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MANAGING BLUEFIN TUNA IN THE MEDITERRANEAN SEA

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Abstract

In order to provide information to improve the stock conservation and sustainability of Atlantic Bluefin Tuna (Thunnus thynnus), this paper provides a background review to the bluefin tuna (BFT) fisheries and management regime in the Mediterranean Sea, and analyzes why it has failed. We find that: 1) the spawning stock biomass of BFT has decreased by 60% in quantity since 1974; 2) the total BFT catch per year in the Mediterranean Sea is about 24,000 t in recent years, however, illegal, unreported and unregulated fishing in the same area could be as high as 47,800 t; and 3) the total landed value for Mediterranean BFT is estimated to be about 227 million USD a year, which results in 29 million USD of resource rent. It is also estimated that about 3,500 full-time fishing jobs are supported by BFT stock. Many factors prevent the successful management of BFT. Among them, the common-property and shared stock nature of the fishery, the existence of non-ICCAT (The International Commission for the Conservation of Atlantic Tunas) members, and EU fishery subsidies. In order to address these issues, we suggest strengthening ICCAT institutions by developing effective cooperative mechanisms, introducing enforceable penalty regimes and establishing effective reporting and monitoring systems. In addition, ICCAT needs to seek ways to manage non-ICCAT members and convince the EU to reduce their fisheries subsidies for BFT fattening farms and vessel modernization. We also recommend the implementation of Marine Protected Areas to support regional management, and suggest that individual countries use individual transferable quotas or dedicated access privileges (where appropriate), and also resource optimization to improve their domestic management.

ملخص

يقدم هذا الفصل نظرة عامة عن مصايد سمك تونة البلوفين في البحر الأبيض المتوسط (أو سمكة التونة ذات الزعانف الزرقاء واسمها العلمي ("Thune thynnu" ونظام إدارة هذه المصايد وتحليل أسباب فشل هذه الإدارة وذلك بغرض توفير المعلومات التي تساهم في تحسين الحفاظ على مخزون هذا النوع من سمك التونة واستدامة الاستفادة منه. وقد توصلنا إلى مجموعة من النتائج كالتالي:(1) انخفضت الكتلة الحيوية لمخزون بيض سمك تونة البلوفين بنسبة 60% عن الكمية المقدرة في عام 1974، (2) تبلغ الكمية الإجمالية التي تم صيدها من سمك تونة البلوفين من البحر الأبيض المتوسط في العام نحو 24,000 طن في السنوات الأخيرة، ولكن كمية السمك التي لم ترد في التقارير الرسمية وتم صيدها بطرق غير شرعية وغير منتظمة تبلغ 47,800 طن سنويا،(3) تقدر القيمة الإجمالية لمساحة البحر الأبيض المتوسط التي تنتج سمك تونة البلوفين بحوالي 227 مليون دولار أمريكي في العام، ويقدر صافي دخل الموارد لهذه المساحة بحوالي 29 مليون دولار أمريكي. وتقدر عدد فرص العمل كاملة الوقت التي توفرها عمليات صيد سمك تونة البلوفين حوالي 3,500 فرصة عمل. وهناك الكثير من العوامل التي تحول دون نجاح إدارة مصايد سمك تونة البلوفين. من هذه العوامل: أن مصايد السمك تتميز بأنها ملكية عامة ويشترك في الاستفادة من مخزون السمك كثير من الأطراف؛ كما أن هناك كثير من الدول ليست أعضاء في اللجنة الدولية للحفاظ على سمك التونة في المحيط الأطلنطي(ICCAT) ؛ والإعانات المقدمة لمصايد الأسماك في الاتحاد الأوروبي كلها من أهم هذه العوامل . ويعرض هذا الفصل بعض المقترحات من أجل معالجة هذه القضايا، وتتضمن هذه المقترحات: تدعيم المؤسسات التابعة للجنة الدولية للحفاظ على سمك التونة في المحيط الأطلنطي من خلال تطوير آليات تعاونية فعالة، واستحداث أنظمة عقوبات قابلة للتطبيق وإنشاء أنظمة فعالة للمراقبة والرصد. وبالإضافة إلى ذلك، فان اللجنة الدولية للحفاظ على سمك التونة في المحيط الأطلنطي تحتاج للبحث عن سبل لإدارة مصايد السمك في الدول غير الأعضاء في اللجنة، كما تحتاج أيضا لإقناع الاتحاد الأوروبي بأن يقلل دعم مصايد الأسماك الذي يقدمه لمزارع تربية سمك تونة البلوفين وتحديث سفن الصيد. كما توصي المقترحات بتفعيل نظام المحميات البحرية وذلك لدعم نظم الإدارة الإقليمية لمصايد السمك، وتوصي أيضا الدول غير الأعضاء في أي تجمعات أو تحالفات باعتماد نظام الحصص الفردية القابلة للتحويل أو امتيازات الدخول لمناطق الصيد (عند اللزوم) والاستخدام الأمثل للموارد لتحسين نظم الإدارة الداخلية لمصايد الأسماك في تلك الدول.

Introduction

Following a general global pattern (e.g., Pauly et al. 2002; Worm et al. 2009), the Atlantic Bluefin Tuna (BFT; Thunnus thynnus) is at risk of depletion, prompting many to call for drastic and immediate action to turn the tide. Some of these drastic actions include a complete shut-down of the fishery, listing BFT on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and cutting the current annual catch quotas by more than half.

The primary reason for the current state of this stock is its common property and shared stock status, which together can easily drive exploiters of a given natural resource into undermining themselves by engaging in non-cooperative behavior (Munro, 1979), which in turn results in the 'tragedy of the commons' (Hardin, 1968).

To deal with the common property and shared stock problem, the International Commission for the Conservation of Atlantic Tunas (ICCAT) was established in 1969 to manage the exploitation of BFT in the Mediterranean Sea. Unfortunately, ICCAT has consistently set BFT catch quotas above the levels recommended by its scientists since 1995 (ICCAT 1993, 1994, 1995, 1996, 2008b). Thus, the organization has been harshly criticized for its failure to manage BFT sustainably (MSBN, 2004; BBC NEWS, 2007 and Renton, 2008). In order to improve stock conservation and sustainability of this important fish stock, this paper provides a background review to the BFT fisheries and management regime in the Mediterranean Sea, analyzes why management has failed, and then propose policy changes to address this failure.

2. The Fisheries

The Atlantic BFT, native to both West and East Atlantic Ocean, can naturally be divided into two groups: West[1] and East Atlantic BFT. These two BFT stocks differ not only in the location of their geographic habitat but also in their life history. Because BFT is highly migratory and has a long life span of up to 30 years, there could be some stock mixing. In terms of fisheries, the east Atlantic and Mediterranean Sea are the two major fishing areas that depend on the east Atlantic BFT stock. In this section, we will focus on BFT fisheries in the Mediterranean Sea.

The BFT fisheries in the Mediterranean Sea started in the 7th Millennium BC (Desse and Desse-Berset, 1994). The popularity of Japanese sushi and sashimi worldwide during the 1980s made the BFT much more economically attractive than before (Fromentin and Ravier, 2005; Porch, 2005). For example, a single BFT was auctioned in the Tokyo market for USD 174,000 in 2001. Consequently, vessel capacity, vessel power and new storage innovations, as well as BFT catches, experienced tremendous increases in the 1980s and 1990s, which imposed severe pressure on the BFT stock.

2.1 Bluefin Tuna Fisheries and Stock Status

Figure 1 illustrates the BFT historic catch by gear type in the Mediterranean Sea from 1950 to 2005. This figure shows that from the 1950s to the early 1970s, total catches were stable at around 5,000 to 8,000 t per year. Starting from the early 1970s, large changes were observed in this area. Specifically, the catch peaked in the mid-1970s, followed by an unusual drop in the early 1980s. From then on to the mid-1990s, the catches steadily increased from 9,000 to 40,000 t per year. After that, there was a substantial decrease to 24,000 t per year in the most recent decade. However, this drop is regarded by the ICCAT SCRS (Standing Committee on Research and Statistics) as due to underreporting instead of official catch reductions (ICCAT, 2008b).

[1] West Atlantic BFT breeds mostly in the Gulf of Mexico (Clay, 1991).

Figure 1 also shows some interesting patterns in the catch by gear type. The bait boat fishery, which mostly catches juvenile fish, contributes very little to the total catch. The long line catch peaked in the mid-1990s along with the purse seines catch. The trap catches have consistently declined over time and have now totally disappeared. In contrast, catches from the purse seiners has been consistently increasing over time, which makes purse seines the major gear used in catching BFT in the Mediterranean Sea.

ICCAT SCRS believes that this unusually high increase in purse seine catches is related to the growth of BFT fattening farms, since the purse seine is the best gear type for ensuring the capture and transfer of live tuna. It is estimated that only 200 t of Mediterranean BFT were 'consumed' in farms in 1997, while between 20,000 to 25,000 t were fattened in farms every year since 2003 (ICCAT, 2008b). In fact, as a consequence of the huge expansion of purse seine fleets, no spawning refuge seems to exist for BFT in the Mediterranean Sea anymore because almost every inch of the sea is now covered by fishing effort (ICCAT, 2008b).

Figure 2 displays the catch at age pattern in the Mediterranean Sea from 1955 to 2006. The catch of age 0 BFT has decreased since the 1960s and it is almost nonexistent today. The catch of other age groups have all increased in weight in 2006 compared to 1950. Relatively, the total weight share of aged-10 group in 1950 is larger than that in 2006, which more or less reveals that the current stock structure in fish numbers has changed a lot compared to what it was a few decades back.

Increasing BFT catches have led to rapid stock declines over years. According to the stock assessment analyses reported by ICCAT, the decline of spawning stock biomass (SSB), one of the most important indicators of stock abundance and health, is evident from analyses on catch data. Figure 3 shows the estimated SSB from 1970 to 2005. In this figure, two model predictions are presented, based on reported and adjusted catch data, respectively. The adjusted catch data takes illegal, unreported and unregulated catch into account. Both of these two model-runs show that, except for a slight increase in the period from 1970 to 1974, SSB has declined persistently and current SSB is estimated to be only 40% of its peak in 1974, which is not a good sign.

2.2 Illegal, Unreported and Unregulated fishing

Illegal, Unreported and Unregulated (IUU) fishing is widely recognized as one of the biggest concerns on BFT management in the Mediterranean Sea and other Atlantic Ocean areas. WWF (2006) found huge gaps between national reports on BFT trade and catch reports to ICCAT, indicating that a large amount of IUU fishing takes place in the region. The cited study estimated that the total BFT catches in the East Atlantic and the Mediterranean Sea were approximately 45,000 t in both 2004 and 2005, which were 40% above the total annual catch (TAC) of 32,000 t set by ICCAT. If the catches by national fleets in Spain, France, and Italy for domestic markets were also included, the total catches could be well above 50,000 t per year. The same study determined that EU (mostly French) and Libyan fleets are largely responsible for most of the IUU catches (WWF, 2006).

ICCAT is also fully aware of this IUU problem. In 2006, based on the number of vessels operating in the Mediterranean Sea and their catch rates, ICCAT estimated total catches to be close to 43,000 t in the Mediterranean Sea in the early 2000s. In 2008, a new evaluation by ICCAT suggested a 2007 total catch of 47,800 t for the Mediterranean Sea and 13,200 t for the East Atlantic. These numbers were estimated from ICCAT's list of BFT vessels, catch rates and stock information. This new evaluation indicates a total catch of 61,000 t for the east Atlantic BFT stock, which is higher than WWF's estimate. These IUU estimates by ICCAT are also supported by the mismatch between reported data and various market sales data (ICCAT, 2008b).

2.3 BFT Farming

After BFT is caught wild and alive with purse seines, farms are used to fatten them in floating cages for periods from a few months up to 1–2 years. WWF (2004) estimated that about 21,000 t of wild-caught tuna were put into BFT farm cages in the Mediterranean Sea in 2003, which was around 66% of the declared TAC. In fact, the detailed farming data are pretty scarce, only few countries' figures are available. According to WWF (2004), 975 t, 1180 t, 3980 t and 1400 t of wild-caught BFT were put into farms in Croatia, Spain, Italy and Turkey, respectively in 2002.

It is important to note that current BFT farming is different from traditional farming, i.e., aquaculture with a complete production chain from hatcheries to feeding and harvests. BFT farming only fattens wild BFT. Since BFT is highly migratory and requires different environmental conditions in its different life stages, it would be difficult to have a complete farming chain for BFT (Susannah, 2008). Some scientists estimate that at least 10 years are needed to get BFT to breed via land-based hatcheries. However, many scientists are skeptical of this due to the complex nature of BFT behavior and life history (Susannah, 2008). Current BFT fattening is expected to help solve the overfishing problem, but in fact the impact of BFT farming on stock abundance is not very clear and could be negative. This is because since BFT can be fattened in a farm, the fishing effort targets juvenile BFT, which could deepen the decline of the stock. The other concern arising from BFT farming is that highly dense farms, which are common, might also have undesirable environmental impacts, one from leftover of bait, which has a negative impact on tourism, and the other from tuna processing without disposing waste (Miyake et al., 2003). Further, the use of chemicals and medicines (e.g. hormones, antibiotics) in the baits is a concern for food safety and quality, which is faced by all other aquaculture industries.

3. Economic Benefits of Bluefin Tuna in the MENA and Non-MENA Regions

BFT is considered a "culture-specific" product because most of the world's consumption occurs in Japan with over 45 countries competing to supply its market (Carroll et al., 2001). The Mediterranean region is one of the major exporters of BFT to Japan. In this section, we estimate the key economic variables related to BFT stocks in the Mediterranean Sea, including the total landed values, the total fishing costs, the resource rent, jobs supported by the fishery and added values through the BFT fish value chain.

3.1 Total Landed Value (Total Revenue)

In order to calculate the total landed value, we need to know BFT catches and ex-vessel prices. Table 1 shows gear specific price data for the Atlantic BFT obtained from NMFS (2010). The ex-vessel BFT price for longline or trap is around 10.67 USD/kg, while catch by purse seine is sold at 9.44 USD/kg.

Using gear specific prices and gear specific catch data from ICCAT (2008b), we compute the total BFT landed values for countries targeting Tuna in the Mediterranean Sea, which are presented in Table 2.

Table 2 shows that around 49.9 million USD of landed BFT value is captured by the countries in the MENA region and 176.9 million USD by non-MENA region countries in 2006. Tunisia records the highest landed value among MENA region countries while France captures the highest landed value among all countries.

3.2 Total Costs of BFT Fishing

Corresponding to landing values are fishing costs. BFT fishing costs have two components: variable and fixed costs. Furthermore, variable costs include fuel, repair, other operation costs and labor costs. Fixed costs are composed of depreciation costs, payment to capital and other

fixed costs. Here, we use purse seine fishing cost and revenue data from Concerted Action (2005, 2008) to compute the percentage of total fishing costs relative to revenue.[2] Then we assume this percentage holds for BFT in the Mediterranean Sea and estimate the BFT fishing costs. According to Concerted Action (2005, 2008), the fishing costs relative to revenue percentages are 99.6% for Spain, 87.6% for France, 73.7% for Italy, 96.6% for Portugal, 99.8% for Korea Republic and 85.0% for Taiwan. For countries where data is missing, we use the average figure for the Mediterranean area, which is 90.4%. The costs estimated for each country, presented in Table 2, show that Tunisia has the highest total fishing costs in the MENA region and France has the highest in the non-MENA region.

3.3 Resource Rent

Resource rent is defined here as the landed value (gross revenue) minus fishing costs. The estimated economic rent for each country is also presented in Table 2. The total resource rent is estimated to be about 4.8 million USD for the MENA region (9.6% of the landed value) and 24.4 million USD for the non-MENA region (13.8% of the landed value) in 2006. Thus, the non-MENA resource rent is about 5 times the rent accruing to the MENA countries. Tunisia and Italy are the two countries with the highest resource rent, among the MENA region, and all the countries, respectively. In this table, we also report the unit resource rent and find that Morocco and Italy have the highest figures in the MENA and the non-MENA regions, respectively.

3.4 Fishing Jobs Supported

BFT fisheries provide job opportunities. In this section, we calculate approximate fishing job numbers directly related to BFT fisheries in the Mediterranean Sea. The approximation method we use and the results obtained are all shown in Table 3.

The column 'BFT proportion to national catch' in Table 3 describes the proportion of BFT catch relative to the total national catch including all fisheries. The total catch data are obtained from FAO and Sea Around Us http://www.seaaroundus.org/. 'National fishery employment' column presents the data of national direct employment for fisheries in each country, which is a compilation of data from the FAO and the ILO (obtained from Teh and Sumaila). We approximate the employment of BFT fisheries by multiplying the BFT proportion to national catch by the national fishery employment. The results suggest that about 3,500 full-time equivalent jobs were provided by Mediterranean BFT in 2006, in which, about 1,714 are in the MENA region and 1,786 are in the non-MENA region. Note that the figure calculated here is just a rough approximation and needs further research. In addition, IUU fishing is rampant in this area, so these numbers could be much higher if IUU catches are taken into account.

3.5 Multiplier Effects

Landed values alone do not measure the importance of the fishery sector fully since there are many other economic activities that directly or indirectly occur because of fisheries, for example, boat building, fish storage and transportation, marketing, etc. These activities could not exist without the basic raw material, i.e., the fish catch. Thus, these activities are linked to fisheries, and are also supported by ocean fish populations. We use multiplier effects here to measure the total economic impacts of BFT resources and emphasize the importance of BFT fisheries (Dyck and Sumaila, 2010; Pontecorvo et al., 1980). The multiplier is defined here as the economic impact of fisheries throughout the fish value chain. Dyck and Sumaila (2010) applied an input-output approach to estimate the multiplier effects induced by fisheries for

[2] Since 86.5% of the catch was caught with purse seine in 2006, it is reasonable to use only purse seine fishing costs.

each country in the world. The economic multipliers for the relevant countries reported in Dyck and Sumaila (2010) are listed in Table 4.

As illustrated in this table, Portugal has the highest economic multiplier, which is over 4, and Cyprus has the lowest. The differences in multipliers can be partly explained by differences in capital investment (non-powered boats vs. large vessels), labor costs or chain length. In total, the induced economic value by fisheries is about 71 million USD in the MENA region and 564 million USD in the non-MENA region. The total economic impact due to BFT in the Mediterranean Sea for 2006 is estimated at about 635 million USD, which is about 2.8 times the total landed value in this area.

4. Institutional Setting

4.1 International Commission for the Conservation of Atlantic Tunas (ICCAT)

ICCAT was created to manage more than 30 Atlantic tuna and tuna-like species in the Atlantic Ocean and adjacent seas, including the Mediterranean BFT. The Commission, composed of 48 Contracting Parties (countries/political entities),[3] is a Regional Fisheries Management Organization (RFMO) responsible for combining a wide array of scientific and socio-economic information into setting TAC of Atlantic tuna species. The quota set by ICCAT is then split among member countries who are individually responsible, but not obliged, to manage their fleet in accordance with the annual total allowable catch (TAC).

The commission holds a regular meeting once every two years, while special meetings can be called at any time at the request of members or the commission's council. If not otherwise stated, decisions made by the commission have to be accepted by the majority of the Contracting Parties (CPs), who each have one vote. Regular and special meetings are the standard procedures for carrying out negotiations among CPs.

ICCAT is also responsible for collecting and analyzing statistical information and making recommendations. Depending on their responsibilities, ICCAT has the following committees:

1) Standing Committee on Research and Statistics (SCRS): Develops recommendations for ICCAT on fisheries statistics related issues and ensures that the most updated information is available to ICCAT, including information on biology, ecosystems and fisheries.

2) Species Panels: Responsible for reviewing the status of geographic-specific species and propose joint actions by the contracting members.

3) Conservation and Management Measures Compliance Committee: Reviews compliance with ICCAT conservation and management measures.

4) Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG): Collects and reviews information on fisheries of non-Contracting Parties (NCPs).

Composed of scientists from Contracting Parties & Cooperating non-Contracting Parties, Entity and Fishing Entity (CPCs), these four committees are responsible for reporting their findings and recommendations to ICCAT.

4.1.1 Determination of total allowable catch by ICCAT

ICCAT is responsible for setting the total annual catch (TAC) based on scientific evidence. Stock assessment analyses are performed by ICCAT SCRS, who is responsible for providing scientific advice to ICCAT on the TAC and quota allocation among member countries.

[3] The 48 contracting parties as of 2010 are the United States, Japan, South Africa, Ghana, Canada, France, Brazil, Morocco, Republic of Korea, Cote d'Ivoire, Angola, Russia, Gabon, Cap-Vert, Uruguay, Sao Tome and Principe, Venezuela, Guinea Equatorial, Guinea Rep, the United Kingdom, Libya, China, Croatia, European Union, Tunisia, Panama, Trinidad & Tobago, Namibia, Barbados, Honduras, Algeria, Mexico, Vanuatu, Iceland, Turkey, Philippines, Norway, Nicaragua, Guatemala, Senegal, Belize, Syria, St. Vincent & the Grenadines, Nigeria, Egypt, Albania, Sierra Leone and Mauritania.

However, ICCAT has traditionally set much higher TACs than what is recommended by this Committee.

The comparison between scientifically recommended TAC and actual TAC set by ICCAT is given in Table 5, which shows a disregard for scientific advice and therefore the future health and sustainability of BFT stocks. For the year 2010, scientists estimate that even with a quota of 8,000 t per year, BFT stocks have about a 50% chance of rebuilding by the year 2023, yet the TAC set by ICCAT was nearly 70% above scientific recommendations (ICCAT, 2010).

4.1.2 Allocation of quota among countries

After setting the TAC, ICCAT allocates shares of the annual TAC to its Contracting Parties. How the shares are divided has undergone changes in two different periods. From 1983–1991, ICCAT allocated the TAC among countries mainly according to their historical catches. In addition, stock spatial status (spatial distribution of stock), proximity to coastal states and small and developing countries have also been taken into consideration (Grafton et al., 2006). However, CPs without large historical catches argued for changes in the allocation formula in the 1990s and succeeded in getting ICCAT to increase their share in 2001 (Grafton et al., 2006). The allocated quota is transferrable among member countries, though transfers have to be made with the approval of ICCAT.

Table 6 shows the BFT quotas allocated to different countries/groups on the East Atlantic BFT stock. The quotas remained almost constant from 2003 to 2006. Among non-EC (European Community) countries, Morocco received the highest quota, and Japan held the second highest quota.

Furthermore, Table 7 shows the allocation among EU countries, but only for 2004 and 2005. Three countries, Spain, France and Italy received about 55% of the TAC in the East Atlantic and the Mediterranean Sea in 2004 and 2005.

4.1.3 Compliance enforcement

In order to help carry out the objectives of ICCAT, CPCs shall collect scientific data and report to SCRS by July 31 of each year. Submitted data is required in two types: annual catch by gear, region and flag (Task I), and catch and fishing effort statistics for each species by defined small area (Task II). Since no penalty is associated with this data reporting, usually partial, late or no data are submitted. In addition to scientific data, a Statistical Documentation Program (SDP) was established in 1994, for Atlantic BFT, to collect multilateral trade information. A local observer program may exist, depending on CPCs' domestic policies, while there is currently no regional observer program.

CPCs (Contracting Parties & Cooperating non-Contracting Parties, Entity and Fishing Entity) are obliged to establish a high seas international enforcement system. Until now, there is no at-sea boarding or inspection. However, a Port Inspection Scheme was established in 1997 to inspect both flag and non-flag state vessels during off-loading and transshipment in ports. Consequently, a list of vessels believed to be engaging in IUU fishing was published in 1999. In contrast, according to ICCAT 1998 and 2000 recommendations, a list of authorized fishing vessels was established in 2002.

CPCs are also responsible for enforcing compliance through domestic policies. Records of non-compliance will be considered by the ICCAT Compliance Committee and trade restrictions or revoking of vessel registration may follow. For NCPs, PWG is responsible for overseeing and collecting their information.

4.2 Domestic BFT Management

Although much of the focus of tuna management in the Mediterranean Sea is on the actions of ICCAT, its yearly TAC is only a recommendation, with implementation left to the

individual member states. Currently, we are not aware of any ICCAT members that manage their share of the TAC using tradable permits or Individual Transferable Quotas (ITQs) in the Mediterranean Sea. It appears that the majority of ICCAT members fishing in this area use licensing systems to manage their fisheries.

While there are attempts at effort control by several nations,[4] lack of effective management at the national level is likely a reason behind the dramatic decline of BFT stock in the Mediterranean. In 2007, three countries, Italy, Spain and France, landed more than 17,800 t over their quota of BFT (Bregazzi, 2007). Additionally, it is estimated that Italy, Spain and Libya, were responsible for under-reporting their catches of BFT by more than 16,000 t in 2007 (Bregazzi, 2007).

5. Why Has the Current Institutional Framework Failed?

5.1 Shared Fish Stock

There is a general consensus that common shared fish stocks are difficult to manage (Munro, 1998; Munro et al., 2004; Payne et al., 2004). Shared fish stocks include transboundary fish resources, which are found in more than one Exclusive Economic Zone (EEZ) of countries, highly migratory species in multiple EEZs or high seas, or fish in the high seas (Munro et al., 2004). Since targeting commonly shared fish stocks usually leads to inevitable externalities, i.e., fishing by one country influences the stock and thus fishing in the other countries, management of shared fish stocks require countries to cooperate, which is very difficult to achieve. To solve this problem, game theory is often applied to examine the cooperative incentives among different entities and then find win-win solutions (Sumaila, 1999). However, since the benefits of cooperation are always highly uncertain, it is extremely challenging to reach agreements in practice.

BFT is a typical shared fish stock since it is highly migratory, crossing multiple EEZs and the high seas. Therefore, it shares all the challenges of managing shared fish stocks, which by nature raises the management difficulty to a level that needs a very high level of cooperation and enforcement. Not surprisingly, the current ICCAT regime, with low monitoring and loose enforcement, cannot succeed in preventing BFT from collapsing without significant improvement.

5.2 Conflicts between Members and Non-Members

Fishing BFT by non-ICCAT members forms another big barrier to the successful management of ICCAT. According to Miyake (1992), significant amounts of catches are made by non-ICCAT countries. Officials from Japan Fisheries Agency pointed out that catches by non-member countries may be more than 80% of those by member countries (Miyake, 1992). An increasing number of boats have been reported flying flags of non-member countries to avoid regulation. This large proportion of catches taken by the non-ICCAT countries serves as a significant barrier for member countries to conform to the ICCAT quota system. This barrier, together with the highly shared nature of BFT, results in lots of IUU catches occurring in the Mediterranean Sea.

5.3 Subsidies

Overfishing of BFT is also exacerbated by government subsidies, which are financial transfers from the public sector to the private sector (Sumaila et al., 2010). Subsidies in the Mediterranean BFT fisheries can be divided into two connected groups: subsidies for fleet

[4] Spain has a system of licensing that limits vessel power and gear usage (Garza-Gil et al. 1996), Syria licenses vessels based on approval by the fisheries department, and Turkey has a strict vessel and licensing system. There is some evidence that many other Mediterranean countries have licensing based effort controls but we have found little official documentation.

modernization, and subsidies to BFT farms. In the following, we will describe the current situation of these two types of subsidies.

We have observed a tremendous expansion of BFT and other tuna farming in the Mediterranean Sea recently. However, it is reported that, in Spain, the market price for farmed tuna, by the end of 2003, was well below the production cost of Spanish tuna fattening farms (WWF, 2004). It is believed that EU subsidies are the main underlying reason for the expansion (WWF, 2004).

EU companies get subsidies mainly through the Financial Instrument for Fisheries Guidance (FIFG), which aims for "fleet renewal and modernization of fishing vessels", "aquaculture development", "processing and marketing of fishery products" and others.[5] FIFG helps to build and modernize purse seine fleets and plays an important role in the Mediterranean tuna fattening expansion. Besides FIFG subsidies, matching funds from national and regional administrations are usually available depending on domestic policies. WWF (2004) roughly estimated that at least 19 to 20 million € of EU public funding has contributed to tuna farm expansions. These subsidies covered up to 75% of the fleet and farm investment cost (EC, 2001). In Spain alone, this subsidy amounted to 6 million €. Although the total subsidy value for fleet modernization is unclear, available evidence shows that huge amounts of public funding have been involved. For example, 40 powerful high-tech purse seine vessels in France were known to have been modernized with subsidies (WWF, 2004). These subsidies directly encourage overfishing in the Mediterranean Sea, which is another important reason why the current institutional framework fails. Unfortunately, ICCAT has failed to address this issue.

6. Policy Recommendations

Based on our understanding of the barriers to effectively managing the tuna stocks of the Mediterranean Sea sustainably, we highlight alternative policy schemes and provide recommendations for the way forward, to ensure the sustainable use of BFT in the Mediterranean Sea for the benefit of the peoples of the MENA and non-MENA regions alike.

6.1 Institutional Improvement in ICCAT

6.1.1 Increase cooperation and reduce TAC

It is clear from the data analyses that ICCAT needs to substantially reduce the current TAC by following scientific advice. A U.S. National Marine Fisheries Service's study showed that if ICCAT had not raised the TAC from 1,160 to 2,660 t in 1983, the adult population would have been 3.4 times what it was in the early 1990s (Powers, 1992).

In order to reduce the TAC, a higher level of cooperation needs to be established among BFT fishing countries/entities. It is expected that the reduction of TAC can be beneficial for all the participants if they cooperate in the management and conservation of BFT. More research should be carried out to determine the economic benefits of multilateral cooperation among participants and discover acceptable compensation mechanisms. For example, if the TAC is heavily reduced, small-scale coastal fisheries may lose profits in some countries while large-scale fisheries may benefit in other countries. In this case, ICCAT can set up platforms for contracting members to negotiate with each other and reach agreements with countries that benefit most compensating the countries that suffer losses. ICCAT also needs to make its members aware of how large the potential benefits from cooperation are and thereby motivate them to cooperate. A mutual compensation fund can be established to enable such cooperation among countries. This fund can help cover some of the costs of an effective inspection program proposed below.

[5] See http://ec.europa.eu/regional_policy/funds/prord/prords/prdsd_en.htm for more information.

6.1.2 At-sea inspection and alternating scrutiny system

A functioning and effective Reporting and Monitoring (R&M) system is pivotal to the success of compliance enforcement. Thus, ICCAT needs to establish a much more strict R&M system. Currently there is only port boarding and inspection. We recommend that, at the international level, an at-sea boarding or inspection program should be established by ICCAT. In addition, local ICCAT member countries could develop an alternating peer scrutiny system, i.e., if there are three countries: A, B, C; then A could inspect B, B inspects C and C inspects A. This design can avoid co-deviation: if A gets to scrutinize B and B securitizes A, they might have the incentives to collaborate and underreport each other's catches.

6.1.3 Penalty regime

The reason why ICCAT cannot succeed in combating IUU fishing is that it lacks an effective detection and penalty system (Sumaila et al., 2010). Since there is no penalty for overfishing, the economic incentives for reducing catches are almost zero. We recommend that ICCAT establish and enforce a penalty system. When an IUU event is found, penalties have to be paid by the country responsible for this IUU fishing. The funds raised from this penalty program can be used for stock rebuilding, research and for covering R&M costs.

6.1.4 Seeking legal rights to manage non-ICCAT entities

Currently, ICCAT has no mandate to manage non-ICCAT entities, which not only adds a significant amount of catches to the total catch, but also imposes negative externalities on the ICCAT members. Furthermore, entities do not have economic incentives to become ICCAT members since non-ICCAT entities are free from any restrictions. Thus, we recommend that ICCAT seek legal rights to manage non-ICCAT entities. For example, political pressures in the United Nations or trade restrictions might be the potential routes to achieve this.

6.2 Subsidies Reduction in EU

As described earlier in this contribution, EU subsidies have become a threat to maintaining sustainable BFT stocks since they have largely distorted investment decisions for fleet modernization and farm expansion. If BFT is managed well, EU will be the largest beneficiary since they have the largest quota in the Mediterranean Sea. Thus, possibilities exist that ICCAT can induce EU to remove harmful subsidies and use the saved resources on programs to reduce overcapacity and overfishing.

6.3 Marine Protected Areas

To cope with the management of the shared fish stock, Marine Protected Areas (MPAs) might be a useful policy instrument (Salm and Clark, 1989; Halpern and Warner, 2002). MPAs are areas in the ocean within which human activities are regulated more stringently than elsewhere (Sumaila and Charles, 2002). Currently the world has more than 5,000 MPAs.[6] As recognized by many, MPAs provide the benefits for conservation of biodiversity, protection of tourism and cultural diversity, increase of fish productivity and insurance against stock collapse (Kelleher, 1999). Especially for fish reproduction, MPAs can conserve the resources within them and increase biomass therein, and consequently benefit surrounding areas through larval and species dispersal. Due to this working mechanism, MPAs would be very effective if the fish are not highly migratory or have relatively fixed spawning sites.

It is well documented that BFT migrate to well defined areas to spawn (Cury, 1994; Fromentin and Powers, 2005; Fromentin, 2006; OCEANA and MarViva, 2008), which is

[6] MPA Global is a worldwide project for MPAs. Refer to http://www.mpaglobal.org/index.php?action=aboutus for more details.

supported by Block et al., (2001), who studied BFT migration behavior using tag data. Also, because BFT congregate to spawn, they are highly vulnerable to commercial fishing at their spawning times (Alemany et al., 2010), which makes MPAs a potentially effective management instrument. ICCAT needs to fully consider the potential of MPAs as one of the regional management tools to ensure sustainable management of BFT in the Mediterranean Sea. In order to investigate whether MPAs are effective management tools for BFT, more research should be carried out by ICCAT to learn how BFT migrates over spaces, and to determine BFT spawning grounds, etc. With such information, locations and sizes of MPAs can be intelligently decided based on additional economic analyses (Halpern, 2003).

6.4 Listing in Convention on International Trade in Endangered Species of Wild Fauna and Flora as an Endangered Species

As ICCAT consistently shows its inability to effectively manage BFT, conservationists have appealed to other alternative authorities, especially CITES, which is an international body with an objective to "ensure that international trade in specimens of wild animals and plants does not threaten their survival." According to the endangered level, CITES has three listings of species, commonly known as Appendix I, II and III. Appendix I lists species that are the most endangered, which are threatened with extinction. CITES prohibits any international trade of species listed in Appendix I except for some specifically authorized non-commercial purposes. So far, the listing of BFT in Appendix I of CITES has been proposed twice, in 1992 by Sweden and in 2010 by Monaco.[7] However, Sweden withdrew the proposal in 1992 and the proposal in 2010 was denied, both due to feverish rejection by some ICCAT member countries, in particular, Japan. Thus, listing in CITES Appendix I is a difficult path and seems infeasible in the near future. As we stated before, we could use other more feasible management tools to try to manage BFT under the current circumstances.

6.5 Domestic Management

6.5.1 Individual Transferable Quota (ITQ) system

An individual fishing quota system—allocating TAC share to individuals or firms with restrictive monitoring—is one of the effective management tools at our disposal currently (Costello et al., 2008). As of 2008, about 10% of global marine catch was managed using ITQs (Chu, 2009). Since ICCAT has allocated TAC to each country, it is possible for them to adopt domestic ITQ systems. However, besides the usual problems in regular fisheries: equity (who gets the quota) and high-grading (smaller fish are discarded) issues, BFT ITQ implementation has more challenges. First, BFT is highly migratory, so it is easy for IUU fishing to occur. Second, BFT is a fish resource that is shared by multiple countries, which highly decreases the incentives for these countries to comply with the TACs.

6.5.2 Dedicated Access Privileges (DAP) program

With Dedicated Access Privileges (or Limited Access Privileges) program, individuals, communities or others are granted the privilege of catching a portion of the TAC or commercial quota. DAP is different from ITQs in two ways. First, individuals and communities or other groups are eligible to receive fishing rights. Second, it grants the privilege to fish, not property rights. As mentioned above, ITQs are often criticized for privatizing public resources, DAP, instead, avoids this problem by only renting out fishing rights. Therefore, BFT fishing countries can consider adopting DAP as their domestic management strategies.

[7] See http://www.cites.org/eng/cop/index.shtml for detailed information.

6.5.3 Optimal resource allocation: a case study of Tunisia

Given the total quota allocated and other countries' actions, individual countries may have possibilities to improve their domestic management. They can choose whether to sell the quota directly, or sell BFT after fishing or fattening them. Optimally allocating quota shares to these different activities can improve a country's total net benefits from its allocated quota. In this section, we use Tunisia as a case study to illustrate what is an optimal quota allocation of BFT to selling the quota to another country, consuming fish domestically and using the catches as inputs to farms. We carry out the analysis with a simple economic model, the details of which are presented in the Appendix.

In this model, we assume that except the quota selling price, all the price and cost parameters in the profit function of quota selling, consuming directly and farming are known.[8] Then we examine, if the quota selling price varies between 8 to 10 USD/kg, what the corresponding quota allocations for these three options would be. Table 8 describes the parameter interpretations and values we use in the model. Figure 4 shows the result for the sensitivity analysis.

Figure 4 shows that as the quota selling price increases, there are different combinations of quota proportions that can optimize the total profits for Tunisia. When the price is lower than 8.2 USD/kg, the quota should not be sold to other countries but all used domestically, and the quota proportion of consuming directly is similar to that of farming. As the quota prices go up, it is more profitable to sell the quota to another country instead of fishing themselves and the farming proportion should be larger than the share for direct consumption.

This figure illustrates that a country can improve the allocations of quota to different economic uses to optimize its total profit given its quota allocated. Similarly, we can also conduct sensitivity analyses by varying other price and cost parameters. Since each country has its own different parameter values, which will change the model results quantitatively, each country needs to take different strategies based on its own situation.

It is worth noting that this model is only a simple illustration of individual countries' resource optimization possibilities. It is conditional on many assumptions: for example, the price, cost and profit structures are assumed to be deterministic, and that IUU fishing is insignificant. In reality, the problems are much more complicated. If there are lots of unreported catches, the ITQ system will be defeated and not effective, in which case there will be a much weaker basis for this kind of resource optimization.

7. Conclusions

We have reviewed the fisheries and stock status of BFT in the Mediterranean Sea and related management issues and find that:

1) The spawning stock biomass of BFT has decreased by 60% from its 1974 quantity;

2) The total BFT catch per year in the Mediterranean Sea is about 24,000 t in recent years; However, IUU in the same area could be as high as 47,800 t. Purse seine is currently the major gear used to catch BFT, which is largely associated with BFT farm expansion in the region;

3) The total landed value for Mediterranean BFT is estimated to be 226.8 million USD a year, which results in 29 million USD of resource rent. It is also estimated that about 3,500 full-time fishing jobs are supported by BFT stock and that the fishery has a multiplier effect on national economies of about 635 million USD;

4) ICCAT has consistently set TACs above the level recommended by scientists.

[8] In reality, we currently have no information about the quota selling price, while we have some data for other parameters. Thus, we carry out sensitivity analysis for quota selling prices in this example.

As pointed out in the analysis, many factors prevent successful management of BFT. Among them, the common-property and shared stock nature of the fishery, the existence of non-ICCAT members and EU fishery subsidies are all important ones. In order to address these issues, we suggest strengthening ICCAT institutions by developing effective cooperative mechanisms, introducing enforceable penalty regimes and reporting and monitoring systems. In addition, ICCAT needs to seek ways to manage non-ICCAT members and convince the EU to reduce their fishery subsidies for BFT fattening farms, and vessel modernization. We also recommend the implementation of Marine Protected Areas to support regional management, and suggest that individual countries use ITQ/DAP and resource optimization to improve their domestic management.

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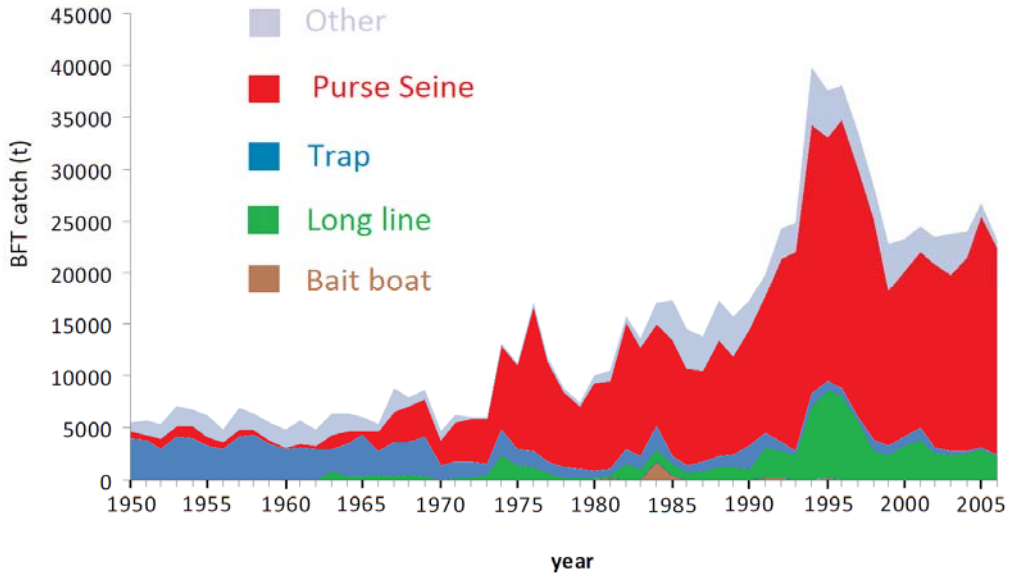
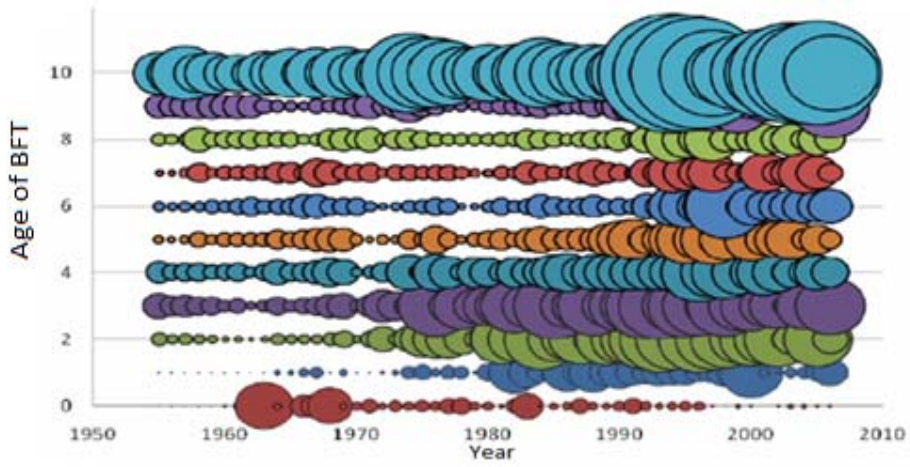
Figure 1: BFT Catch in the Mediterranean Sea



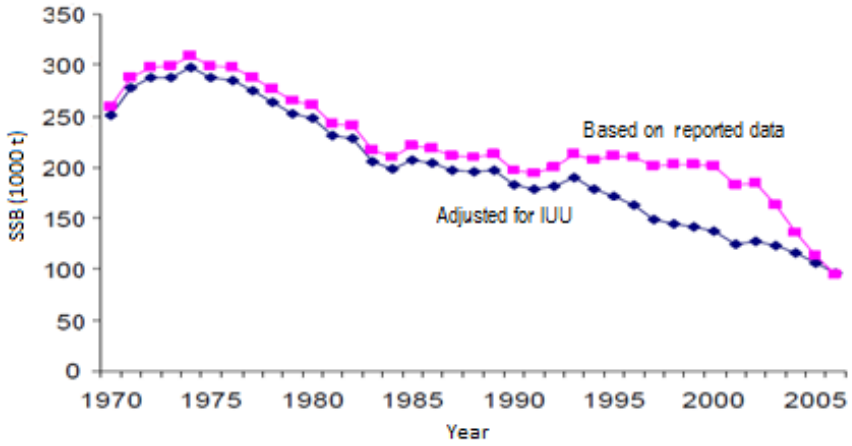
Source: ICCAT, 2008

Figure 2: Catch at Age of the Mediterranean BFT, in Weight



Source: ICCAT, 2008

Figure 1: Spawning Stock Biomass (SSB)



Source: ICCAT, 2008

Figure 2: Optimal Quota Allocation

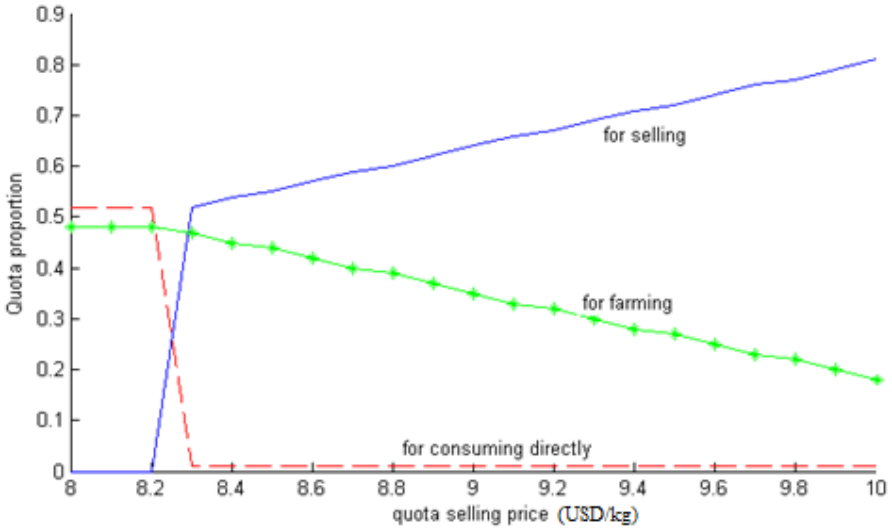


Table 1: Gear Specific BFT Ex-Vessel Prices

Gear	2006 Prices (USD/kg)
Longline/Trap	10.67
Purse Seine	9.44
Others	16.14

Source: NMFS 2010.

Table 2: Mediterranean BFT Landed Value and Resource Rent Estimates in 2006

Country/Entity	Total Reported Catch(T) *	Landed Value (Thousand USD)	Total Cost (Thousand USD)	Resource Rent (Thousand USD)	Unit Resource Rent USD/Kg
MENA region					
Algeria	1,038	10,555	9,539	1,016	0.98
Israel	0	0	0	0	0
Libya	1,280	12,255	11,075	1,180	0.92
Morocco	190	3,047	2,754	293	1.54
Tunisia	2,545	24,045	21,729	2,316	0.91
Regional Total	5,053	49,902	45,096	4,806	
Non-MENA region					
China	0	0	0	0	0
Croatia	1,022	9,648	8,719	929	0.91
EC.Cyprus	110	1,174	1,061	113	1.03
EC.Spain	2,689	26,259	26,143	116	0.04
EC.France	7,664	73,862	64,681	9,181	1.20
EC.Greece	254	2,497	2,257	240	0.94
EC.Italy	4,694	46,673	34,417	12,256	2.61
EC.Malta	263	2,806	2,536	270	1.03
EC.Portugal	11	117	113	4	0.36
Japan	556	5,933	5,362	571	1.03
Korea Rep.	26	277	276	1	0.04
Panama	0	0	0	0	0
Serbia & Montenegro	0	0	0	0	0
Taiwan	5	53	45	8	1.60
Turkey	806	7,609	6,876	733	0.91
Yugoslavia Fed.	0	0	0	0	0
Regional Total	18,100	176,908	159,872	24,422	
Total	23,153	226,810	197,582	29,228	

Notes: *Data source: ICCAT 2008b.

Table 3: Jobs Supported by Mediterranean BFT in 2006

	National Total Catch(T)*	BFT Proportion to National Catch (%)	National Fishery Employment (Thousands)**	BFT Employment (Full-Time Job Equivalent)
MENA Region				
Algeria	145,762	0.71	29	207
Israel	2,144	0	1.4	0
Libya	40,308	3.18	12	381
Morocco	863,993	0.02	61	13
Tunisia	109,774	2.32	48	1,113
Regional Total or average	1,161,981	0.43	151.4	1,714
Non-MENA Region				
China	8,826,914	0	7100	0
Croatia	37,807	2.70	3.7	100
EC.Cyprus	2,135	5.15	1	52
EC.Spain	611,700	0.44	54	237
EC.France	502,557	1.53	21	320
EC.Greece	152,068	0.17	30	50
EC.Italy	304,605	1.54	38	586
EC.Malta	1,330	19.77	1.3	257
EC.Portugal	189,667	0.01	20	2
Japan	3,386,810	0.02	240	39
Korea Rep.	1,194,766	0	180	4
Panama	102,812	0	160	0
Serbia&Montenegro	498	0		0
Taiwan	256,574	0	240	5
Turkey	487,949	0.17	81	134
Yugoslavia Fed.	0	0		0
Regional Total or average	18,100	0.11	8170	1,786
Total or average	17,220,173	0.13	8321.4	3,500

Notes: *Total catch data are from FAO and *Sea Around Us;* ** Data source: Teh and Sumaila (in press), which is a compilation of data mainly from the FAO and the ILO.

Table 4: Multiplier Effects of Mediterranean BFT

Country/Entity	Landed Value (Million USD)	Economic Multiplier	Economic Impact (Million USD)
MENA Region			
Algeria	10.56	1.19	12.54
Israel	0.00	1.03	0.00
Libya	12.26	1.19	14.56
Morocco	3.05	2.81	8.56
Tunisia	24.04	1.46	35.11
Regional Total	49.90		70.76
Non-MENA Region			
China	0.00	3.34	0.00
Croatia	9.65	3.27	31.55
EC.Cyprus	1.17	0.61	0.71
EC.Spain	26.26	3.86	101.36
EC.France	73.86	4.11	303.57
EC.Greece	2.50	3.31	8.27
EC.Italy	46.67	1.75	81.68
EC.Malta	2.81	2.54	7.13
EC.Portugal	0.12	4.78	0.56
Japan	5.93	2.75	16.34
Korea Rep.	0.28	2.91	0.81
Panama	0.00	2.56	0.00
Serbia&Montenegro	0.00		0.00
Taiwan	0.05	3.28	0.17
Turkey	7.61	1.59	12.10
Yugoslavia Fed.	0.00		0.00
regional total	176.91		564.25
Total	226.81		635.01

Table 5: East Atlantic and Mediterranean BFT Annual Quota and Landings

Year	Science-Based TAC Recommended (T)	Quota Set by ICCAT (T)	SCRS Estimate (T)
2003	15,000	32,000	>50,000
2004	15,000	32,000	>50,000
2005	15,000	32,000	>50,000
2006	15,000	32,000	>50,000
2007	15,000	29,500	61,000
2008	15,000	28,500	34,120
2009	8,500 – 15,000	22,000	N/A
2010	8,000	19,950	N/A

Notes: Data source: ICCAT 2005, 2006, 2007, 2008a, 2009, 2010.

Table 6: BFT Quotas (T) Allocated by ICCAT

Country/Entity	2003	2004	2005	2006
Algeria	1,500	1,550	1,600	1,700
China	74	74	74	74
Croatia	900	935	945	970
European Community	18,582	18,450	18,331	18,301
Iceland	30	40	50	60
Japan	2,949	2,930	2,890	2,830
Tunisia	2,503	2,543	2,583	2,625
Libya	1,286	1,300	1,400	1,440
Morocco	3,030	3,078	3,127	3,177
Others	1,146	1,100	1,000	823
Total	32,000	32,000	32,000	32,000

Source: EC 2003, 2004

Table 7: BFT Quota (T) Allocation among EU

Country/Entity	2004	2005
Greece	326	323
Spain	6,317	6,277
France	6,233	6,193
Italy	4,920	4,888
Other	654	650
Total	18,450	18,331

Source: EC 2003, 2004.

Appendix

$$(1)\pi = p_q * q_1 * Q + \sum_s p_s * H_s - Cost\_H + p_A * q_3 * Q * (1+G) - Cost\_M$$

$$(2)Cost\_H = (c_1 + c_2)(q_2 + q_3)Q$$

$$(3)Cost\_M = c_3(q_3 * Q * (1+G))^2$$

$$(4)q_1 + q_2 + q_3 \le 1$$

Equation 1 describes the profit from fishing and farming BFT, in which s is the gear, Q represents quota and P is the price. c_1 to c_3 are the cost coefficients and q_1 to q_3 are quota shares. The first component, $p_q * q_1 * Q$, is the revenue from selling quota, p_q is the quota price, Q is the total quota for one year and q_1 is the percentage of the sold quota relative to the total quota Q. The second component, $\sum_s p_s * H_s - Cost\_H$, is the profit for fishing. Since BFT price is gear specific, we multiply each price by gear, p_s, with its corresponding catch H_s, and then deduct their fishing cost modeled with Equation 2, in which c_1 is the average unit fixed cost and c_2 is the variable cost. The catch consists of $q_2 Q$ directly for consumption and $q_3 Q$ for farming. The last component $p_A * q_3 * Q * (1 + G) - Cost\_M$, calculates the farming profit. Here, $q_3 * Q * (1 + G)$ is the weight after fattening and p_A is the average price for farmed fish. Cost of BFT farming is modelled with Equation 3. To comply with the TAC, the sum of q_1, q_2, and q_3 is not greater than 1, which is a constraint represented by Equation 4. All the variables and values are listed in Table 8.

Table 8: Parameters in Economic Modeling for Tunisia

Known Variables	**Interpretation**	**Parameter Value**	**Source**
s	Gear		ICCAT (2008)
Q	Quota	2,625 tonne	EC (2003, 2004)
p_q	Quota price sold by Tunisia to Japan	8--10 (USD/kg)	Varying variable
p_s	Gear specific price	See Table 1	NMFS (2010)
P_A	Average price	9.8 (USD/kg)	NMFS (2010)
c_1	Average fixed cost per kg	0.31 USD/kg	Lam et al.(in prep.)
c_2	Variable cost	0.88 USD/kg	Lam et al.(in prep.)
c_3	Cost parameter for farming	7.14286E-07	By calibration
G	Fish gain proportion through farming	0.25	ICCAT (2008)
Control Variables	*Interpretation*	*Parameter Value*	*Source*
q_1	Quota proportion for selling		
q_2	Quota proportion for consuming directly		
q_3	Quota proportion for farming		