than an exercise in futility. If A does nothing, and, if B is foolish enough to engage in resource management, A will enjoy the rewards of being a “free rider.” Obviously A’s best strategy will be to do nothing. B is faced with the same set of strategies. What holds true for A, holds true for B. Thus we can predict that A and B will do nothing, while continuing to recognize the consequences of the absence of effective management.

Economists have long come to the conclusion that the predictive power of the economic theory of non-cooperative management of transboundary stocks is high. Case studies presented at the Norway-FAO Expert Consultation reinforced that conclusion. The authors of the case study on the transboundary hake stocks, shared by Angola, Namibia, and South Africa, estimate that the absence of effective cooperative management of the resource has led, through time, to the dissipation of approximately 25 percent of the potential net economic benefits (resource rent) to be derived from the resource (Sumaila, Ninnes and Oelofsen, 2003).

The case study presented at the Expert Consultation, providing the most vivid example of the consequences of non-cooperative management of a transboundary stock, was that on Pacific salmon, shared by the United States and Canada (Miller, 2003).

The Pacific salmon species, being anadromous, are produced in fresh water rivers, streams and lakes. Then, after a time, the fish migrate to an ocean environment, and subsequently return to their fresh water habitats to spawn and die. The fish are normally harvested as they approach the river mouths on their way to spawn.

Pacific salmon, in the Northeast Pacific, are found from northern California to Alaska. The Pacific salmon resource is an inherently shared one. It is inevitable that Canadian fishers capture, “intercept,” some American produced salmon. It is equally inevitable that American fishers “intercept” some Canadian produced salmon.

While many Pacific salmon move into the high seas during part of their life cycle, the Pacific salmon is, nonetheless, a transboundary resource to all intents and purposes. This is due to Article 66 of the 1982 UN Convention. The article, which was included in the Convention due to the joint efforts of Canada and the United States, has had the result that direct high seas fishing of Pacific salmon is deemed to be contrary to international law (Burke, 1994; Miller, 2003; UN, 1982).

¹⁰ The “Prisoner’s Dilemma,” and its relevance to fisheries, is discussed in detail in the appendix to this paper entitled: “The Prisoner’s Dilemma and Fisheries”.

The two coastal States were in no doubt that cooperative management of the resource would be mutually beneficial. Moreover, the two, priding themselves on the quality of their respective fisheries management, clearly had the joint capability to manage the resources effectively.

Cooperation initially focussed on the Fraser River, wholly in Canadian territory, which was, and is, arguably the most important Pacific salmon river in the Western Hemisphere (Munro and Stokes, 1989). In the 1960s, it was decided that the focus on the Fraser River was insufficient. Negotiations on cooperative resource management were extended to include all Pacific salmon resources, from northern California to the Gulf of Alaska.

The negotiations led ultimately to the signing of the Canada – US Pacific Salmon Treaty in 1985 (Treaty, 1985). The negotiations, leading up to the Treaty were difficult. While the arrangements pertaining to the Fraser River remained in place, non-cooperative management governed the other salmon stocks. During the years, prior to the signing of the Treaty, there was a constant threat of damaging “fish wars” – deliberate overexploitation of the resources – erupting. Furthermore, it was recognized that both countries had opportunities to enhance the size and strength of the stock produced in their salmon rivers, through various enhancement projects. Each country held back on initiating such projects, for fear that the other would “free ride” (Munro and Stokes, 1989). Indeed, it was the combined threat of “fish wars”, and the continued blocking of enhancement projects, which served as a prod to drive the negotiators on, until they finally achieved (temporary) success.

The Treaty, while initially successful, encountered serious difficulties (for reasons to be explored at a later point), and seized up. The two countries retreated to what we have referred to as the default option, i.e. managing the share of the resources within their respective EEZs, as best they could. During this period, the two countries reverted to competitive behaviour. The “Prisoner’s Dilemma” returned with a vengeance, to the great detriment of the resources. The two coastal States eventually “patched up” the Treaty by signing an Agreement in 1999. While the Agreement has many critics, even the severest critics, with the thought of “fish wars” in mind, concede that an agreement, however flawed, is better than no agreement at all (Miller, 2003; Miller, Munro, McDorman, McKelvey, and Tyedmers, 2001).

The implication of the analysis is straightforward. Even if coastal States sharing a resource have the capability of managing effectively fishery resources within their domestic waters, one has no justification in assuming that, in the absence of cooperation, the resource management outcome will be “adequate,” that what we have referred to as the default option will be sufficient. The risk exists that the outcome will be disastrous. Other than in exceptional cases, cooperation does matter. Moreover, cooperation is not to be seen, merely as a useful supplement to resource management by individual states. Rather, it is to be seen as a fundamental prerequisite for effective resource management.

Consider the following example. FAO Members have approved an International Plan of Action for the Management of Fishing Capacity (FAO, 1999). The IPOA-Fishing Capacity does, *inter alia*, talk about the importance of addressing the problem of excess fleet capacity in the management of shared fish stocks (FAO, *ibid.*, p.2). One can be confident that, if shared fish stocks plagued by excess fleet capacity are managed non-cooperatively, the excess capacity will continue indefinitely, IPOA, or no IPOA.

3.2.3 Cooperative management of transboundary fish stocks: some preliminaries

In examining cooperative management of shared fishery resources, one brings to bear the theory of cooperative games. Moreover, just as reference was made to Nobel Laureate John Nash’s theory of non-cooperative games, so extensive reference will be made to John Nash’s theory of cooperative games (Nash, 1953).

The theory of cooperative games is to be seen, first and foremost, as a theory of bargaining. It is, to repeat, assumed that each player is motivated by self-interest alone. If the players agree to cooperate, it is because each is convinced that it can gain more from cooperation, than it could by engaging in competitive behaviour.

In cooperative games, numbers are important. Once the number of players exceeds two, the analysis becomes much more complex. One has to allow for the possibility of sub-coalitions forming among the players, and acknowledge the fact that the greater is the number of players, the more difficult it is to achieve a stable solution to the game. For the discussion to follow on transboundary stocks, we can safely restrict ourselves to the more tractable two player games. When we come at a later point, however, to discuss the management of highly migratory, straddling and discrete high stocks, we shall have no choice, but to deal head on with games having more than two players, and the complications arising therefrom.

Next, given that a cooperative agreement is arrived at, one has to be able to ensure that the provisions are effectively enforced – the issue of compliance. If communication between and among the parties to the agreement – the players – is excellent, but each lacks the assurance that the others will not cheat, the cooperative arrangement will not hold, in spite of the excellent communication.

The legal expert Daniel Owen maintains that the great majority of cooperative arrangements concerning transboundary stocks take the form of treaties (Owen, 2001). He goes on to point out that treaties are legally binding on the contracting parties. He then qualifies this statement, however, by saying that, at the end of the day, the effectiveness of the treaty will be dependent upon the political will of the contracting parties (Owen, *ibid.*).

In a similar vein, Scott Barrett (2003), while agreeing that treaties are legally binding upon the contracting parties, insists that the treaties must be “self-enforcing.” He means by this that, in contrast to domestic contractual arrangements, the contracting parties cannot, in spite of dispute settlement provisions and the ICJ, really rely upon third party enforcement of the provisions (Barrett, 2003). The Norway-FAO Expert Consultation, as we shall see, did appropriately devote considerable time and effort to analysing the question of implementation and enforcement of cooperative arrangement provisions.

A closely related issue is whether participants in the cooperative resource management arrangement are protected against non-participants sharing in the fruits of cooperation free of charge, as it were. Such non-participants are aptly referred to as “free riders.”

If “free riding” by non-participants is rampant, the cooperative arrangement will have great difficulty in surviving. Indeed, Barrett argues that non-participant “free riding” is the binding constraint upon international cooperation (Barrett, 2003, n.1, p. 271).

Non-participant “free riding”, in the case of transboundary stocks, could conceivably arise in one of two ways. First, a coastal State sharing the transboundary stock might stay out of the cooperative arrangement, and “free ride” on the fruits of the cooperative endeavours of its neighbouring coastal States. While this form of “free riding” is certainly not out of the question, the authors would be hard pressed to come up with significant real world examples. Secondly, vessels of other states (i.e. DWFs) could enter the EEZs of the cooperating coastal States without permission, and exploit the transboundary stock in question. The vessels would, however, be deemed to be engaged in illegal fishing (see: FAO, International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU, hereafter), 2001, para. 3.1.1). The affected coastal States could, under international law, take vigorous measures to repel the intruders.

Of course, some “free riding” of the second form does, nonetheless, occur. It should be pointed out, however, that the problem is, in principle, no different from that faced

by any coastal State attempting to protect its intra-EEZ fishery resources against poachers. In any event, we see the problem of “free riding” as being a relatively minor one, in the case of transboundary fish stock management. This stands, as we shall see, in stark contrast to the management of the other three categories of shared fish stocks.

Following upon questions of number of players, compliance and “free riding,” we must also consider the goals of resource management. In the *Shared Fish Stocks: An Overview* section, it was noted that the FAO recognized, well before the conclusion of the UN Third Conference on the Law of the Sea, that there is no necessary reason why the States, sharing a fishery resource, should have the same management goals. If the States have identical management goals, then the theory tells us that the States will attempt to institute a resource management programme, which will maximize the global economic returns from the fishery over time, and will then bargain over the division of the returns. If management goals differ, then the added problem has to be faced of developing a compromise resource management programme.

Finally, in this list of preliminaries, is the question of so called “side payments.” A side payment, in its simplest form, is a type of transfer, where the term transfer is defined broadly. While the transfer may be monetary in form, there is no need whatsoever for it to be so. Moreover, a non-monetary transfer may extend beyond the fishery itself, e.g. trade concession on products other than fish. We shall define, for our purposes, a transboundary fisheries cooperative game without side payments, as one in which one coastal State’s return from the shared fishery is determined solely by the harvests of its fleet(s) within its own waters.

The importance of side payments has become increasingly recognized over the past few years (see: Caddy, 1997). The use of side payments was, as we shall see, discussed at some length at the Norway-FAO Expert Consultation, (where some participants preferred the more connation free term, “negotiations facilitators”). It will be seen that one role, which side payments can play, is that of mitigating some of the difficulties arising from coastal States having differing resource management goals.

3.2.4 Conditions for stable transboundary resource management arrangements: two players

There are two conditions, which must be met as an absolute minimum, if there is to be a stable solution to the cooperative game. Both are straightforward, and both seem entirely compatible with common sense. The first requires some additional economist’s jargon. The late 19th/early 20th century Italian economist, Wilfred Pareto, put forth the proposition that in trade, or in other dealings between, and among, “individuals”, the outcome was certain to be less than optimal, if it were possible by a rearrangement of the dealings to make one individual better off, without making the other individual(s) worse off. This proposition gave rise to the expression “Pareto Improving,” and the concept of “Pareto Optimality.” Any change, or adjustment, which makes at least one individual better off, without making the other individual(s) worse off, is deemed to be “Pareto Improving,” in nature. “Pareto Optimality” denotes a situation, in which the opportunities for “Pareto Improvement” have been exhausted, and in which it is not possible to make one individual better off, except at the expense of the other individual(s).

The first requirement for a stable solution to the two player cooperative game is that it be “Pareto Optimal.” Suppose that the cooperative game consists of two players, coastal States I and II, and that the “solution” to the cooperative game consists of an agreed upon cooperative resource management regime. If changes could be made to the cooperative management regime, which would make both I and II better off, then the “solution” to the cooperative game can hardly be regarded as stable. Once the two States realized that, by altering the cooperative management regime, both would be made better off, the two would, if rational, do just that. What could be more

straightforward?¹¹

The second requirement for a stable solution to the cooperative game has equal appeal to common sense. The requirement is sometimes referred to as satisfying the Individual Rationality Constraint. It states that a solution to the cooperative game will not be stable, unless the payoffs arising from the solution make each and every player at least as well off as it would be under conditions of non-cooperation. If the cooperative management arrangement is such that any given player (a coastal State) finds that its expected economic return from the fishery will be less than what it could have expected under non-cooperation, the player's willingness to cooperate will evaporate. The Report of the Norway-FAO Expert Consultation noted, that, while this requirement should be obvious to all, it is often ignored in practice (FAO, 2002a, p. 8).

Those potential solutions to the cooperative game, which satisfy both requirements, are said to constitute the "core" of the game¹². This immediately raises the question as to whether one can always be certain that such a "core" exists. The answer is no, the "core" can be empty. If that is the case, then there are no solutions, which will satisfy both requirements. Attempts to establish cooperation will prove to be futile, and the players will revert to competitive, non-cooperative, behaviour, with all that that implies.

We now turn to a widely used figure illustrating the conditions necessary for a stable solution to the cooperative game. The figure appears, for example, in the aforementioned 1997 OECD publication, the 1996 World Bank publication, and appears, as well, in the 1997 paper by John Caddy (Agüero and Gonzalez, 1996; Caddy, 1997; OECD, 1997).

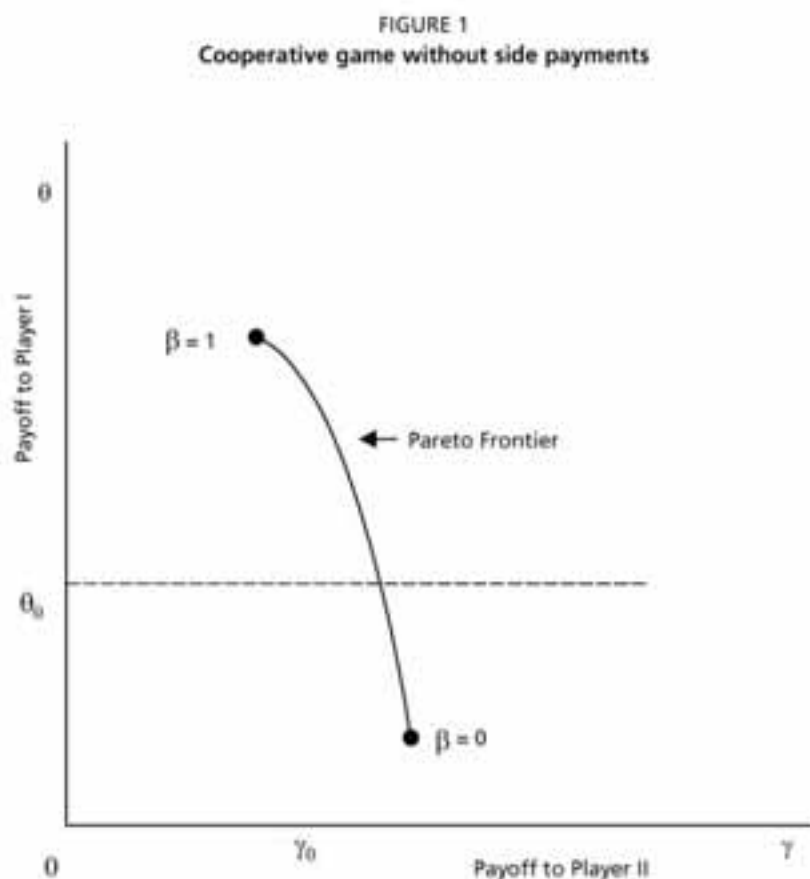
The figure is meant to represent a two player, (two coastal States, I and II), cooperative fisheries game. The axes are the "payoffs" to the two respective players. A given payoff to Player I measures the stream of economic returns through time to Player I, arising from a given resource management programme. Correspondingly, a given payoff to Player II measures the stream of economic returns to that player from a given resource management programme. The two streams of economic returns are measured in terms of Present Value.

It is assumed, in this example, that: i) the two players are not symmetric, they do not have identical management goals; ii) if a cooperative arrangement is achieved, it will be binding in the sense that an absence of cheating and "free riding" is assured; and iii) there is no allowance for side payments. The solid curve represents the Pareto Frontier, in that it shows the payoffs from cooperative management regimes, in which it is not possible to make I better off, except at the expense of II, and vice versa.

If we commence at the top of the curve at $\beta = 1$, we would have a cooperative management programme, which would maximize the benefits from the fishery to Player I. As we move down the curve, Player II would become successively better off, but only at the expense of Player I. By way of contrast, if we were at *any* point below the Pareto Frontier, both Players I and II could be made better off by adjusting the cooperative resource management programme. The parameter β , to which we have referred, is, in fact, a bargaining parameter, $0 \leq \beta \leq 1$. If $\beta = 1$, then the management preferences of I are wholly dominant, while the management preferences of II count for nothing. If $\beta = 0$, the reverse is true.

¹¹ Barrett (2003) prefers to use the term Collective Rationality.

¹² Barrett (2003) adds a third requirement, "fairness." While we do not deny the importance of fairness, or equity, we are not really certain that this third requirement is independent of the other two. Consider a two player cooperative resource management arrangement, free from the possibility of cheating, but in which one player finds that its expected return from the fishery under cooperative management, is less than what it could expect under non-cooperation. The player will deem the arrangement to be "unfair," and refuse to participate. We could, just as easily have said, however, that the arrangement violates the requirement of individual rationality from the perspective of this player.



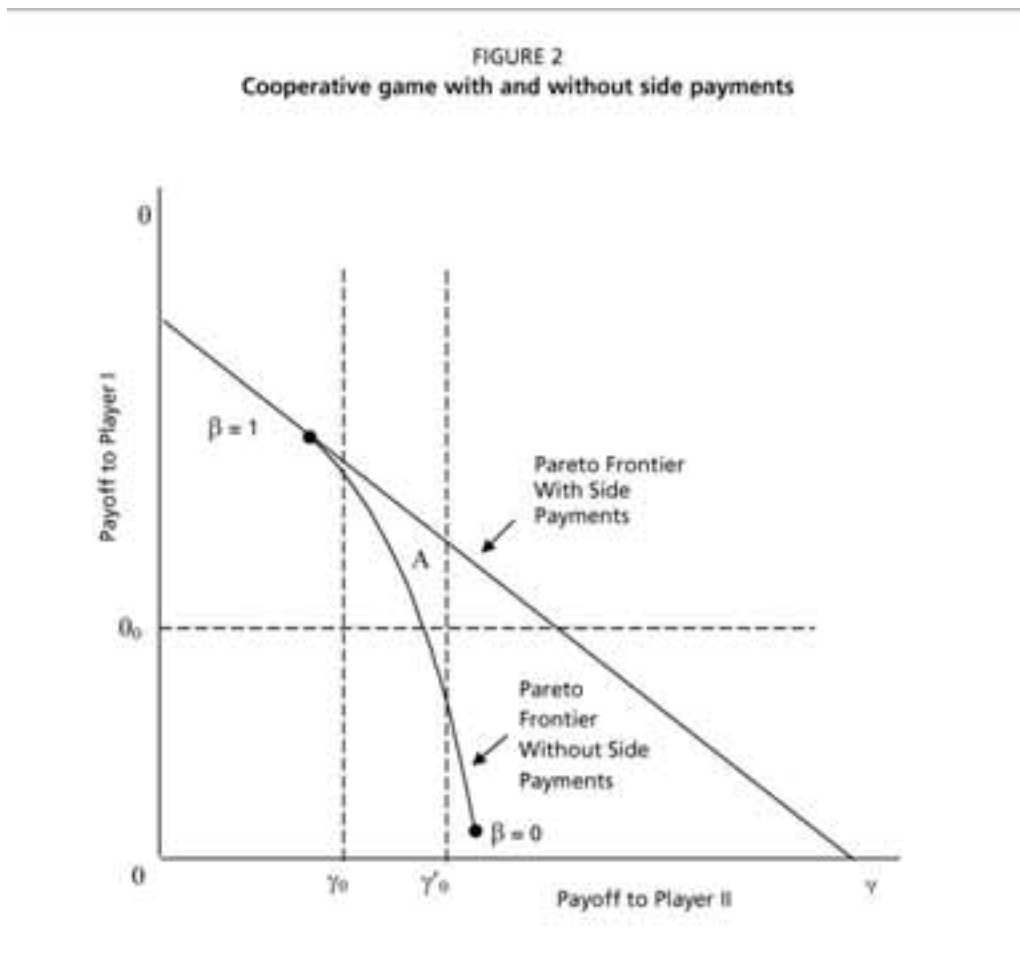
The payoffs, θ_0 and γ_0 are the payoffs, which I and II would enjoy respectively, if there was no cooperation. They might be thought of as the payoffs associated with the solution to a non-cooperative game. John Nash referred to this set of payoffs as the “Threat Point,” as they represent the *minimum* payoffs, which each of the two players must receive for the solution to a cooperative game to be stable (Nash, 1953).

That part of the Pareto frontier segmented by the dashed lines emanating from the Threat Point payoffs represents the “core” of the game. In the example shown, the “core” is positive, so that a stable solution can be achieved. We shall not discuss the theory underlying the determination of the ultimate solution (see: Nash, 1953). It will only be noted that a unique solution does exist, and that, in this example, the management preferences of both players will play a role, i.e., the solution β lies between 1 and 0. A solution, in which the management preferences of either player are wholly dominant, is not feasible. If, for example, the solution to the game was such that $\beta = 1$, the “solution,” the cooperative agreement, could not last, since player II would be worse off than it would be, had it refused to cooperate.

Turn now to Figure 2. In this figure, allowance is made for the possibility of side payments (“negotiation facilitators”)¹³.

When side payments (transfers) are allowed, a particular player’s returns from the fishery are not dependent wholly upon its fleet’s harvest of the resource within its own waters. The Pareto Frontier in this case becomes a 45° line, which is tangent to the

¹³ Some participants in the Norway-FAO Expert Consultation thought that the term “side payments” had a somewhat unseemly ring to it.



Pareto Frontier Without Side Payments, at the latter's highest point. The significance of the 45° line is that, at any point on the line, the sum of I and II's payoffs is equal to the sum of those payoffs at any other point on the line. The implication of all of this is that the players seek to maximize the global returns from the fishery, without regard for differences in management objectives. Bargaining then takes place over the division of the global returns.

It is at this point that a key question must be raised, namely what benefits from a fishery are in fact being divided between the coastal States sharing the resource. Is it harvested fish per se, or is it the economic (and perhaps social) benefits arising from the fishery? If it is the latter, then sharing the harvest must be seen as only one of several ways of sharing the economic benefits from the fishery. If the relevant coastal States insist that the benefits be divided only through harvest shares, which each coastal State is to take exclusively within its EEZ, then they are imposing a constraint upon themselves. In some instances, the constraint could prove to be crippling. Side payments serve to relax that constraint.

Side payments become particularly significant, when the management goals of coastal States sharing the resource differ. Munro (1987) has argued that, when there are differences in management goals, it is invariably the case that one player places a higher value on the fishery than does the other. It might, for example, be that one player has lower harvesting costs than does the other, or it may be that one player discounts the future economic returns from the resource less heavily than does the other. When side payments are possible, then the optimal policy is one in which the management preferences of that player placing the highest value on the resource should

be given full reign. That player should, in turn, then proceed to compensate its fellow player, or players through the use of side payments. The side payments can, as we have indicated, take any number of forms. In another context, Munro referred to this as the “*Compensation Principle*” (Munro, 1987)¹⁴.

Consider Figure 2, yet again. In this example, Player I places the highest value on the resource. The Pareto Frontier With Side Payments is tangent to the other Frontier at the point where $\beta = 1$, i.e., at the point where the management preferences of I are wholly dominant. The implication is that the global economic returns from the resource through time will be maximized by allowing Player I to manage the resource, unimpeded by the management preferences of Player II. Player I will then have to compensate player II through side payments, i.e. transfers of some form.

Ignore, for the moment, the payoff γ'_0 on the horizontal axis. Player II will obviously be better off with side payments, than without. What about Player I, however? Figure 2 provides the answer. In the absence of side payments, the solution to the cooperative game would have to lie within the “core,” shown as that segment of the Pareto Frontier Without Side Payments segmented by the dashed lines emanating from θ_0 and γ_0 . Suppose, for the sake of argument, that the solution to the cooperative game was at point A. The introduction of side payments would clearly be “Pareto Improving”, in that Player I, as well as Player II, could be made better off. The reason lies in the fact that, in the absence of side payments, the players would, in the example before us, be forced to a position, in which the global benefits from the fishery were less than the maximum. Side payments, to the benefit of both players, allow that maximum to be achieved.

Now let us recognize the payoff γ'_0 , and recognize, as well, that Figure 2 presents us with two alternative cases. In the first case, (Player II’s Threat Point payoff is γ_0), which we have discussed, it would be possible to achieve a stable solution to the cooperative game, without side payments. The introduction of side payments has the effect, as we have seen, of making both players better off, by allowing superior management. In the second case (Player II’s Threat Point payoff is γ'_0), the consequence of side payments being disallowed, is that there will be no solution to the cooperative game, because there is no point on the relevant Pareto Frontier at which both Players I and II would be better off than if they had refused to cooperate. The “core” of the game is empty. With side payments, the scope for bargaining is increased, and a stable solution to the game is achievable. Thus, in the second case, side payments make the difference between a successful cooperative arrangement and attempts to achieve cooperation ending in certain collapse.

The two dimensional figures, to which we have referred, do not allow us to portray the full benefits of side payments. The side payments, or “negotiation facilitators,” can lead to “Pareto Improvements,” even when there are no clear differences in resource management objectives between, or among, cooperative arrangement participants. Consider the key issue of allocation of the TACs among these participants.

The Report of the Norway-FAO Expert Consultation concludes that, historically, the primary criteria for allocation of TACs for cooperatively managed transboundary stocks have been historical catches within individual coastal State EEZs, and zonal attachment of these resources. History has revealed, the Report argues, that there are strong advantages to having the percentage TAC allocations, based on such criteria,

¹⁴ The *Compensation Principle*, although not labelled as such, found its way into an FAO publication a decade ago, FAO Fisheries Circular No. 853, *Marine Fisheries and the Law of the Sea: A Decade of Change*, 1992. The author, after introducing a *Compensation Principle* type of example, states that: “The basic principle is the treatment of the fishery resources as resources that have value in situ; a value definable in monetary terms. The model is that of an international regime that achieves stability by the sharing of the benefits deriving from the use of the resource and providing compensation for those members who are less well endowed. (FAO, 1992, p. 41)”.

being stable over time. Seemingly capricious variations in the percentage allocations are certain to undermine the arrangement. The Report then remarks, however, that, in order to make the system work, side payments may be required. This is particularly true when the cooperative arrangement, as is commonly the case, covers multiple species (FAO, 2002a).

Consider the following two cases, examined at the Expert Consultation. The first involves fishery resources shared by Norway and the Soviet Union/Russia, in the Barents Sea (Stokke, 2003). A cooperative resource management arrangement between the two countries dates back to the mid 1970s, and has continued to the present day.

Fixed percentage allocations of the TACs for two key resources in the area, Arctic cod and haddock, were agreed upon early in the history of the arrangement, and were adhered to thereafter. Side payments, or their equivalent, were introduced, however, to provide flexibility. To begin, the two states are not restricted to taking their quotas within their respective EEZs. Groundfish, such as cod, spawning in the Russian zone, reach their adult stage in the Norwegian zone. It makes far greater economic (and biological) sense to harvest the groundfish at their adult stage. Under a Mutual Access Agreement, the Soviets/Russians were/are enabled to take a substantial part of their quota in the Norwegian zone, a decidedly Pareto Improving step (Stokke, *ibid.*).

Secondly, it was almost inevitable that the two countries would place different valuations on the resources, with the consequence that a mutually profitable opportunity to trade quota appeared. Thus, for example, while Norway has had a fixed percentage allocation of the Arctic cod quota, it has effectively “bought” cod quota from its partner by swapping quota in other species (Stokke, *ibid.*). The cooperative arrangement, which, as we have noted, commenced in the mid 1970s, when the Cold War was very much ongoing, has proven to be remarkably stable over time.

The second example involves the Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts (Ranke, 2003). The Convention, which dates back to 1973, has proven to be successful, in spite of the fact that the membership of the cooperative arrangement has, since its origins, been in a state of almost constant flux¹⁵. When the Convention initially came into force, coastal States members had access to fisheries throughout the Baltic Sea. The 1982 UN Third Conference on the Law of the Sea meant that TAC allocations had to be made under a new set of legal conditions.

The TAC allocations for the four major species (herring, sprat, cod and salmon) were made on a fixed percentage basis. Since there was an absence of clear rules, or parameters, the TAC allocations were close to being arbitrary in nature (Ranke, 2003). The system has been made workable by allowance for quota swaps, and reciprocal access arrangements (Ranke, *ibid.*)¹⁶

The Report of the Norway-FAO Expert Consultation did take note of the fact that side payments, as well as increasing the efficiency and flexibility of TAC allocations, can be used to reconcile differences in management goals, i.e. the *Compensation Principle* (FAO, 2003a). An illustration is provided by the case study on Norwegian Spring Spawning Herring, presented to the Expert Consultation (Bjørndal, 2003).

The resource, which has historically been the most abundant fishery resource in the North Atlantic, crashed in the late 1960s-early 1970s, due to overexploitation. A harvest moratorium was imposed. By the mid 1990s, the resource had recovered. It is now managed cooperatively by Norway, Russia, Iceland, the Faroe Islands and the EU¹⁷.

¹⁵ This has been due largely to a combination of the expanding membership of the EU, and the ending of the Cold War.

¹⁶ The precedent has now been set in the Baltic of going beyond quota swaps, to the actual buying of quota (Ranke, 2003).

It is easy to demonstrate that, if the costs of harvesting differ among the joint exploiters of a resource, the harvesting cost differentials can lead to differences in resource management goals (Munro, 1979). Harvesting costs are not uniform among the exploiters of Norwegian Spring Spawning Herring.

In his paper, Bjørndal presents the results of a simulation study on the management of the resource. For the purposes of the study, the partners are placed into three groups, Norway and Russia – “Norway”; Iceland and the Faroe Islands – “Iceland”; and the E.U. “Norway” constitutes the lowest cost harvester of the resource. After demonstrating the predictably disastrous consequences of non-cooperation, the simulation study analyses two cases of cooperative management, these being (i) the “Cartel” case, and (ii) the “Monopoly” case. Under the “Cartel” case, each of the three receives a TAC allocation and proceeds to harvest that allocation to the best of its ability. Under the “Monopoly” case, the lowest cost partner “Norway” does all of the harvesting and determines the resource management policy. “Norway” would have to compensate the other two partners through side payments. As one would anticipate, the global economic returns from the fishery in the “Monopoly” case are considerably greater than they are in the “Cartel” case. Moving from a “Cartel” to a “Monopoly” exploitation and management of the resource would be “Pareto Optimal,” in that all three partners could be made better off, in economic terms, by the move (Bjørndal, 2003).

It is reasonable to say that, while the Norway-FAO Expert Consultation participants found the “Monopoly” case to be of interest, they found the case to be of theoretical interest only, i.e. unrealistic. Yet, history has provided us with an example of cooperative resource management, which mirrors the “Monopoly” case very closely. The example is that of the fur seal fishery of the Northeast Pacific, commencing in the first part of the 20th century. The fishery was shared by four countries, Canada, Japan, Russia and the United States. When the fishery became significant in the late 19th century, there was no cooperative management. The “Prisoner’s Dilemma” played itself out, and the resource was subject to severe overexploitation. Fearing the outright collapse of the resource, the four countries came together and transformed the non-cooperative game into a cooperative one, which took the form of the 1911 Convention for the Preservation and Protection of Fur Seals, which was to last, with one lengthy hiatus, until 1984 (Burke and Christy, 1990; Barrett, 2003).

The four players were not identical. Two, Russia and the United States, were low cost harvesters, harvesting the seals on land (Pribiloff Islands), while the other two, Canada and Japan, were high cost harvesters, harvesting the seals at sea. Moreover, Russia and the United States received higher prices for their seal skins than did the other two countries. Needless to say, Russia and the U.S.A. placed a higher value on the resource than did the other two. Under the terms of the Convention, Canada and Japan were each to receive a certain fixed percentage of the TAC. However, Canadian and Japanese harvesting activities were to be reduced to zero. All harvesting was to be done by Americans and Russians, with the Canadians and Japanese receiving their shares of the TAC in the form of seal skins, each season. The United States and Russia did, of course, determine the resource management regime.

This pure side payments cooperative arrangement proved to be profitable for all four players. Moreover, it also had beneficial conservation consequences. It was estimated that, between 1911 and 1941 (when the hiatus in the Convention, referred to earlier, commenced), the seal herds had increased eighteen fold (FAO, 1992).

¹⁷ The resource spawns in Norwegian waters. When the resource is in a healthy state, it migrates as far as Iceland. When it is in a depressed state, the resource is confined to Norwegian waters. Norway introduced the harvest moratorium for the remnants of the resource, in the early 1970s. Upon the resource’s recovery, the moratorium was lifted. It became necessary to manage the resource cooperatively, since the resource had resumed its pattern of migrating beyond Norwegian waters (Bjørndal, *ibid*).

3.2.5 Conditions for stable transboundary resource cooperative management arrangements: some further considerations

There are two additional requirements for stable cooperative resource management arrangements, which require our attention. Both are linked to the fundamental requirements of Pareto Optimality and satisfying the Individual Rationality Constraint. They are:

- a) effective implementation and enforcement measures
- b) resiliency of the cooperative resource management arrangement through time

Effective implementation and enforcement measures

To this point we have assumed implicitly that participants in a cooperative resource management arrangement all comply fully with the provisions of the arrangement. In practice, of course, there is no justification for assuming that compliance will emerge on its own. It then becomes difficult to argue with John Gulland's statement that "... without adequate implementation and enforcement the best [fisheries] arrangements can be useless" (Gulland, 1980, p. 17).

If compliance within the cooperative arrangement is lacking, the obvious risk arises that one, or more, player(s) will determine that it is not rational for it (them) to cooperate. A player, if not bound by moral consideration, may decide that it would be better off in economic terms, by breaking the rules. A player, which is bound by moral considerations, may calculate that cheating by other players will result in its expected payoff being below its "Threat Point" payoff, and simply withdraw from the cooperative arrangement.

The Report of the Norway-FAO Expert Consultation deals with the issue of implementation and enforcement in some detail and examines it in terms of four possible scenarios:

Scenario I: This, the simplest of the scenarios, is one in which there are two coastal States sharing a transboundary resource, in which the resource is exploited only by the fleets of the two coastal States, and in which all boundary delimitation disputes have been settled. Effective implementation and enforcement of fisheries management regimes requires the following measures, as a minimum (FAO, 2002a):

- i. Maintenance of a register for vessels authorized to fish the stock;
- ii. Use of a system to monitor fishing activities (including, as appropriate, ready access to records relating to the authorization to fish, the amount and species of quota, the area of operation, trip duration, fishing logs, etc.), and
- iii. Port inspections of vessels, catch on board and catch offloaded.

Scenario II: The second scenario is the same as the first, except that there are disputed boundaries between the two States, giving rise to a disputed area for management. It is obviously eminently desirable that the two States develop an "area of joint management", which includes the disputed area.

An example is provided by the previously cited case of the joint Norwegian-Soviet/Russian management of fishery resources in the Barents Sea (Stokke, 2003). There is an unresolved boundary delimitation dispute between the two countries, involving an area of 155,000 square kilometers, rich in fishery resources. The Norwegians and the Soviets resolved the resultant resource management problem by establishing a Grey Zone Agreement, under which the two agree upon harvest quotas, and under which each coastal State regulates its own vessels. The Agreement has continued in force, following the end of the Soviet Union (Stokke, *ibid.*).

The Report maintains that, in addition to the minimum measures put forth in the first scenario, the following measures are required for the Grey Zone type of area:

- Special reporting requirements for fishing vessels when they operate in the said fishing area, including the provision of simultaneous reports to both coastal States; and

- Reciprocal monitoring and surveillance schemes for each coastal State with respect to vessels flying the flag of one of the Parties and operating in the said area, or primarily flag State responsibility for monitoring and surveillance (e.g. boarding, inspection, arresting and bringing into port, etc.).

Scenario III: The third scenario is the same as Scenario I, except that one, or both, of the coastal States, establishes access arrangements to fisheries within its EEZ, to third parties (e.g. distant water fishing states, DWFSs). The following additional measures, designed in part to prevent possible “free riding”, are then required;

- Fishing activities by a third party fishing vessel, authorized to fish in the EEZ of one of the coastal States, should be controlled and subject to surveillance by that coastal State;
- Third party fishing vessels should be subject to at least the same terms and conditions of licence (including boarding, inspection and enforcement requirements) when they are operating in either or both EEZs, as the terms and conditions imposed on national vessels from the coastal States; and
- The flag State legislation should include control measures (e.g. an authorization procedure) for its vessels fishing in the EEZ of another State.

Scenario IV: The fourth scenario, of particular importance, in light of our discussion of the importance of side payments, is identical to Scenario I, except that the coastal States grant reciprocal EEZs access to each other’s fleets. The minimum measures required are those set forth in Scenarios I and III, plus the following:

- Special reporting requirements (e.g. for catch, area of operation, entry and exit from the EEZ, notification, etc.) that would serve to reinforce coastal State management measures. As appropriate, such a requirement could involve real time reporting;
- Collaboration between the coastal States to create a culture to sensitize fishers and to encourage them to abide by the terms and conditions of their licences;
- A means that can be invoked by the coastal State (Party in the agreement or arrangement) in the event that its vessels commit an offence in the adjacent EEZ;
- Observer programme(s) for scientific and enforcement purposes; and
- As appropriate, education and awareness creating programmes addressed to all fishers, where institutional differences (capacity, means of control, etc.) exist among the coastal States Parties to an arrangement.

(FAO, 2002a).

Resiliency of the cooperative resource management arrangement through time

The world of fisheries is not static. In recognition of this fundamental fact, the Report of the Norway-FAO Expert Consultation places considerable stress on the importance of the cooperative arrangement being able to withstand the shocks of unanticipated changes, which can, in turn, arise from environmental, economic, political and other factors. The Report maintains that management plans for shared fish stocks need to recognize the dynamic nature of the systems they are managing and take these into account in their specifications of management targets (e.g. changes in distribution, abundance and/or migration patterns of target species). Past experience has shown that plans not incorporating this flexibility often fail to deliver. The plans should incorporate a review schedule, so that they can be evaluated and updated, as required (FAO, 2002a).

On-going research and monitoring of the changing natural, social, economic and political conditions should underpin the plans, so that adjustments in harvesting activities and management measures can be made. One element, which will be important in this regard, will be the ongoing cooperative scientific efforts to understand better the linkages between the changing biophysical conditions and the stock dynamics and the geographic distribution of the target species. In addition, changes in the relevant social, economic and political conditions should be routinely tracked and openly

communicated among the cooperating parties (FAO, *ibid.*).

In some instances, cooperation in research and monitoring may not be sufficient to achieve the required flexibility. It may be necessary, in addition, to broaden the scope for negotiating, by using tools that reflect changing circumstances, including linkages with non-fishery concessions, provision for quota trades and access arrangements, and other forms of side payments (“negotiation facilitators”) (FAO, *ibid.*).

Among the case studies discussed at the Expert Consultation, the study presenting the best example of the need for resiliency, and the possible consequences of its absence, is that of Pacific salmon in the Northeast Pacific, shared by Canada and the United States (Miller, 2003), which we discussed in the context of the consequences of non-cooperation. It will be recalled that, in the salmon fisheries in the Northeast Pacific, Canadian fishers invariably “intercept,” i.e. capture, American produced salmon, and vice-versa. It will also be recalled that, in 1985, the two countries signed a treaty governing the cooperative management of salmon resources from northern California to the Gulf of Alaska.

At the time the Treaty was signed in 1985, there was a rough balance between Canadian and American “interceptions” of each other’s salmon. A climate regime shift occurred, however, which had a decidedly negative impact upon salmon stocks in Washington, Oregon and southern British Columbia, and equally decidedly positive impact upon salmon stocks in Alaska and northern British Columbia. The rough “interception” balance was thrown into disarray.

The Treaty proved to lack the resiliency to withstand the shock. By 1993, the cooperative arrangement, although legally intact, effectively seized up. As noted, the two coastal States reverted to competitive behaviour. As also noted, the two States signed an Agreement in 1999 in an attempt to repair the damaged Treaty (Miller, *ibid.*).

Since we have emphasized the importance of side payments (“negotiation facilitators”) in enhancing the flexibility, and thus the resiliency, of cooperative resource management arrangement, it is worth observing that the Canada-U.S. Pacific salmon cooperative management arrangement, prior to the 1999 Agreement, was noteworthy for its complete absence of anything remotely resembling side payments. The 1999 Agreement, by way of contrast, does contain provisions for de facto side payments, although they are not specified as such (Miller, *ibid.*).

3.2.6 Administrative and organizational structures

No cooperative fisheries management arrangement can survive without a sound institutional and organizational structure. It therefore behooves us, at this point, to ask what lessons can be drawn from the history of cooperative transboundary fisheries management arrangements, pertaining to institutional and organizational structures.

The first (and obvious) point to be made is that there is no single ideal structure. Several different forms, or approaches, have been implemented, depending upon circumstances. John Caddy (1997) remarks that formal cooperative resource management bodies come at a cost, both financial and, for coastal States at least, in terms of a possible diminution of State sovereignty. In some cases, these costs can be avoided, or at least mitigated, through the use of informal structures. In other instances, nothing less than formal bodies will suffice.

With this in mind, we note that R.R. Churchill and A.V. Rowe, in their study on the Law of the Sea, identify four categories of forms and institutions developed for the cooperative management of transboundary stocks (Churchill and Rowe, 1988). They are:

- A. a set of agreements taking the form of a periodic (usually annual) arrangement negotiated under a pre-existing framework treaty;
- B. a set of arrangements, whereby a bilateral commission set up for the specific

- purposes of management of transboundary stocks;
- C. regional fisheries organizations;
- D. general cooperation agreements for the management of transboundary stocks on an ad hoc basis, but with the likelihood of the management measures being adopted continuing to be uncertain.

Category A: an example is provided by the series of annual arrangements agreed upon between Norway and the EU, within the framework of the Fisheries Agreement of 27 February 1980, whereby the two countries yearly conduct consultations on management measures and allocation of mutual fishing rights for the coming year. The consultations are based on the recommendations from the International Council for the Exploration of the Sea (ICES). Total allowable catch (TACs) are established for the relevant transboundary stocks, with the TAC allocations being based upon zonal attachment of the resources. Provisions are made for Norway to take parts of its quotas in the European Union (EU) zone, and vice-versa. The two parties have developed increasingly close cooperation in the field of monitoring, control and surveillance, and, in addition to a cooperative arrangement with the EU, Norway has entered in control Arrangements with the relevant member States of the EU. In this respect, the exchange of inspectors/observers on Coast Guard vessels and at landing sites are of particular importance. More recently, Norway and the EU introduced a satellite based (vessel monitoring system) VMS system and have entered into a specific arrangement on VMS to harmonize initiatives and regulations (Engesaeter, 1993; Wage, 2001).

Another example is provided by the 1989 Agreement between Denmark, Iceland and Norway concerning the capelin stocks in the waters between Greenland, Iceland and Jan Mayen. Under this agreement, yearly consultations and negotiations are held to decide on unilateral/bilateral quota arrangements, licensing arrangements and other management measures.

Yet another example arises in the Treaty between Australia and Papua New Guinea on Sovereignty and Maritime Boundaries, ratified by the two countries in 1984. Under the Treaty, the parties adopt management measures for the fisheries of the Protected Zone in the Torres Strait, including the setting of TACs allocated between the Parties in fixed percentages (depending on the area concerned) (Staples, 2003)

Category B: the first example is taken from the case of the Barents Sea fishery resource, shared by Norway and Russia, which we have already discussed at some length. Cooperative management of the resources commenced, it will be recalled, in the mid-1970s. Within the framework of the Norway-Soviet Union Fisheries Agreements of 1975 and 1976, yearly quota consultations are undertaken by the Joint Norwegian Russian Fisheries Commission, established by the Agreement of 1975. The Commission consultations are scientifically based upon recommendations from ICES. The primary task of the Commission is to agree on the TACs for the shared stocks, covering the whole migration area of the stocks. Unlike the consultations between Norway and the EU, the Joint Norwegian Russian Fisheries Commission consults, not only on the quota allocation between the parties, but also on quota allocations to third States. Rules on how fish caught by licensed third States vessels are to be deducted from the parties' allocations are laid down in the arrangement.

The cooperation between the two countries has resulted in two major achievements: the establishment of a so-called Surveillance Program in the Barents Sea and the implementation of measures to improve the selectivity of fishing gear. The Program, introduced in the late 1980s, allows for fishing grounds to be continuously surveyed with a view to closing areas, where fish below a prescribed minimum size are abundant. The Program is viewed as an arrangement for closing and opening of fishing grounds on a real time basis. For the purposes of improving the selectivity of fishing gear, the parties have centered on the development of grid sorting systems in the trawl fishery.

The creation in 1993 of the Permanent Committee on Management and Control of the Fisheries Sector has provided a basis for cooperation in the field of Monitoring, Control and Surveillance (MCS). Control both at sea and on land has been improved, procedures have been put in place between the Parties' Coast Guard and Control Authorities, including the exchange of information on catch and landing data, exchange of inspectors/observers on board of Coast Guard vessels and in ports have occurred. A satellite based VMS in Parties' economic zones has also been established. In the year 2000, the basis for the cooperation on MCS was further formalized between the Parties, when an Arrangement on MCS was entered into. On the Norwegian side, the Directorate of Fisheries and the Coast Guard have signed the Arrangement (Stokke, 2003; Wage, 2001).

The International Pacific Halibut Commission, set up by the 1953 Convention on the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea, as amended by a Protocol of 1979, is another representative example of this group. The Convention applies to the waters under the "exclusive fisheries jurisdiction" of each party, collectively known as "Convention waters." The Commission deals with commercial and sport fisheries for Pacific halibut. Interestingly, it has the power to hold annual meetings with representatives of the halibut fishery industry. It generally alternates its regular annual meeting, and its mid-year meeting, between Canada and the United States, and may hold other meetings, if the need arises. The Commission may also hold public hearings, if it so desires. It establishes allocation percentages for halibut stocks shared by Canada and the USA in the North Pacific and Bering Sea.

Other management measures adopted include closed seasons, minimum fish size and gear regulations. The Commissioners consider reports from three groups in total (i.e. the Board, the Processor Advisory Group and the Commission staff) when making final decisions. Article III(1) of the Convention states that "all decisions of the Commission shall be made by a concurring vote of at least two of the Commissioners of each Party" (Convention, 1953). They are advisory in nature and conservation and management measures decided by the Commission require the approval of the parties (Art III(3)). The trigger for decision of measures is that "investigation has indicated such action to be necessary." The measures may be decided with respect to (a) national and fishing vessels of the parties and (b) fishing vessels licensed by the parties.

A third example is provided by another case, which we have discussed at some length, namely Pacific salmon, shared by Canada and the United States. The 1985 Treaty, referred to previously, established the Pacific Salmon Commission, having equal representation from the two countries.

The Commission has as its objective and role the conservation of the relevant salmon stocks, and the allocations of harvests of these stocks. The Commission is assisted in its work by three panels, namely a Southern Panel, a Northern Panel and a Fraser River Panel. Like the Commission, each panel has equal representation from the two Parties.

The Treaty, when signed in 1985, had a set of short term management plans for six specific sets of fisheries, in the form of an annex. Originally, the primary function of the Commission involved negotiation of new management plans, as old ones expired. Following the Agreement of 1999, which called for long-term management regimes, the Commission's focus shifted, away from short term management regimes, to the implementation of the called for long-term regimes (Miller, 2003).

Category C: regional fisheries management organizations, normally associated with straddling and highly migratory stocks, have also been established for transboundary stocks. This is exemplified by yet another case, which we have already discussed, namely the International Baltic Sea Fisheries Commission, established by the 1973 Convention on Fishing and Conservation of the Living Resources of the Baltic Sea and Belts. Contracting parties to the Convention as amended by Protocol are: Estonia, European

Community, Latvia, Lithuania, Poland, and Russia (having succeeded the USSR as a party). The Convention applies to “all fish species and other living marine resources in the Convention Area.” The Convention Area includes all waters of the Baltic Sea and the Belts, excluding internal waters. The Commission, based in Warsaw, under Article IX(1), is to: (a) coordinate resource management “by collecting, aggregating, analysing and disseminating statistical data;” (b) promote coordination, “as appropriate,” of scientific research; (c) prepare and submit recommendations “concerning measures referred to in Article X” (see the Commission website, <http://www.ibsfc.org>) for consideration by the parties; and (d) to examine certain information submitted by the parties (Convention, 1973).

Except where the Commission decides otherwise, its sessions are to be held every two years. In practice, the Commission meets annually (Rules of Procedure for the Commission, rule 6.1). To perform its functions the Commission may set up working groups or other subsidiary bodies and determine their composition and terms of reference. Examples of bodies established include the following: Standing Working Group on Regulatory Measures; Standing Working Group on Finance and Administration; Working Group on Control and Enforcement; IBSFC Salmon Action Plan Surveillance Group; Working Group on Long-Term Management Objectives and Strategies for Herring and Sprat; Working Group on Fishery Rules. Each Party is to have one vote. Decisions and recommendations of the Commission are to be adopted by a two-thirds majority of votes of the Contracting States, present and voting at the meeting. However, any recommendation relating to a Party’s waters shall only enter into force for that party, if that Party votes for it (Art VIII(3)). The Convention, under Article XI, establishes an objection procedure. Thus, though recommendations are binding on the Parties, a recommendation will not become binding on a Party that had objected to it. A Party may at any point withdraw its objection. There is also under Article XI a termination procedure. Following the date of entry into force of a recommendation, a Party may notify its termination of acceptance, whereupon the recommendation will cease to be binding on that party one year later.

In practice, the Commission has established a consolidated set of Fishery Rules. This is updated after each Commission meeting. They include rules on *inter alia*: inter-annual TAC flexibility; quota exchange (e.g. herring against cod) and quota transfers (e.g. cod); catch reporting; refusal of landings; log books; prohibitions on certain types of fishery (end use of fish; method; species); prohibitions on certain species or sizes of fish on board; gear stowage; permissible bycatch; discarding; gear characteristics; marking of fishing gear; and closed areas and seasons. The TACs themselves are listed separately from the Fishery Rules. The TACs are established each year at the Commission meeting for the following year, for the main four commercially exploited species, i.e. cod, herring, salmon, and sprat. The Commission website reports that “TACs have been the main tool or basic tool of the management procedure and they have been introduced first in 1977 for cod, sprat and herring, and in 1988 for salmon” (<http://www.ibsfc.org>).

Long-term management schemes have been adopted. The Commission website states that these include: (a) the 1997 Salmon Action Plan; (b) the 1999 Long Term Management Strategy for Cod Stocks in the Baltic Sea; and (c) the 2000 Long Term Management Strategy for the Sprat Stock; a Long Term Strategy for the Herring Stock was further discussed in 2001 (<http://www.ibsfc.org>).

Finally, illegal fishing and underreporting have, over the past few years, become important issues. This has caused the Commission to adopt control measures such as port/landing controls, a yearly established record of licensed fishing vessels in the Baltic Sea on country basis and more recently a Joint Inspection/Observers Scheme.

Category D: this final category concerns a set of agreements under which parties undertake, in a general way, to cooperate in the management of transboundary

fish stocks on an ad hoc basis. A typical example is the Convention on Fisheries Cooperation Among the States Bordering the Atlantic Ocean adopted in 1991. There are ten contracting parties in the Convention. The objectives of the Convention include, *inter alia*, the promotion of regional cooperation on fisheries management, and the enhancement, coordination and harmonization of the parties' efforts and capabilities for the purpose of conserving and exploiting fishery resources, considering in particular fish stocks occurring within the waters of more than one party. The geographical area covered is assumed to be waters under the sovereignty and jurisdiction of the contracting parties. Parties are to adopt protocols addressing measures, procedures and standards aimed at implementing the provisions of the Convention.

Another example of this group is the Nauru Agreement Concerning Co-operation in the Management of Fisheries of Common Interest of 1982. The scope of the agreement is to coordinate and harmonize, and to cooperate on, monitoring, control and surveillance of fisheries (notably those carried out by foreign fishing vessels) for common stocks in waters under the fisheries jurisdiction of the Parties. An annual meeting of the parties is to be convened preceding or following the regular session of the South Pacific Forum Fisheries Committee in order to promote the implementation of this Agreement.

The Parties are to seek the assistance of the South Pacific Forum Fisheries Agency (FFA) in providing secretariat services for implementing and coordinating the provisions of the Agreement, for instance in establishing procedures and administrative arrangements for the exchange and analysis of *inter alia* catch and effort statistics regarding vessels fishing in the Parties' waters for common stocks; for the exchange and analysis of *inter alia* information on vessel specifications and fleet composition. The Parties are to seek to standardize their respective licensing procedures and in particular: (a) to seek to establish and adopt uniform measures, terms and conditions, and procedures relating to the licensing of foreign fishing vessels, including application formats, licensing formats and other relevant documents; and (b) to explore the possibility of establishing a centralized licensing system for foreign fishing vessels.

Throughout much of the discussion, up to this point, considerable emphasis has been given to the difficulties to be encountered in establishing effective cooperative management regimes for transboundary stocks. Emphasis must also be given, however, to the fact that there are, and have been, cases of successful cooperative management of transboundary stocks, which can serve as examples to others about to engage in cooperative resource management endeavours. Among the case studies presented at the Norway-FAO Expert Consultation, perhaps the most striking example of successful cooperative management of transboundary stocks is to be found in that on the tuna resources shared by the Pacific Island States of the Western and Central Pacific – the South Pacific (Aqorau, 2003). Let us examine this case, to which we have already referred in passing, in more detail.

The South Pacific

Within the Pacific Islands Region of the South Pacific are to be found the most important tropical tuna resources in the world (Aqorau, 2003; Gillett *et al.* 2001). In 2001, the latest year for which complete statistics are available at the time of writing, the reported harvests in the region of the four main tuna species (South Pacific albacore, skipjack, yellowfin and bigeye) was just under 2 million tonnes, with a landed value of roughly US\$2 billion (Aqorau, *ibid.*; Gillett *et al.*, *ibid.*). The resources are, at one and the same time, transboundary and highly migratory in nature. In this section, we will consider the resources in terms of their transboundary aspects alone. A later section will examine some of the highly migratory aspects of the resources.

In any event, the tuna resources were, and are, of fundamental economic importance to the Pacific Island States. Consequently, it could be maintained that the Pacific Island States were, collectively, one of the big “winners” from the advent of Extended Fisheries Jurisdiction (EFJ), in 1982. Having said this, however, it was not at all clear at the time that the economic benefits, which these countries would enjoy from EFJ, would be other than ephemeral.

The Pacific Island States are small, and are spread over an immense ocean space of 35 million square kilometres. The landmass of the Island States is but two percent of the total area of the region (Aqorau, *ibid*; Gillette *et al.*, *ibid.*). Most of the Pacific Islands States intra-EEZ harvests of the resources – 80 to 90 percent – were, and are, taken by DWFSs. Finally, at the advent of Extended Fisheries Jurisdiction, the Pacific Island States were generally at low levels of development. Hence, these countries faced what appeared to be insurmountable monitoring and surveillance problems.

These difficulties were compounded by the following. First, the Pacific Island States effectively were faced with but one DWFS, Japan. As a provider of harvesting services, this economically powerful nation was in the position of a monopolist within the Pacific Islands Region. Secondly, the right of coastal States to assert management jurisdiction over tuna resources, within their EEZs, was bitterly contested at the close of the UN Third Conference on the Law of the Sea.

The Pacific Island States had an incentive to cooperate. Without cooperation, Japan, the one single DWFS, would have had the opportunity to play one Island country off against the other, and if so, was likely to do so successfully (Aqorau, *ibid.*; Munro, 1991). Achieving effective cooperation was, however, very difficult.

The Pacific Island States attempted to cooperate in 1979 through the establishment of the South Pacific Forum Fisheries Agency (FFA), to which we have already made reference. The FFA was to report to the Pacific Islands Forum Leaders.

There were, at the inception of the FFA, fourteen States involved, varying greatly in size, and spread over vast distances. The commonplace observation about the difficulty of attempting to achieve a stable “solution” to a cooperative game increasing exponentially as the number of players increases will be recalled. Outside observers, in the late 1970s, and early 1980s, were generally pessimistic about the future viability of the FFA (Munro, 1982).

The tuna resources in the South Pacific are, however, not evenly spread, tending to concentrate around the Equator. The consequence is that there are, in relative terms, “haves” and “have nots,” among the Pacific Island Nations. Seven of the fourteen could be regarded as “haves.” Concerned about the lack of progress in the FFA, the seven met on the island of Nauru (one of the seven) and signed a formal agreement, the Nauru Agreement, which we discussed under the heading of institutional structures. The seven became known as the Nauru Group thereafter. The Nauru Group made it known that, while the Group had no wish to see the FFA disintegrate, the Group would go it alone unless the others engaged in serious cooperation. The others decided that serious cooperation was indeed in their best interest.

In the discussion of cooperative games with many players, it was pointed out that, in such games, the formation of sub-coalitions is a common occurrence. In the case of the FFA countries, two sub-coalitions were thus formed, the Nauru Group (“haves”), and the “have nots.” It helped that there are two major Pacific Island States, Papua New Guinea (PNG) and Fiji, which were in different sub-coalitions. PNG was in the “haves” sub-coalition, and became its leader, while Fiji became the leader of the “have nots” sub-coalition. An intractable fourteen player game had evolved into what amounted to a two player game (Munro, 1991).

Predictably, the management goals of the two sub-coalitions were not the same. The Nauru Group was much more concerned about the long term stability of the resources, than the less well off sub-coalition. Clearly, the Nauru Group placed the higher value on the resource. The theory tells us that the optimal outcome would be for the management preferences of the sub-coalition placing the higher value on the resource to be made dominant, and for that sub-coalition to compensate its fellow sub-coalition, the *Compensation Principle* once again.

The predictive power of the theory in this instance proved to be strong. The Nauru Group became the cutting edge in terms of formulating management policy. Various forms of side payments emerged, through which the “have not” sub-coalition was compensated (Aikman, 1987; Munro, 1991). These compensations continue up to the present day. Moreover, the “have nots” sub-coalition has played an increasingly important role in the cooperative management of the resource (David Doulman, personal communication), which attests to the growing strength of the cooperative resource management arrangement.

The Pacific Island States (South Pacific countries), through the vehicle of the FFA, have achieved effective cooperation in such matters as fisheries management, the establishment of minimum terms and conditions of access for DWFSs – so that DWFSs cannot play one State off against another – and in monitoring, control and surveillance. While there have undoubtedly been incidents of poaching – “free riding” by non-participants – these have never been great enough to threaten the stability of the cooperative arrangement.

The success of the Pacific Islands Region cooperative transboundary resource management can be attributed to the following factors:

- the South Pacific countries all share a common interest and objective for the conservation and management of shared fish stocks;
- the objectives of the South Pacific countries are explicit;
- the object and purpose of establishing an organization was to assist South Pacific countries deal with their lack of resources in dealing with DWFSs;
- the strong links between the FFA and the South Pacific Islands Forum ensured fisheries problems received the highest political consideration;
- member countries had a clear role in providing policy and administrative guidance in the work programme of the FFA;
- the flexible role and functions of the FFA enabled it to respond to different management challenges in a timely and effective manner; and
- the clear delineation between the functions of the technical Secretariat, headquartered in Honiara, Solomon Islands, and the governing council of the FFA enabled it to operate effectively as an organization.

(Aqorau, 2003, pp. 65-66).

With the review of the issue of the conservation and management of transboundary fish stocks now complete, we turn next to the question of the conservation and management of Categories (b) and (c) (highly migratory, and straddling) stocks.

4. The conservation and management of highly migratory and straddling fish stocks

In the discussion to follow, we shall explore the extent to which the management of highly migratory stocks, and that of straddling fish stocks, do, and do not, differ from the management of transboundary stocks. There is one difference, which we wish to emphasize at the outset. While it is a difference of degree, the difference is so great as to constitute a difference in kind. With respect to the cooperative management of transboundary stocks, we stated the cooperative resource arrangement could be undermined by “free riding” non-participants. We gave only limited emphasis to the problem, because there is little evidence of such “free riding” arising from non-participating coastal States, and because vessels of DWFSs, undertaking authorized exploitation of the transboundary stocks in the coastal State EEZs are deemed to be engaging in illegal fishing. The coastal States can, under international law, undertake vigorous measures to repel the intruders.

Highly migratory/straddling stocks are, by definition, to be found in the high seas adjacent to the EEZ, as well within the EEZ. Consider a highly migratory or straddling stock subject to cooperative management. Vessels of a State, which is not party to the cooperative resource management arrangement, engaged in exploiting the high seas portion of the stock in a manner contrary to the provisions of the cooperative management arrangement, are deemed to be engaged in *unregulated*, not illegal, fishing (FAO, IPOA-IUU, 2001, para 3.3.1). In the past, it was very unclear what measures could be taken, under international law, to control unregulated fishing. We shall discuss how the UN Fish Stocks Agreement, plus the FAO IPOA-IUU are attempting to address the problem.

In any event, the fact that, in the pre-UNFSA era, unregulated fishing was not effectively controlled, meant that pre-UNFSA attempts to manage highly migratory/straddling stocks were plagued by non-participant “free riding.” The consequences of “free riding,” in terms of the economics of the management of any category of shared fish stocks, is straightforward, and is similar to the consequences of non-compliance. If prospective members of a cooperative fisheries management arrangement anticipate that their cooperative management efforts attract “free riding” non-participants, the prospective members could well calculate that their expected payoffs from cooperation would fall below their respective Threat Point payoffs. Should this be the case, the individual rationality condition for cooperation would not be met, and the cooperative arrangement would be still-born (see: Kaitala and Munro, 1997).

It may be, of course, that those establishing the cooperative resource management arrangement do not anticipate the “free riding,” but are subsequently unpleasantly surprised. In this instance, the cooperative arrangement could well be established, and might well appear initially to be successful. When the members of the cooperative arrangement are unpleasantly surprised by “free riders,” the members of the cooperative management arrangement could then be expected to re-assess their expected payoffs from cooperation, leading to the distinct possibility that the cooperative arrangement would unravel.

The baleful impact of “free riding,” in the pre-UNFSA era, is illustrated by the cases of the Northwest Atlantic Fisheries Organization (NAFO) and the Southern Bluefin Tuna Commission. By 1995, NAFO was beset by many difficulties and was found to be in a state of near paralysis (Bjorndal and Munro, 2003). An important contributing factor to NAFO’s near paralysis was uncontrollable harvesting of the high seas groundfish resources, subject to NAFO management, by vessels flying the flags of non-NAFO participants, i.e. “free riders” (Bjorndal and Munro, *ibid.*).

In 1994, two coastal States, Australia and New Zealand, and one DWFS, Japan, established the Commission for the Conservation of Southern Bluefin. The three states had become deeply concerned about the overexploitation of the resource.

The cooperative resource management endeavour initially met with success. The success was short lived, however, as the Commission became threatened by breakdown. Two studies on the history of the Commission appeared at the end of the 1990s. While citing many factors, which led to the breakdown, the studies gave particular emphasis to the fact that the three members of the Commission were unpleasantly surprised by extensive “free riding” by numerous non-participating Pacific DWFSs (Cox, Stubbs and Davies, 1999; Kennedy, 1999).

With these preliminary comments and observations in hand, we shall proceed as we did in our review of the management of transboundary fish stocks. We commence with an examination of the underlying legal regime, and then go on to discuss the basic economics of the management of these resources.

4.1 THE LEGAL REGIME

In examining the legal regime for highly migratory and straddling stocks, we note that there are two international instruments, which are of prime relevance. They are: the 1982 UN Convention, and the 1995 UN Fish Stocks Agreement¹⁸.

4.1.1 The 1982 UN Convention

The relevant provisions of the 1982 UN Convention, for the two categories of stocks under discussion, are to be found in Part V, the Exclusive Economic Zone, and Part VII, the High Seas. The drafters of the Convention, in confronting the issue of highly migratory and straddling stocks, were faced with a particularly difficult problem, namely that of reconciling the rights of nations to fish on the high seas, with the rights of coastal States, granted under Article 56 of the Convention, to manage fishery resources within their EEZs. The problem emerged with particular clarity in the case of straddling stocks.

The UN Office of Legal Affairs prepared a document, in anticipation of the UN Fish Stocks Conference, entitled: *The Law of the Sea, The Regime for High-Seas Fisheries: Stocks and Prospects* (UN, 1992a). The document sets forth the problem succinctly. A coastal State, with a straddling stock, could see its intra-EEZ management measures for the resource rendered useless by unrestrained harvesting of the high seas portion of the resource. With respect to DWFSs, on the other hand, “...having seen coastal States gain control over the resources within 200 miles of the coast, they see these coastal States wishing to extend their jurisdiction beyond 200 miles to the resources that are harvested on the high seas”¹⁹ (UN, 1992a, para. 52).

It should be noted in passing that, at the UN Third Conference on the Law of the Sea in 1982, the management of fisheries on the high seas, and thus the aforementioned reconciliation problem, were not seen as major issues. At the time, it was believed that only 10 percent of the world’s fishable capture fishery resources were to be

¹⁸ For the full title of the Agreement, see footnote 4.

¹⁹ A popular expression among DWFSs, at the time, was that of coastal State “creeping jurisdiction” (Munro, 2000).

found on the high seas. Thus, high seas fishery resources were of minor importance, or so it seemed. The ensuing decade was to demonstrate that this lack of concern was misplaced. Straddling and highly migratory stocks did in fact, become the source of serious resource management problems (Bjørndal and Munro, 2003).

In any event, let us first consider straddling stocks. The relevant article in Part V of the Convention, the Exclusive Economic Zone, is Article 63(2), which reads as follows (UN, 1982):

Where the same stock or stocks of associated species occur both within the exclusive economic zone and in an area beyond and adjacent to the zone, the coastal State and the States fishing for such stocks in the adjacent area shall seek, either directly or through appropriate subregional or regional organizations, to agree upon the measures necessary for the conservation of these stocks in the adjacent area.

The obligation on States exploiting such stocks in the high seas adjacent to the EEZ, DWFSs in particular, is set forth in Part VII, the High Seas. Article 87, the Freedom of the Seas article, states that all States have the freedom to fish in the high Seas "...subject to the conditions laid down in section 2 [of Part VII] " (UN, 1982, Article 87(1)(e)). Within section 2 of Part VII of the Convention lies the key article, Article 116, Right to Fish on the High Seas, which reads as follows (UN, 1982):

All States have the right for their nationals to engage in fishing on the high seas subject to:

- (a) their treaty obligations;
- (b) the rights and duties as well as the interests of coastal States provided for, *inter alia*, in Article 63, paragraph 2, and Articles 64 to 67; and
- (c) the provisions of this section.

Thus, DWFSs exploiting the high seas segments of straddling stocks are required by the Convention to recognize the rights, duties and interests of the relevant coastal States, with explicit reference being given to Article 63(2). Hence, the "reconciliation" is such that, while DWFSs continue to have the right to fish on the high seas, this right is circumscribed to no small degree.

Next let us note the following with regards to Article 63(2). First, cooperation is called for, with respect to conservation of the resources, in the adjacent high seas *alone*. No reference is made regarding cooperation for conservation purposes within the EEZ. Secondly, Article 63(2), in terms of generality, bears a similarity to Article 63(1), in that the article offers little, or no, guidance on how the problems involved in regulating straddling stocks are to be addressed.

Finally, as to the duty of coastal States and DWFSs to cooperate, it can be observed that the duty to cooperate under international law has a substantive content, which may be expressed in terms of a general obligation to cooperate, i.e. duties to notify, to consult and to negotiate²⁰. It is also generally accepted under international law that the duty to cooperate does not involve the duty to reach an agreement, provided that the cooperation has been undertaken in good faith.

Highly migratory species (stocks) in Part V of the 1982 UN Convention are covered by Article 64, which reads as follows (UN, 1982):

1. The coastal State and other States whose nationals fish in the region for the highly migratory species listed in Annex 1 shall cooperate directly or through appropriate international organizations with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region, both within and beyond the exclusive economic zone. In regions for which no appropriate international organization exists, the coastal State and other States whose nationals harvest these species in the region shall cooperate to establish such an organization and participate in its work.

²⁰ P. Reuter, 1975, pp. 711-733.

2 The provisions of paragraph 1 apply in addition to the other provisions of this Part [V].

Article 116, of Part VII, requires that States harvesting highly migratory stocks on the high seas adjacent to the EEZ take into account the rights, duties and interests of relevant coastal States, as in the case of straddling stocks. In so doing, the Article makes specific reference to Article 64 (UN, 1982 Article 116(b); UN, 1992a, para. 70).

Having said all of this, the most striking aspect of Article 64 is that paragraph 1 of the article is much stronger than is Article 63(2). Article 64(1) calls upon coastal States and DWFSs to cooperate for the purpose of ensuring the conservation and optimal utilization of the resource *within, as well as without*, the EEZ.

William Burke (1994) argues that Article 64(1) imposes a constraint upon the coastal State, in its intra-EEZ management of highly migratory fish stocks, which it does not face in its intra-EEZ management of other fish stocks. While the coastal State retains the final decision making authority in exercising its sovereign rights over highly migratory fish stocks within its zone, “it cannot lawfully exercise that authority ... until it has discharged its duty to cooperate with other coastal States and *with distant water fishing nations* to ‘ensure conservation and promote optimum utilization’ ” (Burke, *ibid.*, p. 218).

The development of a cooperative resource management regime is necessarily a process of negotiation and bargaining. The clear implication of Article 64(1) (given that Burke’s interpretation is valid) is that DWFSs may (although not necessarily will) have an influence upon the intra-EEZ management regime for highly migratory stocks.

The language of Article 64(1), and the constraint imposed upon coastal States, reflected the insistence of some States that the coastal States did not have the right to claim jurisdiction over highly migratory stocks within the EEZ (UN, 1992a, para 53). Burke maintains that highly migratory stocks should be seen as a sub-set of straddling stocks, which were placed in a separate category in the Convention, for political, rather than for biological, reasons (Burke, *ibid.*)²¹.

The leading exponent of the view that coastal States have no jurisdictional claim over highly migratory species within the EEZ was the United States. The position of the United States changed, however, after the close of the UN Third Conference on the Law of the Sea. In the early 1990s, the United States revised its Magnuson Fishery Conservation and Management Act, with one of the revisions concerning highly migratory stocks. The nature and substance of the revision was that the United States claimed jurisdiction over highly migratory stocks within its 200 mile zones, effective January 1, 1992 (Burke, *ibid.*; UN, 1992a). With this revision of the Magnuson Act, the rationale, for placing highly migratory stocks into a special category, on political grounds, would seem to have been undermined.

Hence, it is not at all obvious that, following this revision of the Magnuson Act, highly migratory stocks should have been regarded as other than straddling stocks, like other straddling stocks, or that the Article 64(1) constraint on coastal States should have continued to be taken seriously. Be that as it may, the language of Article 64(1) was to carry over to the UN Fish Stocks Agreement.

The 1982 UN Convention, as we have seen, admonishes coastal States and DWFSs to cooperate in the conservation and management of straddling/highly migratory stocks. Moreover, DWFSs are called upon to respect the rights, duties and interests

²¹ Two biologists, with a history of research in tropical tuna, R. Hilborn, and J. Sibert, argued in an article in the late 1980s that major tropical tuna species, e.g. skipjack and yellowfin, are, in fact, less migratory than are many species not to be found in Annex 1 of the 1982 UN Convention. One example, of such a highly migratory non-Annex 1 resource, is herring in the Northeast Atlantic. The authors maintain that “... there appears to be little biological justification for inclusion or rejection of highly migratory species in the current Law of the Sea” (Hilborn and Sibert, 1988, p. 36). See, as well, FAO, 1994.

of coastal States with respect to these resources. The relevant articles – Articles 63(2), 64, 87, 116-120 – were, in addition, buttressed by the dispute settlement mechanisms provided by the Convention. Nonetheless, the 1982 UN Convention contained within it a serious weakness, as it pertained to the effective cooperative management of these two categories of shared fish stocks.

Under the aforementioned set of articles, the rights, duties and obligations of coastal States to the high seas portions of straddling/highly migratory stocks, as opposed to those of DWFs, were opaque (Bjørndal and Munro, 2003). The 1992a UN document, *The Law of the Sea, The Regime High-Seas Fisheries: Status and Prospects*, stresses the fact that problems of management of the two categories of fish stocks requires “an enhanced understanding of the nature of the ‘right’ that States have for their nationals to fish on the high seas, and the relationship of this right to the rights, duties and interests of the coastal State referred to in Article 116” (UN, 1992a, para. 70). This lack of clarity did, in turn, make it very difficult to establish effective cooperative regimes for these resources, with one reason being the near inability of cooperating States to restrain “free riding” by other States. The consequences of non-cooperative management have proven to be no less damaging for straddling/highly migratory fish stocks, than they have for transboundary fish stocks.

The 1992a UN document provides a long list of straddling stock type of fishery resources, in which effective cooperative management was, at the time, obviously lacking. Included in the list are the groundfish resources on the Grand Bank of Newfoundland, subject to Northwest Atlantic Fisheries Organization (NAFO), the pollock resources in the Bering Sea “Doughnut Hole”, jack mackerel resources off of Chile and Peru, and orange roughy resources off the South Island of New Zealand (UN, 1992a). This list of mismanaged high seas resources is far from being exhaustive.

The UN Fish Stocks Agreement

The demonstrably inadequate nature of the management of many straddling/ highly migratory stocks, throughout the world came to the attention of 1992 UN Conference on Environment and Development. The Conference responded through its document, *Agenda 21*, which called upon the UN to mount a conference on the straddling/highly migratory stocks conservation and management issue (UN, 1992b, para. 17.49). The UN General Assembly responded, in turn, by convening the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks. The Conference held its first session in 1993, and concluded its deliberations in 1995, when it brought forth the UN Fish Stocks Agreement, which, as noted, came into force in December, 2001.

The purpose of the 1995 UN Fish Stocks Agreement is in no sense to replace any part of the 1982 UN Convention. Rather, the overarching objective is “to ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks through effective implementation of the relevant provisions of the Convention”²². One might say that the 1993 UN Fish Stocks Agreement was, and is, designed to buttress the 1982 UN Convention.

The Agreement creates a detailed framework for the management and conservation of these stocks. It also goes further and places the conservation and management within a wider context of the need to avoid adverse impacts on the marine environment, of the preservation of marine diversity, and of the integrity of the marine ecosystem²³.

The Agreement applies to the conservation and management of straddling and highly migratory fish stocks beyond the areas of national jurisdiction, *unless otherwise provided*²⁴. This qualification is, in fact, of considerable importance and consequence.

²² UN, 1995, Article 2.

²³ Edeson, 2001.

²⁴ UN, 1995, Article 3.

The main elements of the 1995 UN Fish Stocks Agreement are:

1. The Agreement requires coastal States and DWFs to ensure that the conservation and management measures, which are created within the EEZ, and on the high seas, are compatible.
2. It sets out general principles for the conservation and management of straddling fish stocks and highly migratory fish stocks, including the precautionary approach, which Parties to the Agreement are to apply on the high seas as well as within the EEZ.
3. The Agreement includes detailed rules on the establishment and operation of sub-regional or regional fisheries management organizations or arrangements (RFOs, hereafter)²⁵, which are to establish conservation and management measures on the high seas. Parties to the Agreement are obliged to join RFOs, or agree to comply with the measures they create. If they do not do so, they will not be allowed to fish in the areas where these management measures apply. It can be argued that the RFO regime constitutes the heart of the Agreement²⁶.
4. The Agreement specifies the duties of the flag States with respect to their vessels fishing on the high seas.
5. The Agreement introduces innovative provisions on enforcement for non-flag states, as well as providing for port-state jurisdiction in respect of fishing vessels.
6. The Agreement contains detailed provisions on peaceful dispute settlement.

There are several aspects of the 1995 UN Fish Stocks Agreement that are of particular interest, which we wish to highlight. They are:

I. The duty to cooperate

The duty to cooperate is an essential ingredient of the 1995 UN Agreement. A range of obligations to cooperate apply to straddling fish stocks and highly migratory fish stocks. Cooperation in an initial phase is likely to start with a series of negotiations. Thus, the considerations referred to in the context of transboundary fish stocks are also relevant in the present context²⁷. The 1995 UN Agreement offers elements for specifying the duty to cooperate in Article 7(3), where it provides that: “*In giving effect to their duty to cooperate, States shall make every effort to agree on compatible conservation and management measures within a reasonable period of time*” (UN, 1995, Article 7(3)). Furthermore Article 8(2) focuses on the need for States to engage in consultations “*in good faith and without delay,*” where a threat of over-exploitation exists or where a new fishery is being developed. While the 1995 UN Agreement allows for cooperation to take place directly (Article 8(1)), it is clear that the Agreement displays a strong preference, as Part III of the Agreement makes evident, for cooperation being effected through RFOs (UN, 1995). Indeed, the Agreement could be seen as a set of globally agreed upon principles, under which RFOs should be established and operate (Orrego Vicuña, 1999)²⁸.

II. The issue of compatibility of conservation and management measures

Article 7 attempts to provide a balance between the interests of coastal States and

²⁵ The 1995 UN Fish Stocks Agreement defines an arrangement as “a cooperative mechanism established in accordance with the Convention and this Agreement by two or more states for the purpose, *inter alia*, of establishing conservation and management measures in a subregion for one or more straddling fish stocks or highly migratory fish stocks” (UN, 1995, Article 1(1)(d)).

²⁶ Örebech, Sigurjonsson and McDorman (1998) maintain that “... critical to the success of the 1995 Agreement are ... RFOs which will have a central role in implementing the principles of the 1995 Agreement” (Örebech, et al., 1998, p. 120).

²⁷ See the *North Sea Continental Shelf cases in the context of maritime delimitation* – n. 7 and n. 8.

²⁸ See n. 26.

DWFSs, and to reduce or eliminate conflicts, which may arise between measures taken within an EEZ, and those which apply in the adjacent high seas area, through a strategy based on cooperation. Article 7(1) targets straddling fish stocks, in particular, and calls on relevant coastal States and states whose nationals fish for such stocks in the adjacent high seas, to seek, “*either directly or through the appropriate mechanisms for cooperation provided for in Part III, to agree upon the measures necessary for the conservation of these stocks in the adjacent high seas area.*” (UN, 1995, Article 7(1)(a)). While targeting straddling stocks in particular, Article 7(1) does reflect the language of Articles 63(2) and (64) of the 1982 UN Convention, and restates the distinction between straddling and highly migratory stocks, to be found in the Convention (see: UN, 1995, Articles 7(1)(a) and 7(1)(b)).

Article 7(2) puts forward the basic obligation to achieve compatibility between the conservation and management measures established for the high seas and those adopted for areas under national jurisdiction “*in order to ensure conservation and management of the straddling fish stocks and highly migratory fish stocks in their entirety.*” (UN, 1995, Article 2). To this end, coastal States and States fishing on the high seas have a duty to cooperate for the purpose of achieving compatible measures in respect of such stocks, and to take into account a variety of factors detailed in Articles 7(2)(a)-(e) and ensure that such measures do not result in any *harmful impact on the living marine resources as a whole* (UN, 1995, Article 7(2)(f)). The factors, which States are to take into account, include the extent to which stocks are found and fished for in areas under national jurisdiction, the biological unity and characteristics of fish stocks, and “*the respective dependence of the coastal States and the States fishing on the high seas on the stocks are concerned*” (UN, 1995, Article 7(2)(e)).

According to Article 7(3), “*States shall make every effort to agree on compatible conservation and management measures within a reasonable period of time.*” If no agreement can be reached within a reasonable period of time, Article 7(4) allows any of the States concerned to invoke the procedures for the settlement of disputes provided for in Part VIII.

Pending agreement on compatible conservation and management measures, the States concerned have the duty “*to make every effort to enter into provisional arrangements of a practical nature*” (UN, 1995 Article 7(5)). In the event that they are unable to agree on such arrangements, any of the States concerned may, for the purpose of obtaining provisional measures, invoke additional procedures for the settlement of disputes provided for in the Agreement.

III. Mechanisms for cooperation, RFOs – the issue of participation

Part III of the 1995 UN Agreement commences with the central Article 8 on *Cooperation for Conservation and Management*. As already observed, while Article 8 allows States to choose the level at which to cooperate, the Article does, nonetheless, appear to express a marked preference for RFOs. Moreover, Articles 9 through 13 are all concerned with RFOs.

Linked to the geographical scope of a RFO, is the question of participation: which States, or other actors, have rights or duties to participate in a RFO? At a first glance the type of stocks and geographical range may appear to have some bearings on these rights and duties. However, in the case of straddling stocks, because of the (qualified) freedom of fishing on the high seas, which all States are entitled to exercise, the issue becomes more complex²⁹. Furthermore, as Article 8(3) of the 1995 UN Agreement reads, the duty to cooperate does not automatically translate into a duty to participate in an already existing RFO, or to establish one (Molenaar, 2000). Rather, “*States fishing for the stocks on the high seas and relevant coastal States shall give effect to their duty to*

²⁹ Articles 87(1)(e) and 116 of the 1982 UN Convention.

cooperate by becoming members of such organization or participants in such arrangement, or by agreeing to apply the conservation and management measures established by such organization or arrangement” (UN, 1995, Article 8(3)). As an alternative to becoming member (i.e. to participate) States (coastal states and those fishing for such stocks) can also apply the RFO’s conservation and management measures.

A major critical issue concerning Article 8 is the notion of “real interest” as it is used in paragraph 3, which reads as follows:

*“States having real interest in the fisheries concerned may become members of such organization or participants in such arrangement. The terms of participation in such organization or arrangement shall not preclude such States from membership or participation, nor shall they be applied in a manner which discriminates against any State or group of States having a real interest in the fisheries concerned.” (UN, 1995, *ibid.*)*

The term is in all probability too vague to provide a ready answer to the question of which States will meet this test. In borderline situations, it can be expected to give rise to controversy, as has already happened in the course of the negotiations leading up to the Western and Central Pacific Fisheries Convention (WCPFC, 2000).

Indeed, the privileged position given to those states in Article 8, paragraph 4, namely that: “Only those States which are members of such an organization or participants in such an arrangement, or which agree to apply the conservation and management measures established by such organization or arrangement, shall have access to the fishery resources to which those measures apply” (UN, 1995, Article 8(4)), will very probably lead to arguments, based on the principle of *Pacta Tertiis*, that this provision can only apply to those States which have become Parties to the 1995 UN Agreement. It is one of the most basic rules of international law that a treaty binds only states which are party to it. The same question arises with regard to the application of Part IV on Non-members and Non-participants³⁰. For States arguing that the 1995 UN Agreement does bind non-parties, it will be necessary that these provisions have achieved such widespread acceptance so as to have become part of international customary law³¹.

A closely related issue is that of New Members or Participants, that is to say States, which did not participate in the establishment of the RFO, but which are seen to meet the test of ‘real interest’, and which now wish to participate in the RFO. Articles 8, 10 and 11 make it very clear that members/participants of an existing RFO must be prepared to accommodate new entrants (Örbech, Sigurjonsson, and McDorman, 1998). The question then becomes the conditions under which New Members/Participants are to be brought into the RFO. Article 11 lists various considerations, which existing RFO members/participants are to take into account upon receiving applications from prospective new members/participants. These include *inter alia*:

- the status of the relevant stocks and the existing level of fishing effort in the fisheries;
- the needs of coastal fishing communities dependent mainly on fishing for the stocks, and
- the needs of coastal States whose economies are overwhelmingly dependent on the exploitation of living marine resources

(UN, 1995, Articles 11(a),(b),(c),(d),(f)).

³⁰ In particular, see also Article 17(2) which reads: “Such State (non-member and not agreeing) shall not authorize vessels flying its flag to engage in fishing operations for the straddling fish stocks or highly migratory fish stocks which are subject to the conservation and management measures established by such organization or arrangement.”

³¹ Edeson, 2001.

IV. Mechanism for cooperation, RFOs – the issue of geographic competence

Article 3 of the 1995 UN Agreement states, as we have noted, that the Agreement is to apply to the two categories of stocks beyond the areas of national jurisdiction, unless otherwise provided. Article 7(1)(b), with reference to highly migratory stocks, states clearly that cooperation is to be effected for conservation and management purposes, both within and without the areas of national jurisdiction. We are left, then, with the question of straddling stocks.

It has been seen that Article 7 calls for ensuring the compatibility of the management regimes for straddling stocks, within and without, the zone of national jurisdiction. Örbech *et al.* (1998) argue that, while there is nothing in the Agreement, which explicitly allows a RFO to encroach upon the coastal State's sovereign rights to manage a straddling stock within its EEZ, there is, at the same time, nothing in the Agreement, which prevents the geographical competency of a RFO, concerned with the management of a straddling stock, from extending to the EEZ (Örbech, *ibid.*).

Örbech *et al.* (1998) talk in terms of two approaches to achieving compatible conservation and management measures, which they refer to as *bottom up* and *top down* approaches. With a bottom up approach, the coastal State alone determines the conservation and management measures for the straddling stock within the EEZ. Since the comparable measures for the resource in the adjacent high seas must be compatible with those established within the EEZ, the implication is that the coastal State establishes the conservation and management measures for the entire resource. Under a top down approach, the RFO members as a group have the responsibility for determining the conservation and management measures for the entire resource(s) (Örbech *et al.*, *ibid.*). The implication is that DWFS members of the RFO would, or at least might, influence the intra-EEZ conservation and management regime of the resource.

Örbech *et al.* argue that Article 7(1) appears to favour the bottom up approach, while Article 7(2), on the other hand, appears to favour the top down approach. The authors conclude that the Agreement permits each individual RFO to choose a bottom up, or top down, approach, at its discretion (Örbech *et al.*, *ibid.*).

V. Duties of the flag State

Part V, starting with Article 18, lays down the duties of the flag states that are parties to the Agreement. It establishes the basic concept of flag state responsibility over vessels fishing on the high seas and outlines detailed provisions on the specific obligations to which a flag state must agree and implement before its nationals are permitted to fish on the high seas and in areas managed by RFOs. This provision is worded generally: it is not limited to straddling fish stocks or highly migratory stocks. Some argue that it reflects customary international law.

VI. Compliance and enforcement

Provisions concerning compliance and enforcement raise many “new” points. Of particular interest is Article 21 on “Sub-regional and regional cooperation in enforcement”, which applies only to the State Party. A very much debated issue relates to the boarding and inspection powers of States parties with respect to vessels flying the flags of other States parties in any high seas area covered by a sub-regional or

³² Several regional fisheries arrangements, such as the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) (1982), and the Convention on the Conservation and Management of Pollock Resources (1992) in the Central Bering Sea (1992), include a joint enforcement scheme allowing for boarding, inspection and subsequent investigation by inspectors of States other than the Flag State on the high seas. It is, however, also appropriate to note that Article 21(15) of the Agreement allows for an alternative mechanism, other than boarding and inspection. Furthermore, the legal proceedings penalty levels and prosecution are still primarily the responsibility of the Flag State.

regional fisheries management organization or arrangement. Although the concept is not new³², many DWFSs are critical of these provisions, and are critical in particular of the implementation of the enforcement procedures, spelled out in Articles 20-21, with regards to non-members of RFOs (UN, 1995, Articles 20 and 21).

4.2 Review of the basic economics of the management of straddling and highly migratory fish stocks

We commence by noting that we are blest with an important simplification. There is no meaningful distinction between the economics of the management of straddling fish stocks and that of highly migratory fish stocks. Recall Burke's (1994) argument that the distinction between the two categories to be found in the 1982 UN Convention rested upon political, not biological, considerations. In terms of the economics of resource management, it is appropriate to regard highly migratory stocks as being but a sub-set of straddling stocks.

In the introduction to the economics of the management of transboundary stocks, the point was made that the economics of transboundary stocks management, which draws heavily upon the theory of strategic behaviour, provides the foundation for the economics of straddling/highly migratory stocks management. The need to draw upon the theory of strategic behaviour (games) is now, if anything, stronger. With straddling/highly migratory stocks, one has to contend, not only with strategic interaction between and among coastal States, but also with strategic interaction between and among coastal States and DWFSs.

In analysing the economics of straddling/highly migratory stocks management, economists commence with the economics of transboundary stock management, and then ask what modifications, if any, must be made to accommodate the particular characteristics of straddling/highly migratory fish stocks. In the case of a limited number of such stocks, no modifications whatsoever are required (Bjørndal and Munro, 2003).

One part of this question can be answered quickly. The economic analysis of the non-cooperative management of straddling/highly migratory fish stocks differs not at all from the economic analysis of the non-cooperative management of transboundary fish stocks. Except in unusual circumstances, non-cooperative management of straddling/highly migratory fish stocks will lead to the resources being mismanaged from society's point of view, and will do so for exactly the same reasons that non-cooperative management leads to the mismanagement of transboundary fish stocks – the "Prisoner's Dilemma" once again.

It has been argued that the 1982 UN Convention (Part VII, Section 2 in particular) led to the result that, prior to the 1995 UN Fish Stocks Agreement, the rights, duties and obligations of coastal States to the high seas portions of straddling/highly migratory stocks, as opposed to those of DWFSs, were opaque. This opaqueness virtually ensured that the resources would be managed in a non-cooperative manner. It is not to be wondered at that the 1992 UN document, *The Law of the Sea, the Regime for High-Seas Fisheries* (UN, 1992a) did, as we have seen, list case after case of such resources, which were clearly overexploited.

One of the cases cited in the UN document illustrates our point with particular clarity. The case is that of Alaska pollock, historically the largest single species harvested in the North Pacific, large concentrations of which are to be found in the Bering Sea (FAO, 1994). In the Bering Sea, there exists a high seas enclave between the Russian and American zones, the "Doughnut Hole." The pollock resources in the Doughnut Hole are, without question, straddling stocks (FAO, *ibid.*), which were exploited by the two coastal States, and a number of DWFSs. Cooperative management of the straddling

stocks was non-existent. Non-cooperative management led to the Doughnut Hole pollock fishery becoming a “classic” open access one. The consequence was that the pollock resources therein were more than overexploited; they were plundered (Balton, 2001; FAO, *ibid.*)³³

One can, without fear of contradiction, state the following. The overexploitation of straddling/highly migratory fish stocks worldwide, which provided the rationale for the UN Fish Stocks Conference, bears powerful testimony to the predictive power of the economic analysis of the non-cooperative management of such resources (Munro, 2000).

It is in cooperative resource management that distinctions between transboundary and straddling/highly migratory fish stocks emerge. There are three features distinguishing the cooperative management of straddling/highly migratory fish stocks, from that of transboundary fish stocks, which are particularly striking. They are:

1. **Absolute number of participants:** the number of participants in the typical cooperative transboundary fishery management regimes is small. One can, in analysing the economics of the management of these resources, usually make do with two player models. In the case of straddling/highly migratory fish stocks, involving cooperation among coastal States and DWFSs, one must allow for the possibility that the typical RFO will have a substantial number of participants. Restricting the economic analysis to two player models is simply not acceptable. Having said this, however, let it be conceded that this distinguishing feature is one of degree³⁴.
2. **Exploitation of the resource(s) by States not party to the cooperative agreement:** in the introduction to this section, we emphasized the problem of “free riding” by non-participants to the cooperative arrangement, the importance of which arises from the fact that the relevant resources are to be found, in part, in the high seas. The 1995 UN Fish Stocks Agreement attempts to address this problem primarily through Article 8, which states, as we have seen, that only States which are members of a RFO, or which agree to abide by the conservation and management measures of the RFO, shall have access to the highly migratory/straddling stocks in question (see, as well, Articles 20 and 21). If all relevant States were to honour these provisions of the Agreement, the “free rider” problem would be gone. There remains, however, an important reason for concern. States, which ignore the provision of Article 8, and engage in exploiting the high seas segments of stocks under RFO management, in a manner incompatible with the RFO management regime, are, as we pointed out earlier, deemed to be engaging in *unregulated*, as opposed to *illegal*, fishing. The action, which members of the RFO could take to deal with the unregulated fishing, is less clear than the action, which they could take if confronted with illegal fishing³⁵. The IPOA-IUU attempts to address this problem. It will be

³³ In 1992, the U.S.A., Russia and four DWFSs operating in the region, established the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (see n. 30). Under the Convention, the six states imposed a “temporary” harvest moratorium on the Doughnut Hole pollock resources. The moratorium remains in force at the time of writing, over a decade later.

³⁴ There are, of course, a few cases of transboundary resource management where the number of “players” is large, e.g. the Western and Central Pacific (Aqorau, 2003). These cases are, however, the exception, not the rule. With straddling/highly migratory stocks, large numbers are the rule, not the exception.

³⁵ It is particularly unclear, if the State, whose flag the vessels engaged in unregulated fishing are flying, is not a party to the 1995 UN Fish Stocks Agreement.

argued that, how this problem comes to be addressed in the future, could have a profound impact on the sustainability of the RFO regime, through time.

3. **Nature and Number of Participants Through Time:** in a cooperative transboundary fishery management regime, the nature and number of participants can be expected to remain constant through time. We have, it is true, cited the case of the Baltic Sea, where the nature and number of participants have undergone significant change over time. The case is, however, highly exceptional. In a cooperative straddling/highly migratory fishery regime, on the other hand, some of the participants in the RFO (or equivalent thereof) will be DWFSs, the fleets of which are nothing, if not mobile. Thus, conceivably, a DWFS, originally a participant in a RFO, could withdraw. Of much greater importance, a DWFS, not a founding, or “charter,” member of the RFO, may join at a later stage. It will be recalled that, under the 1995 UN Agreement, “charter” members must be prepared to accommodate new entrants (see: UN, 1995, Articles 8,10 and 11). Moreover, the nature and number may be influenced by the interpretation of ‘real interest’, discussed in the preceding section. It is the inconstancy and uncertainty surrounding the number and nature of participants in the cooperative resource management arrangement, which probably most sharply distinguishes the cooperative management of straddling/highly migratory fish stocks from that of transboundary fish stocks (Munro, 2000).

Before dealing with these three distinguishing features, let us deal with a preliminary issue, namely what we might term the locus of resource management power within the RFO. In the previous section, under the heading of the issue of the geographical competence, we referred to the Örbech *et al.* (1998) two approaches – bottom up vs. top down – to achieving compatibility between the conservation and management regime within the EEZ, and that in the adjacent high seas. In the bottom up approach, all of the resource management powers are concentrated in the hands of the coastal State(s), while in the top down approach, the resource management powers are shared between the coastal States and the DWFSs. Figures 1 and 2 provide us with some insight into what is implied by the two approaches. It should surprise no one that it is essentially a matter of relative bargaining power.

Suppose, in order to simplify our example, that the RFO has but two members, a coastal State (Player I in Figures 1 and 2), and a DWFS (Player II). The bottom up approach is the equivalent of an outcome, in which β (the bargaining parameter) is equal to 1, i.e. the bargaining power lies exclusively with the coastal State. The top down approach is the equivalent of an outcome in which: $0 \leq \beta < 1$, i.e. some of the bargaining power rests with the DWFS.

Observe, however, that the top down approach outcome covers a very wide range. The outcome can vary from one in which the coastal State has the dominant influence over the management regime (β is only slightly less than 1), to one in which the coastal State’s sovereign rights, granted under the 1982 UN Convention Article 56, are no more than a legal fiction.

With these preliminary matters out of the way, let us turn and consider the questions of number of participants, unregulated fishing, new members and the nature of “real interest”.

Number of participants or members

Some straddling/highly migratory stock cooperative resource management arrangements can be expected to have a very large number of participants indeed. In certain cases, the extent of the migration of the resource(s) may be so great that effective management may call for cooperation, not only within RFOs, but between, or among, RFOs as

well. An example is provided by a case study, presented to the Norway-FAO Expert Consultation on a North Atlantic redfish resource. The migration of the resource is so extensive that management of the resource requires cooperation between the North-East Atlantic Fisheries Commission (NEAFC) and the Northwest Atlantic Fisheries Organization (NAFO) (Thompson, 2003).

As a general proposition, the greater the number of players the more difficult it is to achieve effective compliance. With a large number of players, it becomes easier for individual players to defect, without serious risk of detection (Hannesson, 1997; Lindroos, 2002). The obvious requirement is that the RFO be established within a legal regime that has sufficient strength, and powers of dissuasion, to deter any member tempted to defect. The theory of games demonstrates very clearly that, if a strong legal regime does not exist, if one has to rely solely upon the good will and honesty of the players, then the number of players, which a cooperative management promising stability can support, is depressingly small, in some cases no more than two (see, for example: Pintassilgo, 2003; Lindroos, 2002).

Numerous other complexities arise. As well as being concerned with the possibility of complete non-cooperation, of players competing with one another on an individual basis, one has also to be aware of the possibility of partial cooperation, of players forming sub-coalitions, and of those sub-coalitions then competing with one another. The full benefits of cooperation are, of course, achieved, when the players form a single coalition, referred to as the Grand Coalition. In order for the Grand Coalition to be stable, it is not enough that each individual player receives a payoff at least as great as it would under competition. There must, in addition, be assurance that no sub-coalition would be better off by standing on its own, and then refusing to cooperate with the rest.

Unregulated fishing and “free riding”

Uncontrolled unregulated fishing brings with it the threat of rampant, “free riding,” by non-RFO participants (or adherents). As we have noted, it is easy to demonstrate, with the aid of game theory, that “free riding” can readily undermine a RFO. It is also easy to demonstrate that, if such “free riding” can be limited only by persuading non-participants to join the RFO voluntarily, the number of players, which a Grand Coalition is likely to be able to support is decidedly modest (often no more than two). With a large number of players, “free riding” becomes too easy, and too attractive (Pintassilgo, 2003; Lindroos, 2002).

³⁶ The relevant paragraphs from the FAO IPOA-IUU (FAO, 2001) are as follows:

68. States should cooperate, including through relevant global and regional fisheries management organizations, to adopt appropriate multilaterally agreed trade-related measures, consistent with the WTO, that may be necessary to prevent, deter and eliminate IUU fishing for specific fish stocks or species. Multilateral trade-related measures envisaged in regional fisheries management organizations may be used to support cooperative efforts to ensure that trade in specific fish and fish products does not in any way encourage IUU fishing or otherwise undermine the effectiveness of conservation and management measures which are consistent with the 1982 UN Convention.

69. Trade-related measures to reduce or eliminate trade in fish and fish products derived from IUU fishing could include the adoption of multilateral catch documentation and certification requirements, as well as other appropriate multilaterally-agreed measures such as import and export controls or prohibitions. Such measures should be adopted in a fair, transparent and non-discriminatory manner. When such measures are adopted, States should support their consistent and effective implementation.

70. Stock or species-specific trade-related measures may be necessary to reduce or eliminate the economic incentive for vessels to engage in IUU fishing.

71. States should take steps to improve the transparency of their markets to allow the traceability of fish or fish products.

For a detailed discussion and analysis of the implications of product certification, see: Wessells *et al.*, 2001.

In the case of straddling/highly migratory stocks, “large numbers,” we have repeatedly emphasized, can be expected to be the rule, not the exception. The implications are obvious. If the RFO regime is to be sustainable through time, effective implementation of the FAO IPOA-IUU is not simply desirable. It is mandatory.

An example of the measures being advocated by the IPOA-IUU, which RFO members could use to curb unregulated fishing consists of product certification³⁶. Under this measure, RFO members would agree to ban imports of fish, and fish products, not certified to have been harvested by acceptable means. Fishing in an unregulated manner would be deemed to be highly unacceptable.

Japan, to take a country example, has reporting requirements (including area of capture) for all imports or transportation of tunas into Japan by boat (Wessells *et al.*, 2001). These requirements could be used to bar tuna harvested on an unregulated basis in the high seas of the Western and Central Pacific (Wessells *et al.*, 2001). Japan is a signatory to the *Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific* (WCPFC, 2000), which is providing the framework for an emerging Western and Central Pacific RFO.

The new member and ‘real Interest’ problems

Considerable time and attention was devoted to the New Member and ‘real interest’ problems, at the Norway-FAO Expert Consultation. Participants in the Consultation were in agreement that, of the issues, upon which they were called to discuss and analyse, none were more difficult than these two. (FAO, 2002a).

The 1995 UN Agreement requires that “charter” members of a RFO must be prepared to accommodate New Members/Participants, unless, of course, the prospective new entrants refuse to abide by the terms of the RFO management regime. Furthermore, according to Örebech *et al.* (1998), the New Members/Participants, “must be offered *just and reasonable* shares of the TAC available under a [RFO] management plan” (Örebech *et al.*, 1998, p. 123).

The question of the terms and conditions, under which New Members/Participants are to be admitted, including, *inter alia*, what constitutes *just and reasonable* shares of the TAC, is of direct relevance to the economics of the management of straddling/highly migratory stocks. The reason is simple. The terms and conditions can affect the stability of the cooperative management regime.

Several years ago, Kaitala and Munro (1997) demonstrated the following. If *just and reasonable* implies that New Members/Participants, upon joining a RFO, should receive, at no further cost as it were, shares of the Total Allowable Catch, or the equivalent, on a pro-rata basis, then, when planning is undertaken for the establishment of a RFO, prospective “charter” members could well calculate that their expected payoffs from cooperation would fall below their respective Threat Point payoffs. Hence the RFO would be stillborn.

The aforementioned interpretation of *just and reasonable* poses the threat described, because it may give rise to a type of “free rider” problem, different from, and more subtle than, any we have yet encountered. This new type of “free rider” problem has nothing whatsoever to do with unregulated fishing, with refusing to participate in the RFO.

The Kaitala-Munro argument can be explained in terms of the following example. Suppose that a hitherto overexploited straddling or highly migratory stock comes under the management of a RFO consisting of coastal State V, and three DWFSs, W, X and Y. The four “charter” members undertake the cost and sacrifice of rebuilding the resource over, let us say, a seven year period. In the eighth year, the four are in a position to enjoy a return on their resource investment, through harvesting. At the beginning of the eighth year, a prospective new member, DWFS Z, appears. It demands access to the RFO, agrees to abide by the resource management rules, but demands,

“free of charge,” a pro-rata share of the harvest, and by implication, a pro-rata share of the net economic returns from the fishery. If DWFS Z’s demands were acceded to, Z would effectively be a “free rider.” Having incurred none of the costs and sacrifices of investment in the resource, it will enjoy, at no cost, a pro-rata share of the return on the investment. A straightforward application of game theory demonstrates that the impact of this new form of “free riding” is no different from the impact of the “free riding” associated with unregulated fishing. Anticipation by “charter,” or prospective “charter,” members of a RFO of extensive “free riding,” of either form, could lead the “charter” members to conclude that they would be better off by refusing to cooperate (Kaitala and Munro, *ibid.*).

The Norway-FAO Expert Consultation was presented with two examples of attempts by RFO (or RFO like) bodies to address the New Member issue. The attempts are remarkably similar.

The first of these bodies is NAFO. At its 21st Annual Meeting (1999), NAFO adopted the following resolution to guide the expectation of future members regarding fishing opportunities within the NAFO regulatory area (cited in FAO, 2002a, para. 61):

1. NAFO is an open organization. Non-members may join the Organization by depositing an instrument of accession in accordance with Article XXII of the Convention. In accordance with Article IV of the Convention, all Contracting Parties are members of the General Council.
2. *Should any new member of NAFO obtain membership in the Fisheries Commission, in accordance with Article XIII (1) of the Convention, such a new member should be aware that presently, and for the foreseeable future, stocks managed by NAFO are fully allocated, and fishing opportunities for new members are likely to be limited, for instance, to new fisheries (stocks not currently allocated by TAC/quota or effort control), and the “Others” category under the NAFO Quota Allocation Table.*

The second body is NEAFC. NEAFC had prepared a discussion paper entitled, “Indications to Guide the Expectations of Interested Non-Contracting Parties of NEAFC,” which contains both a “general,” and an “individual,” policy. Included in the “general” policy is the following:

1. New members will participate, on the same basis as existing Contracting Parties (CPs), in future allocations of stocks which are unregulated at the time when the application is made (cited in FAO, 2002a, para. 62).
2. New members who were previously “Co-operating NCPs” will “carry with them” part of the relevant Co-operative quota.
3. New members will be able to fish stocks, which are regulated when the application is made. However, such fishery can only be conducted on Others-quotas established for this purpose.

A prospective new member can request to be treated as a special case, i.e. on an “individual” basis. If the “CPs” are agreeable to such special consideration, negotiations would then commence (FAO, 2002a).

In any event, it is quite evident that NAFO and NEAFC are both taking, with great seriousness, Article 11(a) of the 1995 UN Agreement, which admonishes existing members of a RFO, when preparing to accommodate new entrants, to take into account the status of the relevant stocks and existing fishing effort. To be blunt, *a just and reasonable share* of the TACs for new entrants is interpreted largely as being what is left over.

There is, of course, an alternative. The alternative is to allow prospective new entrants to buy quota from existing RFO members, in much the same way that a prospective new entrant to a domestic ITQ fishery would offer to buy quota from existing ITQ holders. The alternative was discussed at the Norway-FAO Expert Consultation. The

Report states: “If ... it were possible for prospective New Members to purchase quotas from existing members of RFMOs [RFOs], this would serve to ease the problem of quota allocation to New Members” (FAO, 2002a, para 63)³⁷.

With respect to the problem of ‘real interest’, one aspect of this problem can have implications for the stability of RFOs, similar to that of the New Member/Participant problem. The aspect relates to whether a State professing a ‘real interest’ in the fishery is to look forward to entering the RFO as a “charter member,” or at a later stage as a New Member. There are obvious advantages to being a “charter member.”

It will be recalled that Article 8(3) states that “... States having a real interest in the fisheries concerned may become members of such organizations ‘i.e. RFOs’” (UN, 1995). The Dutch legal expert, Erik Molenaar (Molenaar, 2000), argues that States/entities having a ‘real interest’ in the relevant fisheries can be taken to include the following categories:

- (i) coastal States and DWFSs currently engaged in active exploitation of the fisheries;
- (ii) DWFSs, which are not currently engaged in exploiting the fisheries, but which had done so in the past, and which would now like to re-enter the fisheries;
- (iii) DWFSs, which had never exploited the fisheries, but which would now like to do so.

Article 8(5) of the Agreement, discusses the establishment of new RFOs. The paragraph calls upon States falling within Category (i), alone, to commence the establishment. Article 9(2) states that “States cooperating in the formation of a ... regional fisheries management organization [Category (i) states] ... shall inform other States which they are aware have a real interest in the work of the proposed organization [Category (ii) and (iii) States] ... of such cooperation” (UN, 1995). Molenaar maintains that one can infer from all of this that, upon so informing such Category (ii) and (iii) States, the Category (i) states would then invite their (ii) and (iii) colleagues to enter the RFO negotiations (i.e. become “charter” members) (Molenaar, 2000, n. 80). The Molenaar position is not universally accepted³⁸.

If the Agreement is interpreted, over time, to mean that Category (ii) and (iii) States must be invited to become “charter” members, then it is easy to see that the same type of “free rider” problem, threatened by the New Member issue, can readily arise. Return to our New Member problem example, discussed earlier. Suppose, as before, that States V,W,X, and Y come together to establish a RFO to oversee the management of a straddling or highly migratory stock, which had, in the past, been overexploited. Suppose now that all four had been actively involved in the fishery, and that hence they can be classified as Category (i) States. The four plan to re-build the resource

³⁷ If new entrants are to “buy” their way in, then the obvious implication is that the “charter” members would have de facto collective “property” rights to the resources encompassed by the RFO.

Economists have argued, for 50 years, that it is the absence of effective, or effectively implemented, “property” rights, which is the root cause of so many, if not most, of the problems of capture fishery management (see: Gordon, 1954). The opaqueness, under the 1982 UN Convention, of the rights duties and obligations of coastal States, as opposed to those of DWFSs, with respect to the high seas portions of straddling/highly migratory stocks, meant that the “property” rights to these high seas resources lacked definition.

Kaitala and Munro, in 1997, had recommended the acknowledgement of “charter member” de facto collective “property” rights to the resources as a possible solution to the new entrant problem (Kaitala and Munro, 1997). Munro, in 2000, commented of this proposal stating that “... all of this should come as no surprise. It was, after all, the property rights to straddling/highly migratory stocks, so ill defined by the 1982 UN Convention, that lay at the heart of the straddling/highly migratory fish stock management crisis in the first place” (Munro, 2000, p. 276).

³⁸ See Orrego Vicuña (1999) for a markedly different view of the issue.

³⁹ One instance, to which we have already referred, in which this aspect of the ‘real interest’ arose was in the negotiations surrounding the *Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific* (WCPFC, 2000), and its implementation.

over a seven year period. Let us suppose that DWFS Z is a Category (iii) State. Rather than wait to come in later as a New Member, Z demands full and undiluted “charter” membership. The four feel compelled to accede to Z’s demand. Z incurs no real sacrifice in the re-building of the resource, because it had not hitherto been engaged in harvesting the resource. Z will simply bide its time over the seven year period, and then, when the eighth year arrives, will come to enjoy a share of the return on the resource investment, as the “free rider” that it most certainly is. Once again, the possibility of such “free riding” could undermine the viability of the RFO³⁹

The New Member and ‘real interest’ problems leads to yet another issue, or problem, which, heretofore, had been largely ignored. This problem concerns those developing States, which are emerging as DWFSs⁴⁰. Since these States are emerging, rather than established, DWFSs, they lack a catch history in fisheries coming under RFO management. Hence, they cannot qualify, under a narrow interpretation of ‘real interest,’ to become “charter” RFO members. As New Members, they face the prospect of receiving a very modest amount of quota free of charge, or the prospect of having to purchase quota, which may be beyond their financial capabilities. At the time of writing, there is no obvious solution to this problem.

Two special cases

We turn now to two real world cases, which in our view, merit particular attention in our examination of the management of straddling/highly migratory fish stocks. The first case does so, because it provides a particularly striking example of the difficulties that can be encountered in establishing a RFO, and the consequences of less than effective cooperative management. The second concerns an emerging RFO, which is of such magnitude that it is unlikely to be matched in importance by any other RFO, now, or in the future. The success, or lack thereof, of this RFO could have a profound impact upon the ultimate success of the 1995 UN Fish Stocks Agreement.

The South Tasman Rise orange roughy fishery

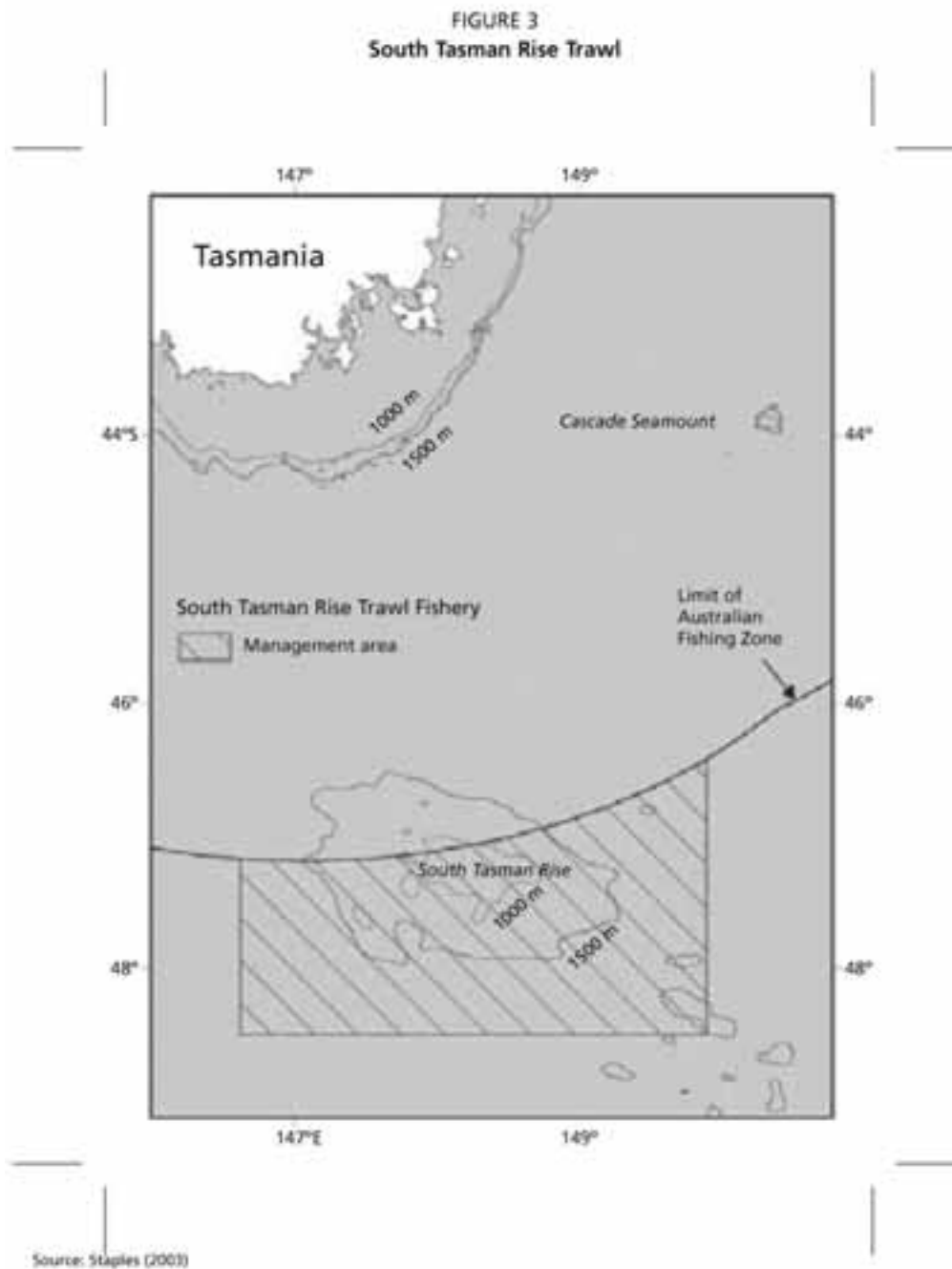
The South Tasman Rise orange roughy resource is a straddling stock, which is to be found in the Australian AFZ (Australian Fishing Zone), and the high seas adjacent to that zone. Historically, the resource has been exploited by Australia and New Zealand, but also by third parties. Case studies on the fishery were presented to the Norway-FAO Expert Consultation from both the Australian (Derek Staples, 2003), and the New Zealand (Jane Willing, 2003), perspective.

Orange roughy is a deep sea resource, requiring specialized technology and great skill to harvest (Willing, 2003). Once the technological barriers have been surmounted, however, the resource proves to be very vulnerable to overexploitation. The resource is exploited during the spawning phase, when an intense aggregation of the resource occurs. The species is extraordinarily long lived (up to 150 years) and slow growing. The harvests are high valued (Willing, *ibid.*). Uncontrolled exploitation of the resource, during its spawning phases, can easily lead to the resource being effectively mined out. Although it is true that a heavily exploited resource may ultimately recover, the recovery is likely to take a generation, or more.

Exploitation of the South Tasman Rise orange roughy resource commenced in 1997, after the 1995 UN Fish Stocks Agreement was in place, but before it came into force. During that year, the Australian fishing industry found significant aggregations of the resource in the high seas adjacent to the AFZ. The Australian exploitation activity did, in turn, arouse the interest of the New Zealand fishing industry.

The Australian resource managers, fearing overexploitation of the resource, approached their New Zealand counterparts to establish what amounted to a de

⁴⁰ e.g. Namibia.



facto RFO. The two “players” commenced with strong advantages. Australia and New Zealand are close neighbours, with similar cultural and historical backgrounds. Secondly, both have exemplary records in domestic fisheries management. If a resource, comparable to the South Tasman Rise orange roughy resource, were to be found wholly within the AFZ, or wholly within the New Zealand EEZ, the probability is high that the resource would prove to be effectively managed and conserved over time.

There were, however, two difficulties, which quickly became apparent. First, negotiations were initially bedevilled by the fact that there was uncertainty about the status of the resource, whether it was a true straddling stock, or whether it was a discrete high seas stock (Willing, *ibid.*). Secondly, the value of the resource, and its vulnerability, meant that the threat of the “Prisoner’s Dilemma” was acute. If the Australian/New Zealand vessel owners had any doubts about the stability of the management

regime, the rational strategy for them, regardless of how fervently they might believe in the benefits of conservation, would be to attempt to exploit the resource quickly, and to do so with all the harvesting capacity at their command.

The Australian and New Zealand authorities entered into an agreement in December 1997. Under the agreement there would be a TAC of 2 100 tonnes for the 1998–1999 season, to be divided on an 80–20 percent basis between Australia and New Zealand. An MOU was drafted which, upon ratification, would come into effect on 1 March, 1998. The agreement was only for one year, however, which created some element of uncertainty as to what would lie beyond 28 February, 1999. Furthermore, there was no provision for the possible entrance into the fishery of third parties. Finally, there appears to have been some lack of clarity about what fishing activities were to be permitted in the interim, between December 1997 and 1 March, 1998.

New Zealand, the de facto DWFS in this case, agreed to withdraw its fleet from the fishery, until the March 1998 start date. The Australian fleet did not withdraw. It is alleged that, during the December–February interim, the Australian fleet harvested in excess of 2 000 tonnes – recall that the agreed upon TAC for 1998/1999 was 2 100 tonnes (Staples, *ibid.*; Willing, *ibid.*).

New Zealand maintained that the spirit of the agreement had been violated. During the term of the MOU, Australia was to claim that New Zealand was exceeding its quota. The MOU expired on 28 February, 1999, with bitterness and recriminations on both sides. The MOU was not renewed (Staples, *ibid.*; Willing, *ibid.*).

There was, however, at least an informal agreement between the two countries for the 1999/2000 season. The two agreed that they would work towards a TAC of 2 100 tonnes. Australia stated that it was prepared to continue with the previously agreed upon division of the TAC. It would restrict itself to 80 percent of the TAC, leaving 20 percent for New Zealand. The Australian authorities did, in fact, close the fishery to its fleet, after there was evidence that the fleet had exceeded the 80 percent limit.

Twenty percent of 2 100 tonnes is 420 tonnes. The New Zealand fleet harvested in excess of 1 600 tonnes, during the 1999–2000 season (Staples, *ibid.*), a not unexpected reaction by that fleet to its experience in the previous season⁴¹.

Validated harvests for the two countries, for the 1999–2000 season approached 3 700 tonnes, almost 75 percent in excess of the informally agreed upon TAC (Staples, *ibid.*). While this was bad enough, the two countries were caught by surprise, during the 1999/2000 season, by third party unregulated fishing, i.e. non-participant “free riding”. Four vessels appeared, three flying the flag of South Africa, and one flying the flag of Belize.

Diplomatic pressure was brought to bear, and the vessels left the fishery⁴². No one, however, knows what these vessels succeeded in catching before they were encouraged to depart. Anecdotal evidence suggests that their harvests may have been as great as 6 200 tonnes (Staples, *ibid.*). If the anecdotal evidence is valid, then actual total harvest was in the order of 10 000 tonnes – four to five times as great as the recommended TAC.

In 2000, Australia and New Zealand signed a new MOU, which was to be long term in nature, and under which the two countries agreed to address the problem of unregulated fishing (Staples, *ibid.*; Willing, *ibid.*). The new MOU may, however, have come too late.

Anecdotal evidence is, of course, just that, and may not be much better than hearsay. Consequently, the validity of the claim of high catches through unregulated fishing during the 1999/2000 season cannot be verified. What is known, however, is that the total harvests during the 2001–2002 season were less than 190 tonnes (Staples, *ibid.*).

⁴¹ The reader would, at this point, find it both useful and instructive, if not revealing, to review the appendix at the end of this paper, entitled, “The Prisoner’s Dilemma and Fisheries”.

⁴² To put not too fine a point on it, the third party vessels were “seen off.”

Derek Staples states that “current indicators suggest a low remaining biomass and low future yields,” (Staples, *ibid.* p. 163). Jane Willing, in turn, remarks that equilibrium is maintained because yields are so low. Unregulated fishing is no threat, because it is not worth the while of non-participants to bother with the fishery (Willing, *ibid.*, p. 205). One could also speculate that the Australian and New Zealand fishing industries probably do not see one another as a threat worth worrying about, as far as this fishery is concerned.

In our discussion of the underlying theory of games analysis we discussed a “solution” to competitive fisheries games, which, in some instances, might approach Bionomic Equilibrium. One could argue that the South Tasman Rise orange roughy fishery has, MOU or no MOU, all of the appearances of such a competitive fisheries game “solution.”

Western and Central Pacific Fisheries Convention

In the discussion of transboundary fishery resources, the case of the tuna resources of the Pacific Island States of the Western and Central Pacific was discussed in some detail. The point was made that these resources constitute the most important set of tropical tuna resources in the world. The point was also made that the intra-EEZ harvests of these resources are taken largely by DWFSs (Aqorau, 2003).

While the resources are transboundary in nature among the Pacific Island States, we should note that they are transboundary with respect to neighbouring Southeast Asia countries, as well. Research undertaken by the then South Pacific Commission, in the early 1990s, revealed that the countries of the South Pacific share these resources moderately with the Philippines, and massively with Indonesia (Munro, 1995).

By definition, the tuna resources are highly migratory, as well as transboundary in nature. There are high seas enclaves between, and among, the EEZs of the Pacific Island States. Overtime, harvesting of the resources in the high seas enclaves became a matter of steadily increasing concern.

The 1995 UN Fish Stocks Agreement provided a framework within which this problem could be addressed. In 1996, a Multilateral High-Level Conference, involving coastal States and relevant DWFSs⁴³, was convened for the purpose of establishing a RFO for the management of western and central Pacific highly migratory species⁴⁴. Twenty-five states participated. After four years, the Conference concluded and brought forth a convention: the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean⁴⁵. At the time of writing, the entry of the Convention is immanent. It is anticipated that the Convention will enter into force no later than 19 June, 2004⁴⁶.

The area covered by the Convention is immense, extending well beyond the South Pacific into the North Pacific. Indeed, the eastern boundary of the Convention Area, north of the 4° parallel of south latitude, the 150° meridian of west longitude, extends to the North Pole (see map on page 54).

The heart of the Convention is to be found in Part III, Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific (WCPFC, 2000). The Commission, the headquarters of which are to be determined⁴⁷, will, *inter alia*, have responsibility for establishing TACs, or fishing effort equivalents, for the relevant resources in the Convention Area (WCPFC, 2000,

⁴³ With the most important DWFSs being Japan and the United States.

⁴⁴ To be covered are all species listed in the 1982 UN Convention, Annex 1, with the exception of sauries, plus other species deemed appropriate for inclusion by the negotiators. Western and Central Pacific Fisheries Convention Preparatory Conference, <http://www.ocean-affairs.com>.

⁴⁵ Popularly referred to as the Western and Central Pacific Fisheries Convention (WCPFC, 2000g).

⁴⁶ WCPFC Preparatory Conference, *op. cit.*

⁴⁷ WCPFC Preparatory Conference, *ibid.*

Article 10(1)(a)), and for developing criteria for the allocation of TACs (and fishing effort equivalents) (WCPFC, 2000, Article 10(3)). One can hazard the guess that the approach to ensuring compatibility of the intra-EEZ and high seas management regime will, almost inevitably, be a top down one⁴⁸.

The Multilateral High-Level Conference called for a Preparatory Conference, in the interim between closing of the Multilateral High-Level Conference (2000) and the coming into force of the Convention. The Preparatory Conference has had five sessions, up to the time of writing.

Initially, Japan's reservations about the proposed Convention served to prevent Japan from attending the first two sessions of the Preparatory Conference. Given Japan's importance to the region and the fisheries therein, Japan's non-participation could have had serious consequences for the future of the Convention. Japan's reservations were overcome, however, with the consequence that Japan participated actively in the following sessions of the Preparatory Conference.

The emerging RFO has experienced the 'real interest' problem, in having had to deal with the issue of countries and entities that were to be considered as potential "charter" members. It is by no means unlikely that the New Member problem will have to be confronted in the future. It is not without relevance that the Permanent Commission of the South Pacific, which has as member states the four Pacific coast countries of South America, requested and received observer status at the Preparatory Conference⁴⁹. Finally, the issue of IUU fishing has been brought up for active discussion at recent Preparatory Conference sessions⁵⁰.

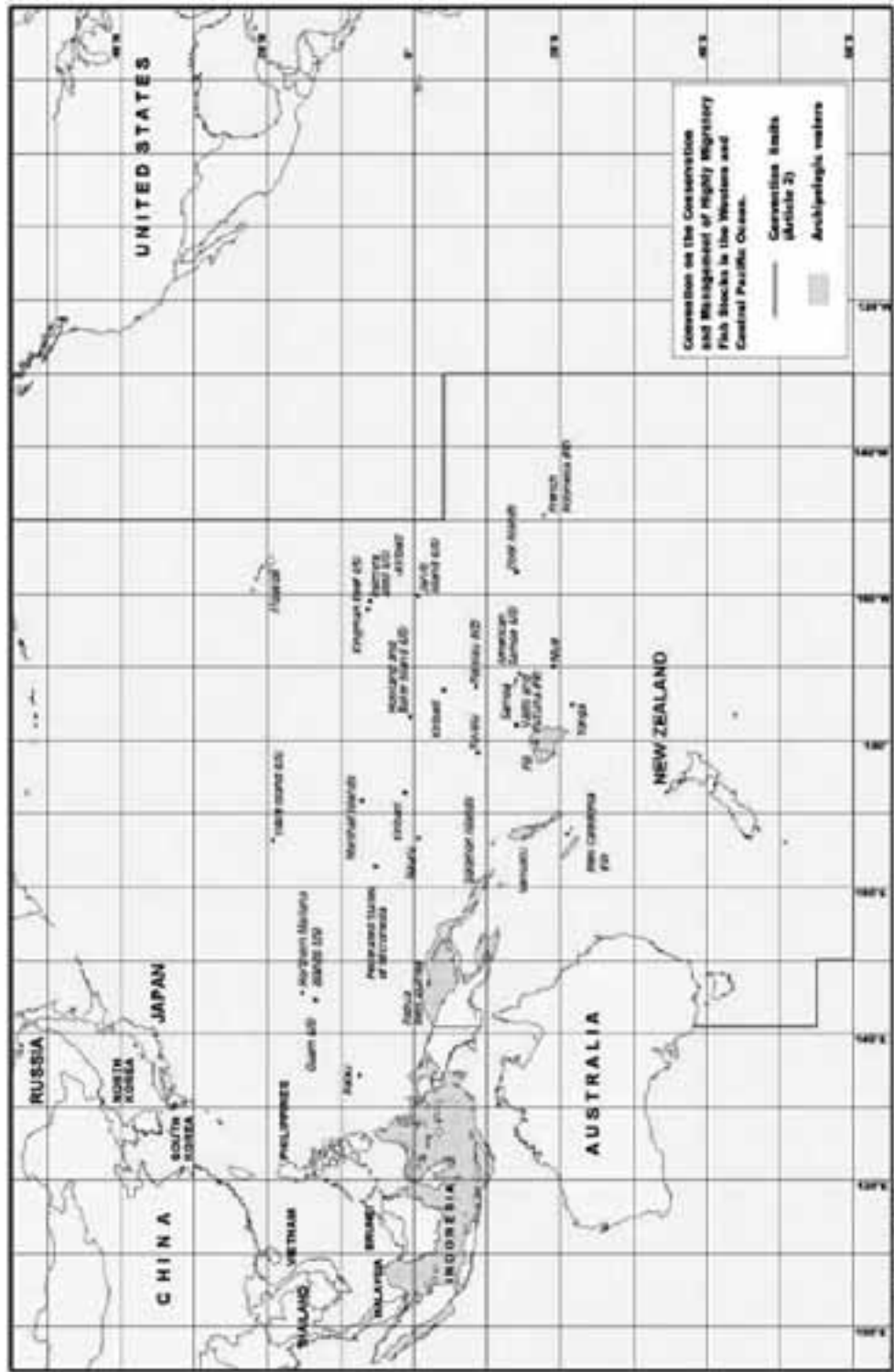
To conclude, we must repeat that the WCPFC represents an immensely ambitious undertaking. If it is successful, one can anticipate that it will serve as a model for emerging RFOs throughout the world.

⁴⁸ See Örebech et al., 1998.

⁴⁹ WCPFC Preparatory Conference, *op. cit.*

⁵⁰ WCPFC Preparatory Conference, *ibid.*

FIGURE 4
Reproduced with the kind permission of the Interim Secretariat for the WCPFC Preparatory Conference



5. Discrete high seas stocks

There is very little that one can, at this stage, say about these stocks. They might best be described as the “orphan” fish stocks of the ocean.

In legal terms, the resources are covered by the 1982 UN Convention Articles 116(a), 116(c), 117-120. States exploiting such stocks are admonished to cooperate for the purposes of conserving the resources. No mechanism for cooperation is suggested.

These articles proved to be inadequate for the conservation of straddling and highly migratory stocks. One has no justification whatsoever for assuming that these articles will prove to be any more adequate for the conservation of discrete high seas stocks. If cooperative resource management arrangements, focused on these resources alone, were established, one could look forward, with confidence, to an intractable “free riding” problem.

Without an effective mechanism for cooperation, we can anticipate that the discrete high seas stocks fisheries will play themselves out as competitive fisheries games, with the to be expected destructive consequences. It may be that a solution could be found in extending the mandate of RFOs to cover these resources, but this is, of course, pure speculation at this stage.

6. Conclusions

We commenced this paper with the proposition, which served as the rationale for the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks, that the effective management of shared fish stocks stands as one of the great challenges towards achieving long-term sustainable fisheries. There is no doubt about the importance of these resources. Highly migratory fish stocks and straddling fish stocks (actual and potential) alone account for around one fifth of world capture fishery harvests. The proportion could be as high as one third, if the other classes of shared fish stocks were included.

Our first conclusion is that, with few exceptions, stable cooperative management of shared fish stocks is required, if these resources are to be exploited on a sustainable basis. It is dangerous, if not foolhardy, to assume that non-cooperative management of shared fishery resources will suffice. The Norway-FAO Expert Consultation provided examples of resources shared by States, with exemplary domestic fisheries management records, which were overexploited, due to inadequacies in the cooperative resource management arrangements.

The legal foundation for such cooperative management is provided by the 1982 UN Convention, Parts V and VII in particular. The Convention proved to have some weaknesses, with respect to the management of straddling and highly migratory stocks. As a consequence, the 1982 UN Convention has now been supplemented by the 1995 UN Fish Stocks Agreement, which came into force in December 2001. The purpose of the Agreement is in no sense to substitute for any part of the Convention. Rather the purpose of the Agreement is to buttress the Convention, and ensure the Convention's effective implementation.

Cooperative resource management at what we have chosen to call the secondary level, involving full joint management, is admittedly difficult and costly. The Norway-FAO Expert Consultation did, however, provide encouraging examples of effective cooperative management at this secondary level, which should provide examples to others.

Having said this, however, there is one category of shared fish stocks, which should be a source of ongoing concern. This category consists of discrete high seas stocks, which we have (deliberately) referred to as "orphan" fish stocks.

Stability in cooperative resource management arrangements requires that certain requirements be met. Several of these requirements are obvious. First, for a given arrangement to be stable, it must not be possible to find an alternative arrangement, which is capable of making all "players" better off. Secondly, the so called "Individual Rationality" constraint must be satisfied. Even if only one "player," or subcoalition of "players," party to the arrangement, concludes that it can do better, by refusing to cooperate, the full cooperative arrangement will not hold.

Thirdly, where the number of participants in a cooperative management regime is large, it is imperative that the surrounding legal framework be found to have strength. Cooperative management arrangements, which purport to be binding, but which in fact are nonbinding, are unlikely to survive the stress created by large numbers. The need for a strong legal framework was seen to be particularly important in the case of straddling and highly migratory stocks, where the issue of unregulated fishing, "free riding" by non-participants, must be dealt with effectively. Implementation of the FAO IPO-IUU is to be viewed as a fundamental prerequisite for the stability

of the RFO regime, over the long run. Fourthly, also with respect to straddling and highly migratory stocks, means must be found of accommodating New Members, in accordance with the 1995 UN Fish Stocks Agreement, which do not, at the same time, undermine the long term viability of RFOs.

A less obvious, but highly important, requirement, relevant to all categories of shared fish stocks, is that the cooperative management arrangement be “resilient.” The cooperative resource management arrangement must have the flexibility and robustness to withstand, through time, the shocks of unexpected and unpredictable changes.

Ensuring that the individual rationality constraint is satisfied, and maximizing the robustness of the arrangement, requires, in turn, that the scope for bargaining be as great as possible. One means of so doing, stressed in this paper, is by making full use of “negotiation facilitators” (side payments), broadly defined.

Appendix: The prisoner's dilemma and fisheries

In the discussion on non-cooperative management of transboundary fishery resources, we discussed briefly one of the most famous of all non-cooperative games, the "Prisoner's Dilemma." The game, as we have seen, is also fully relevant to the management of the other three classes of shared fish stocks. The point of the game is that the players are driven inexorably to adopt strategies, which they know to be undesirable. The name, it will be recalled, comes from a story used to illustrate the game, involving two male companions, A and B, who are (justifiably) arrested on suspicion of grand larceny. In our example, cooperation is made impossible by virtue of the fact that the two cannot communicate. If the two could communicate, but thoroughly distrusted one another (dishonour among thieves), so that establishing a true binding agreement between the two was out of the question, we would get the same result.

In any event, each player (A and B) has before him two strategies: to plead guilty, or to plead not guilty. If both were to plead not guilty, they would be released from prison, after serving a minimum sentence. Both, however, are driven to plead guilty, and can look forward, as a consequence, to serving lengthy sentences. We can now show the outcome of, or "solution" to the game in greater detail by setting up a Payoff Matrix. The payoffs in the Matrix are expressed in terms of prison sentences. Consider the following, adapted from Luce and Raiffa (1957):

Prisoner A\Prisoner B	Pleads guilty	Pleads not guilty
Pleads guilty	5 years each	0 years for A, and 10 years for B
Pleads not guilty	10 years for A, and 0 years for B	1/2 year each

Suppose that Player B pleads guilty. Player A would clearly be better off pleading guilty. Suppose that Player B pleads not guilty. Player A would, once again, be better off pleading guilty. Regardless of which of the two strategies Player B may adopt, the best strategy for Player A is to plead guilty. Hence, pleading guilty is the dominant strategy for Player A. What holds true for Player A, also hold true for Player B.

Colin Clark, in his book *Bionomic Modelling and Fisheries Management* (Clark, 1985), presents a lucid example of the Prisoner's Dilemma applied to fisheries. Consider a fishery resource, shared by two countries, in which the costs of harvesting are independent of the size of the biomass, and in which the price for harvested fish and unit fishing effort costs are the same for the two countries, and are both constants. For each country, the net return for each unit of fish harvested is $p-c$, where p is the price of harvested fish and c the unit cost of harvesting. For the sake of simplicity, let $p-c=1$.

Let x denote the biomass, and $G(x)$ the growth of the biomass, and thus the sustainable harvest for any given level of x . Suppose that we commence at the global optimal biomass level, i.e. the biomass level at which the global economic returns from the resource will be maximized. Denote that biomass by x^* . The global economic return from the resource at $x = x^*$ is the present value of the sustainable harvest

through time, which can be expressed as: $G(x^*)/\delta$, where δ is the appropriate rate of interest, or discount rate, assumed to be common to the two countries.

One possible harvest policy is simply to deplete the resource. Since harvesting costs are independent of the size of the resource, the resource could be reduced to zero. If, commencing at $x = x^*$, the resource is depleted to zero, the economic return from so doing would be just x^* . We assume that x^* is positive, which implies, in turn, that $x^* < G(x^*)/\delta$.

Country 1 has two possible strategies: deplete the resource, or conserve it. If Country 1 adopts the deplete strategy, while Country 2 follows the conserve strategy, it is assumed that Country 1 can deplete the resource so quickly that Country 2 receives nothing (and thus ends up as the "goat"). What holds true for Country 1, holds true for Country 2, which faces the same set of strategies.

Finally, we assume that the two countries have equal bargaining strength and harvesting power. Hence, if the two follow the same strategies, they will share the economic returns from the fishery equally.

The Payoff Matrix looks as follows:

Country 1/Country 2	Conserve	Deplete
Conserve	$\frac{G(x^*)}{2\delta}, \frac{G(x^*)}{2\delta}$	$0, x^*$
Deplete	$x^*, 0$	$\frac{x^*}{2}, \frac{x^*}{2}$

If both conserve, each will receive one-half of the present value of the sustainable harvest, i.e.

$$\left(\frac{G(x^*)}{\delta}\right) \times \frac{1}{2}$$

If both deplete, each will receive

$$\frac{x^*}{2}$$

Since

$$\frac{x^*}{2} < \left(\frac{G(x^*)}{2\delta}\right),$$

then it follows that, if the two countries could communicate with one another and were prepared to enter into a binding agreement, they would cooperate and we would end up with the resource being conserved.

Suppose, on the other hand, that there is no cooperation, no communication, between the two countries. Assume, to begin with, that

$$x^* > \left(\frac{G(x^*)}{2\delta}\right)$$

and consider Country 1. If Country 2 should follow the conserve strategy, Country 1 will receive

$$\frac{G(x^*)}{2\delta},$$

if it conserves, and x^* , if it depletes. If Country 2 should follow the deplete strategy, Country 1 would receive 0, if it follows the conserve strategy, and

$$\frac{x^*}{2}$$

if it follows the deplete strategy. Clearly Country 1 should adopt the deplete strategy. What holds true for Country 1, hold true for Country 2, and we end up with a deplete, deplete outcome. This is a perfect Prisoner's Dilemma case (Clark, 1985, pp. 151-153).

Suppose, on the other hand, that

$$x^* < \left(\frac{G(x^*)}{2\delta} \right).$$

Country 1 would be better off conserving, if Country 2 followed the conserve strategy. It is possible that we would end up with a conserve, conserve outcome. But, such an outcome is decidedly unstable. Suppose that Country 1, guessing that Country 2 will conserve, adopts the conserve strategy, but is then proven wrong. Country 2 depletes, with the result that Country 1 is left with 0, and is indeed the "goat."

There is, in the theory of games, a famous criterion for selecting strategies in non-cooperative games, which is particularly applicable when one's opponent is both aggressive and unpredictable. It is referred to as the *maxmin* criterion. The criterion states that one should look at the worst possible outcome from following each strategy, and then compare. Choose the strategy having the least worst outcome.

In the case under discussion,

$$x^* < \left(\frac{G(x^*)}{2\delta} \right),$$

the Payoff Matrix tells us that the worst outcome for Country 1, if it follows the conserve strategy, is that it will receive 0 (the "goat" outcome). The worst outcome for Country 1, if it follows the deplete strategy, is that it will receive

$$\frac{x^*}{2}.$$

An application of the *maxmin* criterion would lead Country 1 to choose the deplete strategy. If Countries 1 and 2 each regard one another as aggressive and unpredictable, we can look forward to a deplete, deplete outcome. We might refer to this as the imperfect Prisoner's Dilemma case (Clark, 1985, *ibid.*; Bacharach, 1976).

References

- Agüero, M. & Gonzalez, E.** 1996. *Managing Transboundary Stocks of Small Pelagic Fisheries: Problems and Options*, World Bank Discussion Paper No.329, Fisheries Series, Washington.
- Aikman, C.C.** 1987. Island Nations of the South Pacific and Jurisdiction Over Highly Migratory Species, *Victoria University of Wellington Law Review* 17: 101-124.
- Al-Husaini, M.** 2003. Fishery of Shared Stock of the Silver Pomfret, *Pampus Agreuteus*, in the Northern Gulf: A Case Study, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 44-56.
- Aqorau, T.** 2003. Cooperative Management of Shared Fish Stocks in the South Pacific, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 57-67.
- Bacharach, M.** 1976. *Economics and the Theory of Games*, London, The MacMillan Press.
- Balton, D.A.** 2001. The Bering Sea Doughnut Hole Convention: Regional Solution, Global Implications, in Olav Schram Stokke (ed.), *Governing High Seas Fisheries: The Interplay of Global and Regional Regimes*, Oxford, Oxford University Press: 143-178.
- Barrett, S.** 2003. *Environment and Statecraft: The Strategy of Environmental Treaty-making*, Oxford, Oxford University Press.
- Bjørndal, T.** 2003. Management of a Straddling Fish Stock: The Case of the Norwegian Spring Spawning Herring Fishery, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 68-85.
- Bjørndal, T. & Munro, G.R.** 1998. The Economics of Fisheries Management: A Survey, in Tom Tietenberg and Henk Folmer (eds.), *The International Yearbook of Environmental and Resource Economics 1998/1999: A Survey of Current Issues*, Cheltenham, Edward Elgar: 153-188.
- Bjørndal, T. & Munro, G.R.** 2003. The Management of High Seas Fisheries Resources and the Implementation of the UN Fish Stocks Agreement of 1995, in Tom Tietenberg and Henk Folmer (eds.), *The International Yearbook of Environmental and Resource Economics 2003/2004: A Survey of Current Issues*, Cheltenham, Edward Elgar: 1-35.
- Burke, W.T.** 1983. 1982 Convention of the Law of the Sea Provisions on Conditions of Access to fisheries Subject to National Jurisdiction, in FAO, *Report of the Expert Consultation on the Conditions of Access to the Fish Resources of the Exclusive Economic Zone, Rome, 11-15 April 1983*, FAO Fisheries Report No. 293, Rome: 23-42.
- Burke, W.T.** 1994. *The New International Law of Fisheries: UNCLOS 1982 and Beyond*, Oxford, Clarendon Press.
- Burke, W.T. & Christy, F.T. Jr.** 1990. Options for the Management of Tuna Fisheries in the Indian Ocean, FAO Fisheries Technical Paper No. 315, Rome.
- Caddy, J.F.** 1997. Establishing a Consultative Mechanism or Arrangement for Managing Shared Stocks Within the Jurisdiction of Contiguous States, in D. Hancock (ed), *Taking Stock: Defining and Managing Shared Resources*, Australian Society for Fish Biology and Aquatic Resource Management Association of Australasia Joint Workshop Proceedings, Darwin, NT, 15-16 June 1997, Sydney, Australian Society for Fish Biology: 81-123.
- Chaluleu, J. D.** 2003. Shared Fishery: Argentine-Uruguayan Common Fishing Zone, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of*

- Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 86-104.
- Churchill, R.R. & Lowe A.V.** 1988. *The Law of the Sea*, Second Edition, Manchester, Manchester University Press.
- Clark, C.** 1980. Restricted Access to a Common Property Resource, in P. Liu (ed.), *Dynamic Optimization and Mathematical Economics*, New York, Plenum Press: 117-132.
- Clark, C.** 1985. *Bioeconomic Modelling and Fisheries Management*, New York, Wiley Interscience.
- Clark, C.** 1990. *Mathematical Bioeconomic: The Optimal Management of Renewable Resources*, Second Edition, New York, Wiley Interscience.
- Convention on the Conservation of Antarctic Marine Living Resources*, 1982.
- Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea*, 1992.
- Convention on Fishing and Conservation of the Living Resources of the Baltic Sea and Belts*, 1973.
- Convention on Fisheries Cooperation Among the States Bordering the Atlantic Ocean*, 1991.
- Convention on the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea*, 1953.
- Cox, A., M. Stubbs, & Davies L.** 1999. *Southern Bluefin and CITES: An Economic Perspective*, Report for Fisheries Research Fund and Environment Australia, ABARE Research Report 99-2, Canberra: Australian Bureau of Agricultural and Resource Economics.
- Edeson, W.R.** 2001. The Law of the Sea: Recent Developments, *Seminar on International Marine Fisheries and the Introduction of Vietnam's Draft Fisheries Law, September 2001*, FAO, Rome.
- Engeseter, Sigmund 1993. Scientific Input to International Fishery Agreements, *International Challenges*, 13: 85-106.
- FAO.** 1979. *Interim Report of the ACMRR Working Party on the Scientific Basis of Determining Management Measures*, FAO Fisheries Circular No. 718, Rome.
- FAO.** 1992. *Marine Fisheries and the Law of the Sea: A Decade of Change*, FAO Fisheries Circular No. 853, Rome.
- FAO.** 1994. *World Review of Highly Migratory Species and Straddling Stocks*, FAO Fisheries Technical Paper 337, Rome.
- FAO.** 1999. International Plan of Action for the Management of Fishing Capacity, Rome.
- FAO.** 2001. International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, Rome.
- FAO.** 2002a. *Report of the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695, Rome.
- FAO.** 2002b. *The State of World Fisheries and Aquaculture 2002*, Rome.
- FAO.** 2003a *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome.
- FAO.** 2003b *Code of Conduct for Responsible Fisheries*, Rome.
- FAO.** 2003c FISHSTAT, Rome.
- Gillett, R., McCoy, M., Rodwell, L. & Tamate, J.** 2001. *Tuna, A Key Economic Resource in the Pacific Islands*, A Report Prepared for the Asia Development Bank and the Forum Fisheries Agency, Manila, Asian Development Bank.
- Gordon, H.S.** 1954. The Economic Theory of a Common Property Resource: The Fishery, *Journal of Political Economy* 62: 124-142.
- Gulland, J.A.** 1980. *Some Problems of the Management of Shared Stocks*, FAO Fisheries Technical Paper No. 206, Rome.

- Hannesson, R. 1997. Fishing as a Supergame, *Journal of Environmental Economics and Management* 32: 309-322.
- Hilborn, R. & Sibert, J. 1988. Is International Management of Tuna Necessary? *Marine Policy* 12: 31-39.
- International Baltic Sea Fishery Commission. 2004. <http://www.ibsfc.org>.
- International Court of Justice. 1964. *Reports 1964*, The Hague.
- Kaitala, V. & Munro, G. 1993. The Management of High Seas Fisheries, *Marine Resource Economics* 8: 313-329.
- Kaitala, V. & Munro, G. 1997. The Conservation and Management of High Seas Fishery Resources Under the New Law of the Sea, *Natural Resource Modeling* 10: 87-108.
- Kennedy, J. 1999. A Dynamic Model of Cooperative and Non-cooperative Harvesting of Southern Bluefin Tuna With an Open Access Fringe. Presented to the 1999 World Conference on Natural Resource Modeling, Halifax.
- Levhari, D. & Mirman, L.J. 1980. The Great Fish War: An Example Using a Dynamic Cournot-Nash Solution, *Bell Journal of Economics* 11: 649-661.
- Lindroos, M. 2002. Coalition in Fisheries. paper Presented to the XIVth Annual Conference of the European Association of Fisheries Economists, Faro, Portugal.
- Luce, R.D. & Raiffa, H. 1957. *Games and Decisions: Introduction and Critical Survey*, New York, John Wiley & Sons.
- McRae, D. & Munro, G. 1989. Coastal State "Rights" Within the 200 Mile Exclusive Economic Zone, in P. Neher, R. Arnason and N. Mollet (eds.), *Rights Based Fishing*, Dordrecht, Kluwer: 97-112.
- Miller, K.A. 2003. North American Pacific Salmon: A Case of Fragile Cooperation, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 105-122.
- Miller, K., Munro, G., McDorman, McKelvey, T. R. & Tydemers, P. 2001. The 1999 Pacific Salmon Agreement: A Sustainable Solution? *Occasional Papers: Canadian-American Public Policy*, No. 47, Orono, Canadian-American Center, University of Maine.
- Molenaar, E. 2000. The Concept of "Real Interest" and Other Aspects of Cooperation Through Regional Fisheries Management Mechanisms, *The International Journal of Marine and Coastal Law* 15: 475-531.
- Munro, G. 1979. The Optimal Management of Transboundary Renewable Resources, *Canadian Journal of Economics* 3: 271-296.
- Munro, G. 1982. Cooperative Fisheries Arrangements between Pacific Coastal States and Distant Water Fishing Nations, in H.E. English and A.D. Scott (eds.), *Renewable Resources in the Pacific*, Ottawa, International Development Research Centre: 247-253.
- Munro, G. 1987. The Management of Shared Fishery Resources Under Extended Jurisdiction, *Marine Resource Economics* 3: 271-296.
- Munro, G. 1991. The Management of Migratory Fishery Resources in the Pacific: Tropical Tuna and Pacific Salmon, in R. Arnason and T. Bjørndal (eds.), *Essays on Economics of Migratory Fish Stocks*, Berlin, Springer-Verlag: 85-106.
- Munro, G. 1995. The Management of Tropical Tuna Resources in the Western Pacific: Trans-Regional Cooperation and Second Tier Diplomacy, in Gerald Blake, William Hildesley, Martin Pratt, Rebecca Ridley and Clive Schofield (eds.), *The Peaceful Management of Transboundary Resources* London, Graham and Trotman: 475-490.
- Munro, G. 2000. The UN Fish Stocks Agreement of 1995: History and Problems of Implementation, *Marine Resource Economics* 15: 265-280.
- Munro, G. & Stokes, R. 1989. The Canada-United States Pacific Salmon Treaty, in D. McRae and G. Munro (eds.), *Canadian Oceans Policy: National Strategies and the New Law of the Sea*, Vancouver, University of British Columbia Press: 17-35.
- Nandan, S.N., Rosenne, S. & Grandy, N.R. (eds.) 1993. *United Nations Convention on the Law of the Sea 1982: A Commentary*, Vol. ii, Dordrecht, Nijhoff.

- Nash, J.** 1951. Noncooperative Games, *Annals of Mathematics* 54:289-295.
- Nash, J.** 1953. Two-Person Cooperative Games, *Econometrica* 21: 128-140.
- Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest*, 1982.
- OECD.** 1997. *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources*, Paris.
- Örebech, P., Sigurjonsson, K. & McDorman, T.L.** 1998. The 1995 United Nations Straddling and Highly Migratory Fish Stocks Agreement: Management, Enforcement and Dispute Settlement, *The International Journal of Marine and Coastal Law* 15: 361-378.
- Orrego Vicuña, F.** 1999. *The Changing International Law of High Seas Fisheries*, Cambridge, Cambridge University Press.
- Owen, D.** 2001. Legal and Institutional Aspects of Management Arrangements for Shared Stocks with Reference to Small Pelagics in Northwest Africa, Study Undertaken for the Food and Agriculture Organization of the UN, and the Nansen Programme on Fisheries Management and Marine Environment, GCP/INT/730/NOR.
- Pintassilgo, P.** 2003. A Coalition Approach to the Management of High Seas Fisheries in the Presence of Externalities, *Natural Resource Modeling* 16: 175 – 197.
- Ranke, W.** 2003. Cooperative Fisheries Management Issues in the Baltic Sea, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 123-132.
- Reuter, P.** 1975. De l'Obligation de Négocien. *Studi in Onore di Gaetano Morelli*, Comunicazioni e Studi, vol. XIV, Milan, Giuffrè.
- Samb, B.** 2003. Case Study of Small Pelagic Fish Resources in Northwest Africa, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 133-142.
- Staples, D.** 2003. Management of Shared Fish Stocks – Australian Case Studies, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 159-179.
- Stokke, O.S.** 2003. Management of Shared Fish Stocks in the Barents Sea, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 180-191.
- Sumaila, R., Ninnes, C. & Oelofsen, B.** 2003. Management of Shared Fish Stocks in the Bengula Marine Ecosystem, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 143-158.
- Thompson, A.** 2003. The Management of Redfish (*Sebastes Mentella*) in the North Atlantic Ocean – A Stock in Motion, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 192-199.
- Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon**, March. 1985.
- Tucker, A.W.** 1950. A Two-Person Dilemma, Stanford University, unpublished.
- United Nations.** 1982. United Nations Convention on the Law of the Sea. UN Doc. A/Conf.62/122.
- United Nations.** 1992a. *The Law of the Sea: The Regime for High Seas Fisheries: Status and Prospects*, Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, New York.

- United Nations.** 1992b. Conference on Environment and Development, *Agenda 21*, New York.
- United Nations.** 1995. United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks. Agreement for the Implementation 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 Doc. A/Conf./164/37.
- Van Houtte, A.** 2003. Legal Aspects in the Management of Shared Fish Stocks: A Review, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 30-42.
- Wage, A.** 2001. Norway's Experience: Management of Common Stocks Focusing on Issues Related to the "Grey Zone," *Seminars on International Marine Fisheries and the Introduction of Vietnam's Draft Fisheries Law, September 2001*, FAO, Rome
- Wessells, C.R., Cochrane, K., Deere, C., Wallis, P. & Willmann, R.** 2001. *Product Certification and Ecolabelling for Fisheries Sustainability*, FAO Fisheries Technical Paper No. 422, Rome.
- Western and Central Pacific Fisheries Convention (WCPFC)** (Convention on the Conservation and Management of Highly Migratory Stocks in the Western and Central Pacific) 2000. <http://www.ocean-affairs.com>.
- Willing, J.** 2003. Arrangement between the Government of Australia and the Government of New Zealand for the Conservation and Management of Orange Roughy on the South Tasman Rise, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 200-214.
- Zuzunaga, J.** 2003. Some Shared Fish Stocks of South Eastern Pacific, in FAO, *Papers Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks Bergen, Norway, 7-10 October 2002*, FAO Fisheries Report No. 695 Supplement, Rome: 216-230.