Individual Interests, Public Detriments: An Institutional Economics Analysis of the ICCAT's Atlantic Bluefin Tuna Policies

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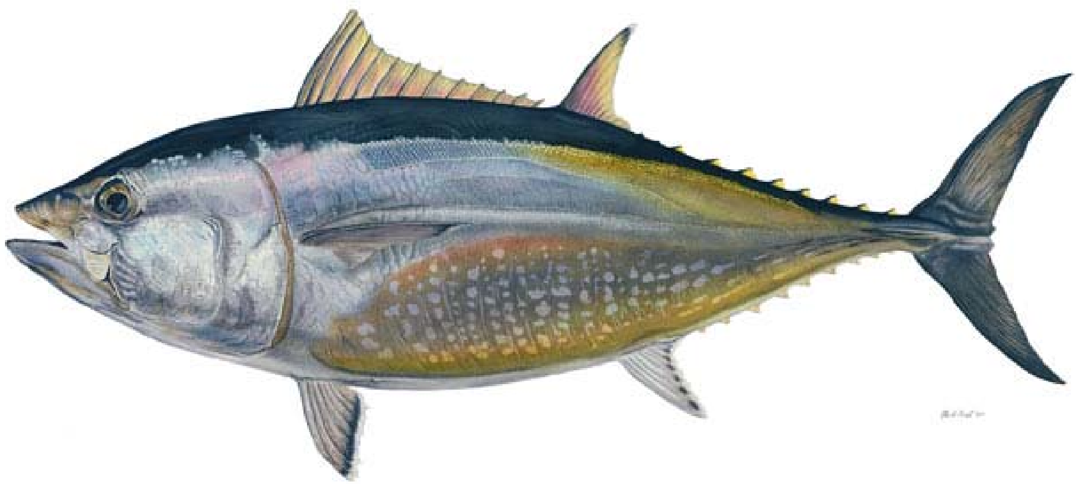

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I. Introduction

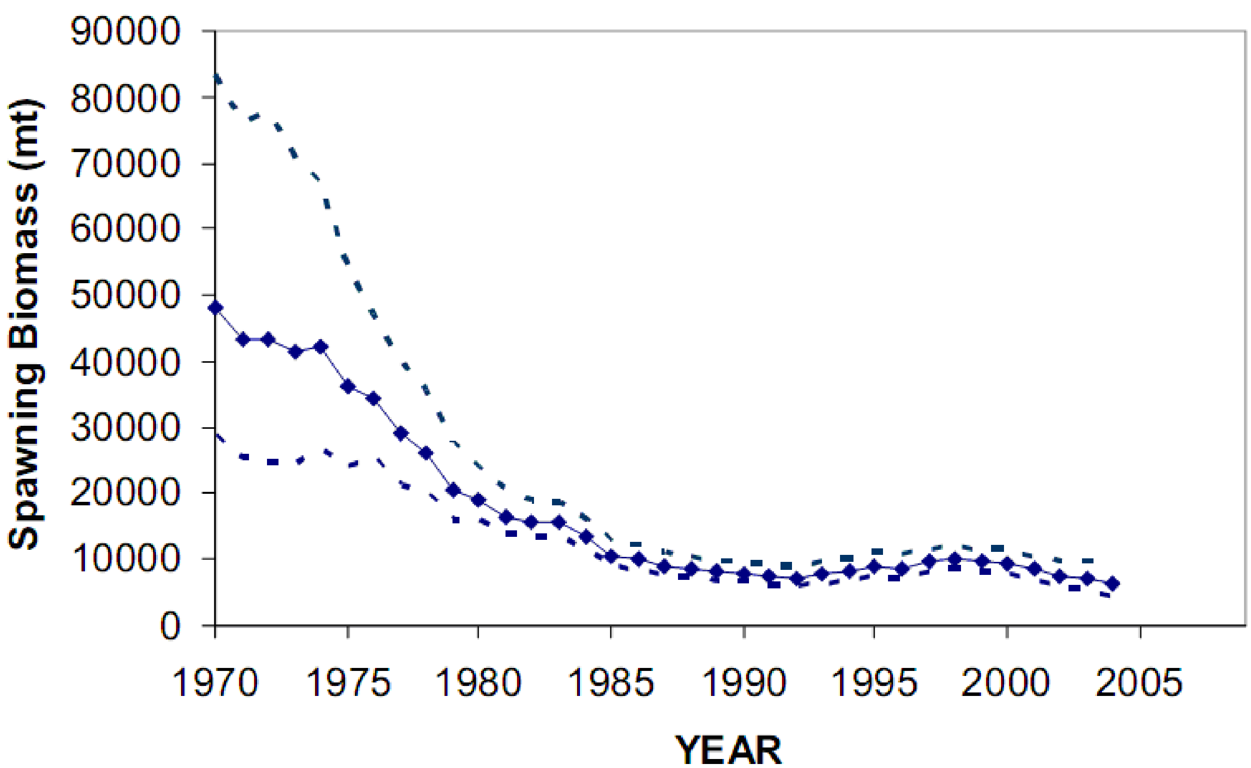
Once solely an ingredient in cat food, bluefin tuna (*Thunnus Thynnus Thynnus*) now represents the single highest value fishery in all of the world‘s oceans; well-marbled specimens can sell for upwards of $200 a pound on the Tokyo fish market (Cummings, 2007). Because of this enormous increase in the demand of these once considered “garbage” fish, the price of this rare commodity has risen drastically. Single fish often break the hundred thousand dollars barrier and in 2001, a single adult bluefin tuna sold for $173,600 in the Tokyo Tsukji fish market (World Wildlife Foundation, 2007). With the opening of the Japanese fish market in the seventies and the explosion of popularity that sushi experienced in the United States and elsewhere, global demand for giant bluefin has soared to unprecedented levels. The average cost of fishing for Atlantic Bluefin Tuna has also fallen; with technical advances like sonar and spotting planes, the difficulty of finding and catching adult Atlantic Bluefin tuna has dropped dramatically.

As early as 1960s, there was significant interest in the management of the Atlantic bluefin tuna (ABFT); fishing pressure had resulted in a noticeable change in the size of the fishing stock among bluefin tuna fishing boat operators (Buck, 1995). Because markets had developed for both fresh and canned bluefin tuna, in 1966 the International Convention for the Conservation of Atlantic Tunas (ICCAT) was formed (Buck, 1995). The ICCAT began as an organization “responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas.” Over the next several decades, the ICCAT set quotas on Atlantic bluefin and attempted to prevent over-utilization of the resource. Organizing coordination between the sixteen original members, the ICCAT endeavored to prevent overfishing and reduce fishing effort.

By 1992, ICCAT estimated that the western Atlantic bluefin spawning population had declined to 10 percent of its 1975 level (Buck, 1995); similar estimates were made for the eastern

Atlantic and Mediterranean stocks. In less than twenty years, the ICCAT mismanaged the Atlantic Bluefin Tuna population almost out of existence. The Atlantic Bluefin tuna fishery has remained, hovering over total collapse, for over a decade now (Atlantic Bluefin Tuna Stock Assessment, 2007). Figure 1 illustrates the decline in the estimated size of the Atlantic Bluefin able to spawn (a common measure of a fisheries recovery potential); this radical decrease and subsequent non-recovery clearly illustrates the failure of the ICCAT to manage the Atlantic stocks of the bluefin tuna. In the past, the ICCAT has entirely failed to place the interests of economic efficiency and the viability of tuna populations over the short run gains to be made by overfishing. However, with the strengthening of the ICCAT, it may be able to overcome the market failure involved with Atlantic Bluefin Tuna; sadly, it is likely too late for the tuna themselves.

Figure 1



II. Theoretical Framework

Neo-classical economics on the issue of fisheries management revolves around several key issues: the difficulty in valuation of natural resources, achieving maximum benefit from the fishery, and lowering overall fishing effort to prevent unsustainable yields. Techniques for valuing the environment can be difficult due to the complexity of assessing the benefits and costs associated with a use or disuse of the environment; often, natural resources have a monetary value as well as other, inherent values not easily quantified by standard valuations (Krutilla, 1967). Krutilla states that "there is a family of problems associated with the natural environment which involves the irreproducibility of unique phenomena of nature…the utility to individuals of direct association with natural environments may be increasing while the supply is not readily subject to enlargement by man (1967)." Even excluding the intrinsic value of having fish in our oceans, it is regularly difficult to estimate the true value of a fish because fish produce more fish, not humans.

The classic equation of valuation for a natural resource presents a way to quantify the losses and gains presented by a proposed environmental or natural resource issue. The model follows a simple form illustrating the net benefits of any given action. Dixon (1986) presents the model

$$NPV = B_d + B_e - C_d - C_p - C_e$$

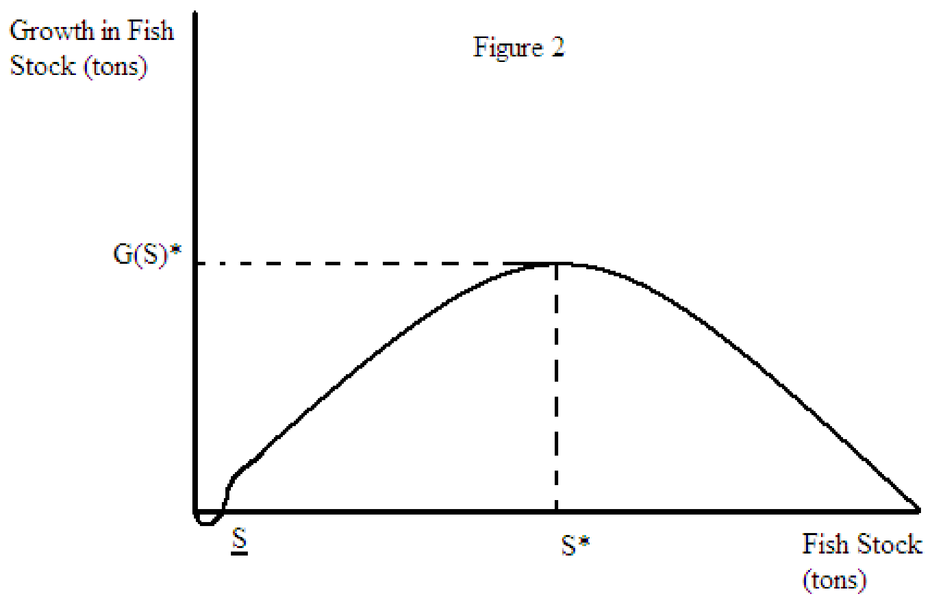
Where

NPV = net present value
B_d = direct project benefits
B_e = external (and/or environmental benefits)
C_d = direct project costs
C_p = environmental protection costs
C_e = external (and/or environmental costs) (p. 6).

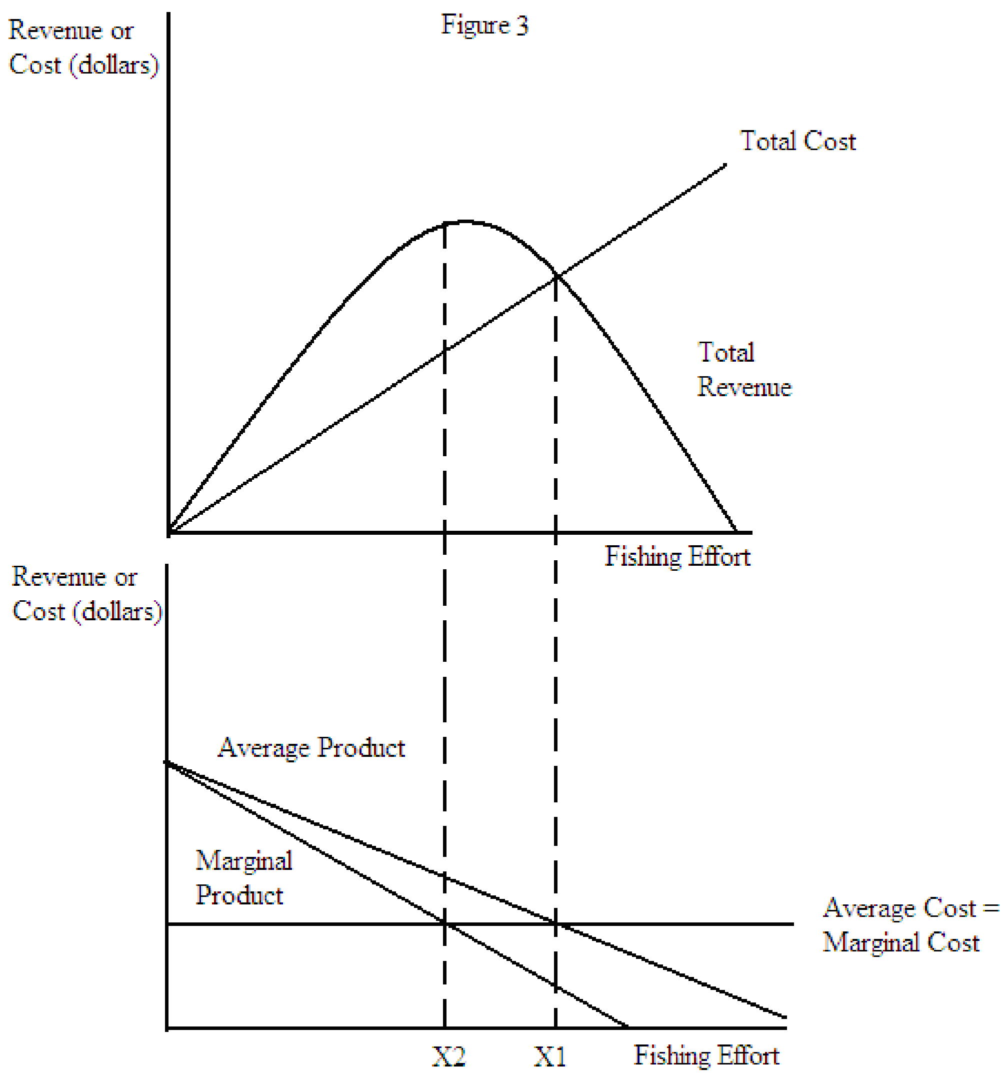
This model contrasts with earlier accounts that simply quantified the direct benefits and costs to be gained from any endeavor (Dixon, 1986). Thus, given a technique to asses the monetary value of any given environmental or external impact (a difficult process in and of itself), firms and governments can account for the change in the environment. The most important aspect of judging the economics of environmental impact is understanding that most projects affect a number of individuals, firms, or governments and that estimating the lasting, external costs to any project is complex and often very difficult. The model above can give an accurate representation of the costs associated with a change in the institution of renewable common pool resources like fisheries.

On the most basic level, any fishery consists of two values. The first of these is the monetary value of the fish that can be extracted from it environmental valuation; currently, using average price of the final tuna in the Tokyo fish market, the value of all Bluefin tuna in the Atlantic Ocean stands at around $1,500,000,000 (Atlantic Bluefin Tuna Stock Assessment, 2006). Fish also have an additional non-market value because fish are a "catch resource", that is, fish produce more fish (Iudicello, 1999). There is value in leaving fish in the ocean because given time, fish will produce more fish. The value of this future catch depends on numerous factors including the discount rate for fish, fish spawning and growth rates, and spawning age. It is also important to note the basic idea that the supply of Atlantic Bluefin Tuna, while renewable, cannot be significantly affected by humans except if left alone (Gordon, 1954).

One of the more critical aspects of the valuation and allocation of fisheries rents comes in the form of a model describing the relationship between size of fish population and the rate of growth (Tietenberg, 2006). Specifically, fish biomass grows the most at the median range of population (see figure 2). Since, if the fishery is sustainable, the maximum catch is equal to the growth of fish biomass, the maximum output of the fishery also represents its highest growth point. S* represents the *maximum sustainable yield* of a given fishery because in order for fish stocks to remain at a given point S*, no more fish biomass can be harvested than grew in the given length of time. The highest growth point will occur at S* because there are significant numbers of fish to reproduce at a high rate and at the same time, there are enough resources for a higher number of juvenile fish to survive to breed. The slight initial dip in the figure represents the point where fish stocks are so low that they cannot reproduce in sufficient numbers and will become extinct soon. However, despite being the largest extraction point for the fishery, S* does not necessarily correspond to the most economically efficient point (Gordon, 1954).



The reason that efficient levels of output for fisheries differ from maximum sustainable yields is that private property would result in a balancing between asset value (the value of all fish including the future ability to produce more fish) and catch value (the monetary value of fish caught and sold), open access results in a “race for the fish” (Iudicello, 1999). For a firm engaged in perfect competition, profits are maximized where marginal product equals marginal cost. If the fishery resource were private property, individual fishing boat production will occur at point X2 on figure 3, because the individual is now concerned about asset value (Tietenberg, 2006).



However, because open ocean fisheries are common resources generally open to all, individual fishermen end up operating were average production equals marginal cost (Gordon, 1954). This occurs because average productivity now indicates where the profitable point takes place due to the fact that fishermen cannot tell what their marginal costs will be. Individual fishermen will fish until average cost equals marginal benefit because they do not experience an increase of marginal costs as they personally continue to fish (Tietenberg, 2006). Thus, individual fishermen will continue to fish until the value of fish they catch equals the cost of the effort required to obtain them. Tietenberg (2006) states that “the resource owner with exclusive property rights balances the use value against the asset value…when access to the resource is unrestricted, exclusivity is lost. As a result, it is rational for fishermen to ignore asset value, since he or she can never appropriate it, and simply maximize the use value. (p. 295)"Because of this information asymmetry, fishing effort occurs at point X1 on figure 4 rather than at point X2, where economic efficiency is highest because marginal revenue most exceeds marginal cost.

It is important to keep in mind the idea of efficiency in a discussion of fishing efforts; while many fishery policies result in a reduction of fishing effort through smaller seasons or use of out dated gear, this cannot be the most efficient way to employ capital or labor. If fishermen are required to use more expensive, less efficient older gear, during only some of the season, the labor and capital involved will likely remain unused for long periods of time. This outcome is inefficient because it lowers the fish caught per unit of effort or capital; efficiency would occur when a much lower number of fishermen operate all year long with high capitalization (Tietenberg, 2006).

In equilibrium, the above figure has shown that the market equilibrium of fisheries leads to inefficiency and, a production beyond the maximum sustainable yield. One possible solution is to make the fishery privately held rather than commonly held; with this change, the owner of the fishery would have an incentive to fish above maximum sustainable yield because it would maximize present and future value. In practice, this has become an extremely difficult idea to implement. Fishermen are loath to give up what they see as their "right" to fish and migrating fish often make it impossible to allocate a singer owner (Iudicello, 1999). Individual transferable quotas (ITCs) have arisen as a way of allocating private property and generally offer a workable way of managing fisheries; however, numerous issues have arisen with their implementation (Tietenberg, 2006). ITCs allocate a piece of the total allowed fishing amount to individual fishermen; ideally an objective third party will set the maximally efficient catch point.

The second way of solving the problem of overfishing is raising the real cost of fishing and fishing effort. As figure 3 illustrates, a simple increase in the total cost of fishing effort would drive back fishing effort to sustainable levels. Through the use of regulation or taxes, the government can force a shift in the marginal cost curves, causing less fishing effort on the whole and an outcome much closer to the single user outcome. Again, however, difficulties arise in creating an incentive for individual fishermen to expend less effort (H. John Heinz II Center, 2000). Fishermen are, not surprisingly, almost universally against a tax on fishing effort where the government receives the rents from the tax (Tietenberg, 2006). Some fisheries have attempted to use the rents from an effort tax for rebuilding efforts but rarely does the majority of the rent eventually return to the fishery (Iudicello, 1999). In the end, reducing individual fishermen effort is difficult because it is easy for individuals to shirk and effective implementation faces numerous difficulties. The difficulty of reducing fishing effort is in the execution; finding an equitable solution is problematic because it involves changing historical precedents (and bankrupting individuals) or a loss of efficiency.

The neo-classical framework illustrates that efficient management of biological resources like fisheries can occur: with the right incentives and an interest in the long run, markets can clear in a Pareto efficient manner that maximizes social welfare. If fishing effort can be reduced to a level where marginal benefit of the fish taken out equals the marginal cost of fishing plus the extra cost of the caught fish not being able to spawn ($MB_{fish} = MC_{fishing} + EC_{spawn}$), by definition, overfishing will not occur. EC will increase with each fish taken out because that fish represents a greater portion of the entire breeding stock. Achieving this objective, however, turns out to be difficult in practice. New Institutional Economics allows a formal method for the construction of a system of rules that can mitigate this market failure (Petersen, 2006).

New institutional economics brings valuable analysis to the study of fisheries; now that policy-makers understand the methods for creating sustainable, efficient fisheries, new institutional economics enables economists to examine the necessary steps to construct and implement these ideas. NIE centers on the idea that information is imperfect, costly, and asymmetrical, this lack of information results in market failures. For example, in fisheries, it is often difficult (if not impossible) for governments or international organizations to catalogue every catch by individual fishermen and cataloguing the entire catch of a fishery is enormously expensive. The cost of mitigating these informational asymmetries is a transaction cost; it is important to consider this cost because the cost of correcting for imperfect information can overwhelm the benefit gained from the change in equilibrium. New institutional economics is study of the institutions that crop up to correct for these information asymmetries. An institution is defined as a rule that governs behavior among people. These institutions are either informal (internal) or formal (external). In fisheries economics, there are specific applications of NIE that examine the most important pieces of an effective and efficient fisheries institution (Petersen, 2006).

Generally, there are a few significant ways in which imperfect information and transaction costs factor into fisheries. In the implementation of fisheries institutions, imperfect information causes many of the problems that lead to overfishing. First, and most important, is the simple fact that fishermen have no information about other individuals' catches. This leads to fishermen not only being unable to find where marginal product equals marginal cost (because they cannot know how productive the fishery will be until they have already produced fish) but also means that there is a "race for the fish". If individual boats were to reduce fishing effort in an attempt to promote future value, the other fishermen would continue to fish and deplete the resource. Thus, the first boats on the ocean have the easiest time locating fish (more fish in the same amount of ocean means fish are easier to find) and if the limited resource is divided among fishermen solely by fishing effort, then whoever finds the fish the quickest stands to make the most money (Iudicello, 1999). In a fishery, especially if stocks or breeding rates are very low, there is a significant negative externality to each fish that a fisherman takes. If a property rights system is implemented, fishermen still have an incentive to shirk that is fish more than their allotted effort or quota, because the likelihood they will get detected is low.

In a sense, the condition of imperfect information can been seen to cause over fishing—if fishermen knew the exact catch and productivity of the fishery, they could punish shirkers and work towards a sustainable fishery. Information asymmetries also puts scientists and fishermen at odds—individual fishermen have a more complete knowledge of not only their own catch but of the health of the fishery as well. The years of experience found aboard most fishing vessels is uniquely suited to understanding overall trends in population, There is also the less economic but equally difficult issue of scientists' imperfect information regarding the collective size of the stock of fish—measuring the entire number or biomass of any fish, let alone one as wide ranging as bluefin tuna, is extraordinarily costly if not impossible. These transaction costs and others like them prevent equal information among all participants that would ensure success of the market.

In *Institutional Economics and Fisheries Management*, Petersen outlines a framework for examining or creating fisheries institutions (2006). The system she outlines revolves around mitigating the market failures of natural resource governance. Specifically, it attempts to alleviate and account for the informational problems and externalities associated with environmental impacts. Petersen states that "the role of institutions goes beyond supporting markets…while some decisions are made by the government owing to some recognizable reason for market failure, for others there has never been a market, nor is it foreseeable that they will be controlled by market processes" (p. 3). Institutions not only correct for failed markets, they exists where markets cannot. Petersen identifies three key issues as paramount to building an effective natural resources institution: “property rights, entitlement systems, and mechanisms for allocating and adjusting resource entitlements” (p. 3).

The first of these issues, property rights, Petersen “describes the nature of an entity holding decision-making power as to the way in which a resource is used” (p. 8). The four types of property rights are open-access, private-property, state-owned, and common-property. In an open access resource, no predefined group of owners exists and the benefits of the resource are available to all. In private property or state owned forms, an individual, government or corporation has the ability to exclude others from the resource. In contrast to the above forms, in a common-property resource, a formal or informal institution exists so that the community can manage the use of a resource. In the case of fisheries, there are generally nested levels of property rights with governments or international organizations on top with individual fishermen on the bottom—table 1 illustrates this hierarchy. In fisheries economics, the goal of property rights is balancing the interests of the catch value with the asset value; this can be accomplished in a number of ways (Petersen, 2006).

Table 1: Conceptual Property Right Hierarchy in an International Fishery

Scope of Allocation Problem	Parties to Decision Making	Conceptual property right regime	Allocation decision
Allocation of fish stocks amongst nations	Multiple national governments	Common property	Definition of territorial waters
Allocation of fish stocks amongst regional communities	National government	State property	Exclusive commmunity rights to fishing areas
Allocation of fish stocks amongst individual fishermen	Community Members	Common property	Individual transferable quotas
Allocation of quotas to fishing effort or sale to other fishermen	Individual fishermen	Private property	Private production and investment descisions

Source: Petersen (2006)

The second important piece of a fisheries institution is an entitlement system. An entitlement system enables the owners (private individuals or firms, governments or communities) of a natural resource to allocate the resources within their property. In fisheries, these take two forms: direct controls of either input or output restrictions or indirect controls of taxes, subsidies, fiscal controls, or price strategies. Input restrictions can be broken down into four methods: gear restrictions, closed seasons or areas and limits on entry. Gear restrictions consist of limitations on the amount of capital used by individual fishermen; they can be effective but often result in decreased efficiency. For example, many North American fisheries have banned the use of purse seines in favor of older hook and line gears (The H. John Heinz III Center, 2000). Limitations on fishing season or area often results in more concentrated effort in times and places without limitations and are generally of limited effectiveness; despite the fact that Canada's herring fishery was open only for 12 hours in 1995, fishermen still managed to exceed their quota (Tietenberg, 2006).

Limiting entry suffers problems similar to time and area restrictions; the transaction costs involved with monitoring the actions of individual fishermen has historically been extremely costly, especially in developing countries. There are two types of output controls in Petersen's model: quotas and restrictions on the size, age, or type of fish that can be landed. Contrasted with the entitlement systems above, quotas can be both biologically and economically efficient, if the total catch is know and the most efficient fishermen are given the right to fish. The second type of output control, limits on fish landed, can generally only be effective if transshipment is not possible and all landing ports are monitored. All of these systems should be seen as a way to manage fishing effort; Petersen outlines the fact that it is important to remember that fishing effort is the control variable and "how to control effort and what institutional setting might best implement these controls is the fisheries management problem (p. 9)."

The final piece of Petersen's framework, mechanisms for allocating and adjusting entitlements, can be broadly divided into two types: market-based or administrative. Petersen states that "administrative systems allocate or adjust entitlements either by unilateral decisions from particular circumstances or by establishing a set of *a priori* rules which establish the circumstances under which allocation can occur (p. 11)." Most commonly, the methods for allocating fishing rights are: historical participation, catch size, socio-economic conditions, and a lottery. Each method has its own complications; historical participation favors older fishermen who are not necessarily the most efficient. Catch size encourages false reporting while a socio-economic basis or a lottery is unlikely to choose the most efficient fishermen. A lottery is unlikely to choose the most efficient fishermen because it chooses equally among all fishermen, including those who might have been forced out of production if the fishery were operating otherwise. The most efficient fishermen are rarely chosen in socio-economic selection because the most efficient fishermen generally have the highest levels of capitalization; poorer countries or fishermen cannot always afford the most effective fishing equipment (Petersen, 2006). Market based systems of entitlements allow for trading between fishermen and the governing body (ITCs are a kind of market-based allocation) which, in the long run, results in the most efficient fishermen producing fish. In theory, these more efficient fishermen will have higher profits and eventually purchase the shares of less efficient fishermen. The most common form of market-based allocation is an auction of quota pieces; with proper design, this ensures that the most efficient individuals will purchase the quota (Petersen, 2006).

All of these sections combine to form the basis for the selection or creation of an institution to prevent the market failure generally associated with fisheries. The most effective and the most efficient institution, in terms of institutional economics, minimizes the transaction costs associated with a transfer to the new institution and generates the most benefit, current and future, from a fishery. Once the institution addresses the clear issues with overuse of the resource, the main determinant will be its ability to reduce transaction costs. Petersen divides these into two distinct types: static transaction costs (those associated with making and executing decisions within an existing institutional framework) and dynamic transaction costs (the costs of altering an existing institutional framework). On the most basic level, the value of an existing institution can be compared to the evolved or new institution by evaluating the benefits of the new institution minus the transaction costs of both implementing and maintaining the new institution. The equation

$$IV = NB + TC_s + TC_d$$

Where

IV = Institution value
NB = Net benefits for the institutional change
TC_s = Static transaction costs
TC_d = Dynamic transaction costs

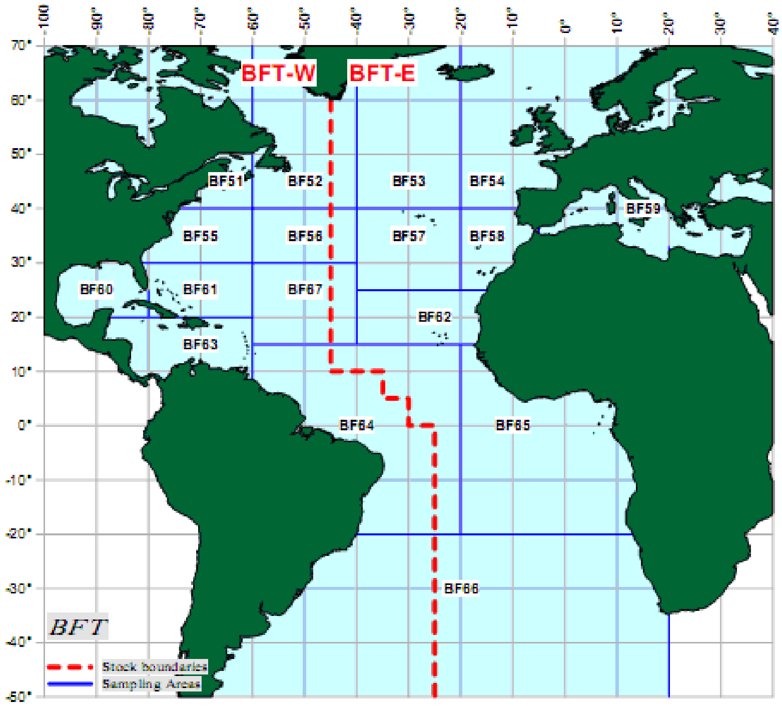
Using the above Institutional Value model, a fishery model created under Petersen's framework can be additionally evaluated on a cost/benefit basis compared to existing institutions. Applying this model to the ICCAT's Atlantic Bluefin tuna fishery, it can be shown exactly where the failure to maximize efficiency occurred and also, where possible issues exist in the latest framework.

III. Atlantic Bluefin Tuna Fishery Background

There are several important issues that make international regulation of bluefin stocks difficult to manage. First, even the biology of the fish complicates the management process. Atlantic Bluefin Tuna are a rare kind of warm-blooded fish; thus they are equally at home in warm tropical waters as well as the frigid coast off of Canada (Munro, 2007). Because of their hydrodynamic form, bluefin can swim over 60 miles per hours for brief periods of time. This enables them to cross the Atlantic in under a month and roam throughout the ocean searching for food. Adult bluefin tuna also average about 550 pounds, with some weighing in at over 1,500 pounds (World Wildlife Federation, 2007). Bluefin tuna are also extremely long lived: individual fish may live for more than 25 years and only breed after a decade. Adult specimens are by far the most valuable; the world's largest importer of bluefin tuna, Japan, actually has little demand for less fatty juvenile fish (Pintassilgo, 2002).

Further complicating the biology of the Atlantic Bluefin tuna fishery is the existence of two stocks. The eastern Atlantic and Mediterranean is a significantly larger stock while the western Atlantic is smaller. Figure 4 shows the scientific division and location of both stocks (Atlantic Bluefin Tuna Stock Assessment, 2007). Difficulties arise because scientists dispute the amount of interbreeding between the two stocks; estimates vary between 3-4% (Bjorndal, 2005) to enough of a portion that the western stock could never recover without a parallel cutback in the eastern stock (Buck, 1995). This causes further problems for the ICCAT; nations who fish the western stock accuse eastern nations of inadequate conservation that directly affects the western stock despite the ICCAT's assessment of separate populations (Bjorndal, 2004).

Figure 4



Source: Atlantic Bluefin Tuna Stock Assessment, 2007

Intranational management of the fishery is further complicated by the UN exclusive economic zone (EEZ) limit. The EEZ is a 200 mile border around each country that affords each nation "sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds. (United Nations)" Because Atlantic bluefin tuna roam across many different countries EEZs, they have traditionally been an open access resource (Bjorndal, 2004). Between the low value of the fish prior to the 1960s and the relatively higher total cost and lower efficiency of fishing methods, overfishing generally didn't occur.

With the introduction of purse seining in the mid 1960s, the average cost to catch any age of Bluefin tuna dropped drastically. Purse seining allows fishermen to catch huge quantities of adult bluefin extremely easily; often, the only difficulty is locating the fish (Iudicello, 1999).

With recent technological innovations like GPS, fish radar, and spotter plains, the average cost to locate fish has continued to drop. Because of this incredible gain in efficiency, the total combined biomass of both Atlantic stocks is currently around 100,000 metric tons, down from approximately 800,000 metric tons in 1975 with an estimated maximum of 1,200,000 metric tons before heavy fishing occurred (Atlantic Bluefin Tuna Stock Assessment, 2007). With the ICCAT in charge of maximizing yield from Atlantic Bluefin tuna stocks since 1966, this dreary picture of stock decline can be attributed to one main factor: the ineffective management stemming from the weak nature of the ICCAT from it's inception until the late 1990s. Petersen's framework illustrates how the institution has changed and evolved in an attempt to combat the hemorrhaging of Atlantic bluefin tuna stocks.

IV. Analysis of ICCAT Policies

The existence and workings of the ICCAT's policies on Atlantic Bluefin tuna can be roughly divided into three distinct phases: first, until 1974, the early ICCAT existed as primarily a research and recommendation body. Not only was the primary function of the ICCAT to research on the biology and population of tuna, most of its recommendations were ignored (Bjorndal, 2004) From 1974 until 1996, the ICCAT attempted to organize and effectively manage the Atlantic Bluefin tuna fishery yet, because of capacity and incentive issues, it was largely ineffective. With the introduction and beginning of a general strengthening of ICCAT policy and implementation in 1996, the ICCAT may finally have the ability to effectively manage the stocks it oversees. Utilizing the Petersen framework to breakdown the pieces of the ICCAT regulation, institutional economics can elucidate which parts failed. In both early stages of the ICCAT, the system for managing bluefin tuna stocks succeeded in some aspects of Petersen's three key points (property rights, entitlement systems, and mechanisms for allocating and adjusting resource entitlements) yet managed to fall drastically falling short in others. On the whole, the Petersen fisheries framework allows the ICCAT's bluefin tuna policies to be analyzed with a focus on efficiency and fish conservation.

In order to understand the current situation with Atlantic Bluefin tuna fishery, it is important to understand the way that the ICCAT works to correct market failures. When it was first formed in 1966, the ICCAT was largely expected to coordinate "a mutual interest in maintaining the populations of tuna and tuna-like fishes found in the Atlantic Ocean (Basic Texts, 2007)." Table 2 shows how the ICCAT has evolved over time—what began as a primarily research-oriented institution with only vague powers of recommendation is in the process of becoming a regulatory body with international strength to prevent the over-harvest of Atlantic Bluefin tuna. In 1966, there was little research on both the biology and the stock levels of Bluefin tuna in the Atlantic. Initially, the ICCAT's duties consisted almost entirely of research coordination. Once this research occurred, the committee would then make recommendations to the community of members of the ICCAT. As late as the 90s in the Eastern stock but ending in the early 80s in the Western stock, members would then take this advice into consideration and set their own quotas. This resulted in the same information issues that single fishermen faced above: individual nations did not know the amount of fishing effort input allocated by other nations, so they simply tried to catch as many fish as possible, without regard for the overall health of the population.

Table 2: Summary of Selected ICCAT Resolutions and Developments

1966	Nations Sign the International Convention for the Conservation of Atlantic Tunas
1969	Parties to the Convention establish the International Commission for the Conservation of Atlantic Tunas (ICCAT) to develop conservation and management recommendations
1974	ICCAT recommends a minimize size and a cap to current fishing entry
1975	US enacts Atlantic Tunas Convention Act: mandates membership in ICCAT
1981	ICCAT accepts two stock management theory, eliminates fishing in some spawning grounds
1991	Sweden proposes listing western and eastern Atlantic Bluefin tuna on Convention of International Trade in Endangered Species (CITES); Sweden later withdraws proposal under pressure from US and Japan
1992	US reduces its own quotas below ICCAT recommended levels
1994	US national research council rejects two stock hypothesis in favor of a single stock with two separate breeding grounds and recommends future stock assessments integrate trans-Atlantic mixing
1995	ICCAT recognizes the need for a recovery plan
1996	ICCAT begins to require import bans on non-member tuna
2000	ICCAT recognizes the prevalence of illegal, unregulated or unreported (IUU) pirate fishing boats
2001	Implementation of Stronger Criteria for Allocation
2006	ICCAT develops a capactity group for the sole purpose of strengthening the ICCAT

Source: Adapted from Buck, 1995

From 1966 until 1981, the ICCAT developed in a number of ways to facilitate a more structured approach to management. If the initial stage of the ICCAT revolved around research, the second stage, beginning with the implementation of total catch size limits and fish size limits in 1974 (Buck, 1995). While these measures were largely ineffective in stopping the eventually stock decline, they represented a significant starting point for the ICCAT to begin to regulate instead of recommend. Catch of small Atlantic Bluefin tuna (age 0 & 1) fell to about 10% of 1974 levels as early as 1977 (SCRS Report, 1980). Using Petersen's framework for fisheries, we can breakdown where the most grievous initial failure occurred. Beginning with the first issue, the ICCAT has, since the beginning, managed the issue of property rights as common property. Even though for almost the first decade of the existence of the ICCAT, tuna stocks weren't managed at all and resource use was open access, the resource was still treated as something owned by nation signatories of the ICCAT collectively (Buck, 1995). In this respect, little has changed since the conception of the ICCAT. The other two factors of Petersen's framework (entitlement systems and mechanisms for adjusting entitlement systems) in the early ICCAT were either entirely absent or barely functioning.

It is important to note that all of the data for sustainable catch levels and thus the mechanism for allocating and adjusting entitlements in the ICCAT centers around the Standing Committee on Research and Statistics (SCRS). Formed along with the rest of the ICCAT in 1966, the SCRS makes recommendations to the legislative procedural section. In economic terms, the purpose of the SCRS is to mitigate or even eliminate the transaction costs resulting from the imperfect information about the amount of Atlantic Bluefin left in the sea. Initially the core of the ICCAT, the SCRS has become increasing peripheral in the issues surrounding and contributing to overfishing today; rather than a simple lack of biological data, the ICCAT currently faces issues with transshipments, pirate fishers, and rogue nations. However, in the early days of the ICCAT, the SCRS existed to "make recommendations designed to maintain the populations of tuna…at levels which will permit the maximum sustainable catch (Basic Texts, 2007)." This, it was hoped, would prevent over-utilization by sharing catch information among member nations and allocating property rights.

Until 1974, the ICCAT was entirely without entitlement systems. While the constitution of the ICCAT warned members to remember "the mutual interest of sound management", it does nothing to prevent the usual issues of fisheries: information asymmetries that result in shirking (Basic Texts, 2007). This kind of problem resulted in the collapse of the eastern North American cod fishery: governments and intra-industry groups simply could not get fishermen to agree on a collective entitlement system (Tietenberg, 2006). The other piece, mechanisms for adjusting entitlement systems, can obviously not function correctly if there are no initial entitlement systems to correct. However, by the middle of the 1970s, the legislative methods of the ICCAT kicked in and the entitlement system was adjusted. It can be argued that this early failure of the ICCAT to correct for the market failures of overfishing is a result of a lag in realization that the fish actually needed to be protected. Because the ICCAT began as a research institution, it merely took time for them to not only realize the need for effective conservation but arrive at a place where they could effectively implement it. Considering these facts, it is impressive that the ICCAT was able to make this transformation so quickly. This successful alteration can largely be attributed to an initial depletion of the Western stock, which forced wealthy, Western nations to directly confront the costs of ABFT overfishing. These relatively powerful and influential nations (The United States and Canada) helped change the ICCAT (Buck, 1995).

In the second phase of the ICCAT development, from 1974 until 1996, the regulatory bodies of the ICCAT exhibit a consistent trend of recommended regulation with ineffectual results. Realizing the need for increased regulation after some alarming reports from fishermen about the state of the fishery, in 1974 the ICCAT began to control both the inputs and outputs of the fishery. As outlined above, the ICCAT began by cutting off further entry into the burgeoning Bluefin market and limiting the size of caught fish (attempting to exclude fish below age 2). In this second era, Petersen's framework illustrates how ICCAT policy has moved to a more efficient yet still lacking model. As before, the ICCAT still utilized a common-property resource usage system to allocate property rights among nations. In this stage of the ICCAT, the piece most strengthened were the entitlement systems—the ICCAT moved toward a complex input-output limitation. These entitlement systems allowed the ICCAT to slow the decline of tuna stocks yet the continued failure of the adjustment mechanisms resulted in a repeated depletion of stocks.

The ICCAT's bluefin tuna entitlement systems are based around a complex system of size, age, time, gear, and entry restrictions (Atlantic Bluefin Tuna Stock Assessment, 2007). In the United States alone, fishermen use purse seines, harpoons, handgear, angling equipment, longline, and trap methods (Massachusetts Division of Marine Fisheries, 2006). Once broken down, there are nested levels of entitlement systems, much like the property rights example above (table 1). Firstly, individual nations have quotas; they are allowed to allocate this quota among any number of gear types. In the United States, for example, the majority of Bluefin tuna is caught by purse seine with minor amounts by longline and handgear and the other types are out of use or used in recreation (Atlantic Bluefin Tuna Stock Assessment, 2007). Most nations choose to favor inefficient methods like long lining over more efficient purse seining; much of this stems from the fact that purse seining damages the fish. Because fishermen must jump into the large purse and kill the fish quickly, these fish often have a lower selling price (Bjorndal, 2005). Indirect price controls exist but almost solely take the form of capitalization subsidies in Europe and in other eastern fishery members.

The second stage of the ICCAT evolved complex rules regarding the adjustment of the entitlement system that, while attempting to build on the strength of the earlier SCRS, in reality pandered too much to the desires of some countries who were more interested in the short term gains from overfishing. Though complicated in procedure, the ICCAT legislative body works in a relatively straightforward manner. The SCRS comes up with an estimate for the scientifically allowed recommended catch (early in the ICCAT, this simply took the form of maximum sustainable yield estimates but recently this has included recovery measures as well) (Basic Texts, 2007). Once this recommendation was presented to the commission, member nations would then discuss and finally allocate their own quotas, taking into “consideration” the SCRS committee recommendation. These member-recommended quotas would then be approved by the commission. As expected, this did little to alleviate the overfishing pressures on the bluefin tuna.

Especially in the early stages, few if any nations attempted to lower their catch significantly and the few that did were primarily located in the smaller, more depleted Western stock (Buck, 1995). This error can be faulted as the primary mishap of the second stage of the ICCAT; because the ability of nations to set their own quotas, there was still no linkage between the marginal private benefit of the fish catch and the marginal social cost of removing the fish from the ocean. This also did little to alleviate the information asymmetries and transaction costs associated with the overuse of fish resources because nations only set a quota at the beginning of the year; statistics and actual catch weren't tallied until much later (Buck, 1995). Finally, there was a strong incentive for nations to ask for higher quotas because they knew that if they approved other member's large quotas, their own would have a much higher chance of being approved.

The noteworthy failure of the methods for allocating and adjusting allocations stands as the sole reason for the failure of the ICCAT to conserve and even maintain Atlantic Bluefin Tuna populations in the 80s and 90s. According to Buck, "between 1990 and 1994, ICCAT and U.S. management regimes were increasingly criticized with science, economics, and politics all being blamed for unsuccessful bluefin management (1995, 1)." However, since this rocky period ended with the notable turning point of import-ban impositions in 1996, the ICCAT has steadily moved towards a working procedure for allocating and adjusting resource entitlements. Each of the policy changes outlined below can be seen as a step toward effective adjustment of fishery resource appropriation: when all member nations listen to the ICCAT and don't shirk by taking more fish than is allotted, the Petersen model can be seen to work effectively and a sustainable fishery is created.

There are several key ways that the ICCAT works to overcome shirking among member nations. In 1996, the ICCAT took a crucial step towards addressing a major incentive issue. Prior to the introduction of import bans, there was little incentive for middle income nations to join the ICCAT; wealthy nations would attempt to conserve fish stocks and allow them to replenish while nations with enough capital to catch tuna but not enough governmental capacity to constrain the fishermen would continue to overfish the tuna (Environmental Justice Foundation, 2006). Since 1996, however, member nations of the ICCAT have been required to prohibit imports of tuna and swordfish from non-member nations. This step has been singularly effective in encouraging nations to join the ICCAT: because high demand for bluefin tuna in Japan and significant demand in the United States as well as Europe, with one stroke the ICCAT cut away price incentives for direct disregard of ICCAT policies. The Environmental Justice Foundation states "in several cases this has proved very effective with the countries in question joining the ICCAT…for example, Panama was sanctioned for imports of bluefin tuna in 1996 and joined the ICCAT in 1998. Sanctioned were lifted in 1999 (2006)." Hailed as one of the most effective and creative developments in fisheries management, these import bans have encouraged legalization and regulation beyond the more traditionally conservationist members.

Following the introduction of import bans in 1996, the ICCAT again upped the ante in 1997 by instituting harsher punishments for members exceeding their quotas. Recommendation 96-14 states that

> "any contracting party exceeds it's catch limit, it's catch limit will be reduced in the next subsequent management period by 100% and the ICCAT may authorize other appropriate actions...if any contracting party exceeds it's catch limit during any two consecutive management periods, the commission will recommend appropriate measures, which may include, but are not limited to reduction in catch limit equal to 125% of the excess harvest, and, if necessary, trade restrictive measures. Any trade measures under this paragraph will be import restrictions on the subject species and consistent with each Party's international obligations. The trade measures will be of such duration and under such conditions as the Commission may determine."

With this second piece of stricter legislation, the ICCAT again increased capacity with the goal being able to set effective mechanisms for adjusting allocations of fishery resources. Providing an incentive (in this case a punishment) to those rogue nations and vessels for cooperating with ICCAT conservation approaches alleviates some of the information asymmetries inherent in fishery management. Rather than having to monitor every vessel on the sea attempting to fish for bluefin tuna, the ICCAT can incentivize for those rogue parties to enter into the existing framework. However, three main problems still threaten effective and efficient conservation: rogue nations, pirate fishing vessels and transshipment.

A significant portion of the failure of the ICCAT in the 90s and 00s was derived from problem nations who ignored or permitted pirate fishing as well as nations who weren't members but fished bluefin tuna extensively, table 3 shows current ICCAT membership. Before the imposition of important bans in 1996, the only strong incentive to join the ICCAT was pressure by Western Europe and The United States. Nations who were not members could still get away with overfishing ABFT and not face any penalties for it. However, with the introductions of import bans in 1996, the lucrative markets for illegally fished ABFT dried up. The flood of countries entering between 1996 and 2006 (22) doubled total membership over the prior 30 years. While some nations continue to fish ABFT outside of ICCAT jurisdiction (notably Greece), the issue of nations abusing the current ICCAT regime has largely disappeared.

Table 3: ICCAT Membership

Founding Members (1966)	**Additional Members**	**Additional Members (Cont.)**
Argentina	Brazil (1969)	Algeria (2001)
Brazil	Maroc (1969)	Mexico (2002)
Canada	Angola (1976)	Vanatu (2002)
Cuba	Gabon (1977)	Iceland (2002)
Republic of Congo	Cap-Vert (1979)	Turkey (2003)*
France	Equatorial Guinea (1987)	Philippines (2004)
Japan	Libya (1995)	Norway (2004)
Portugal	China (1996)	Nicaragua (2004)
Republic of Korea	Croatia (1997)	Guatemala (2004)
Republic of South Africa	European Union (1997)	Senegal (2004)
Senegal	Tunisia (1997)	Belize (2005)*
Spain	Panama (1998)*	Syria (2005)
USSR	Trinidad and Tobago (1999)	St Vincent & The Grenadines (2005)

USA	Namibia (1999)	Nigeria (2007)
Uruguay	Barbados (2000)	Egypt (2007)*
Venezuela	Honduras (2001)	

Source: www.iccat.es/contracting.htm *denotes problem member

Another continual problem with the ICCAT mechanism implementation is illegal, unreported and unregulated pirate fishing (IUU). According to the Environmental justice foundation “two factors make tuna prime targets for illegal fishing: their high value on international markets, and the fact that they are caught in the open ocean, in areas remote from fisheries surveillance. (2007)” IUU fishing boats take advantage of the information asymmetries inherent in open ocean fisheries and the transaction costs involved in monitoring fishing vessels. Tied into the IUU fishing problem is the issue of transshipment. To disguise their status as IUU vessels or vessels affiliated with nations facing import bans, vessels often meet ships with correct credentials at sea to transfer caught fish (EJF, 2006). Because this system allows pirate fishing boats to effectively integrate with the global tuna markets, it has the potential to seriously undermine conservation efforts.

While the number of boats on the ICCAT’s IUU black list has dropped from 400 to ten known vessels, IUU fishing is still a significant problem (EJF, 2006). As of November 2007, however the ICCAT passed a resolution to tag every catch of ABFT not only physically but also with a standardized radio contact with governing ICCAT bodies. The Vessel Monitoring System (VMS) implemented in Recommendation 07-08 requires all fishing activity is directly reported to ICCAT officials. This system attempts to solve the information asymmetries and mitigate the costs of monitoring or patrolling for pirate fishing vessels. The model $IV = NB + TC_s + TC_d$ can be used to understand these increased transaction costs. Assuming there is a net benefit to adopting stricter vessel monitoring, this system will be efficient if the costs of implementing and maintaining this system don’t overwhelm the gains from it. For example, if the VMS encourages more vessels to become IUU pirate boats because of the difficulty of dealing with ICCAT officials after every catch, then the value of it is below zero. However, because the value of leaving fish to spawn in the ocean is so high (because so few remain), it is likely that any change that reduces fish mortality will be a net benefit to the fishery.

V. Conclusion

The most recent phase of the ICCAT has apparently finally implemented effective mechanisms for adjustment and allocations. With the introduction of import bans, effective curtailment of IUU fishing vessels and transshipment, the ICCAT may finally have contained fishing effort to a sustainable level. It took from the beginning of fishing management of Atlantic Bluefin Tuna in 1966 until forty years later to effectively implement the institution necessary to control fishing of these migratory, valuable fish. Even now, there is no sure guarantee that bluefin stocks will stop declining: IUU fishing boats may find new ways around the VMS or a myriad of other catastrophes could occur. Sadly, however, the bluefin tuna itself will likely never recover. Down from an estimated peak of 1,200,000 metric tons of biomass in the early 1960s, currently about 8% of that remain in the Atlantic—mostly in the form of juvenile fish who simply aren’t as efficient at feeding or breeding (H. John Heinz III Center, 2000). Without recovery to optimal stock levels of 500,000-800,000 tons, not only does the fishery stand to forgo significant economic rents, the fish stock itself has a high chance of collapsing (Bjorndal, 2004). Biometric studies estimate that it would take upwards of a ten year moratorium on ABFT harvesting to restore stocks to maximum sustainable yield levels (Pintassilgo, 2002). There is a very high chance this will never happen. The extreme value of adult bluefin tuna on Japanese sushi markets is simply too high of an incentive.

The only possibility for a true recovery lies in the wealth of Western nations with a desire to restore ABFT levels to maximum sustainable yield. If the United States, Canada, Japan, and the European Union banded together to purchase boats dedicated to bluefin fishing as well as purchasing the stakes of less developed nations with technological or other aid, it could be possible to halt bluefin fishing entirely—especially if the above nations refuse to import any kind of bluefin tuna. If the incredible amount of money involved in bluefin tuna fishing is the primary drive behind overfishing, there is a way wealthy western nations can “buy out” poor countries and illegal fishermen.

Development assistance could persuade problem nations to keep a stricter watch on vessels suspected of pirate fishing. Admittedly, the transaction costs of implementing such a system would be high, but the economic value alone of allowing the fishery to recover would be in excess of $845,000,000 per year harvest after the moratorium expired (Bjorndal, 2004). Allowing the Atlantic Bluefin tuna to recover would increase incomes across the board for poorer fishermen from industrializing countries that do most of the fishing of bluefin tuna in the Atlantic. This scenario could only work, however, if local and international governments and organizations work together to give these workers other options for employment and remain vigilant on fishing tuna breeding grounds. Ultimately, it would hinge on wealthy nations refusing to import Bluefin tuna. If the rich Japanese, United States, and European markets disappear, so will many of the overfishing problems.

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