Received: 22 October, 2012
IOTC-2012-WPTT14-INF09

Marine Policy 36 (2012) 985–992

Contents lists available at SciVerse ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Managing fishing capacity in tuna regional fisheries management organisations (RFMOs): Development and state of the art

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ARTICLE INFO

Article history:
Received 12 November 2011
Received in revised form
19 January 2012
Accepted 25 January 2012

Keywords:
Overcapacity
Shared stocks
Tuna fisheries
Regional fisheries management

ABSTRACT

Overcapacity is a major threat to the sustainability of tuna resources. Diverse actions are being carried out by tuna RFMOs to counteract this problem. This paper reviews and analyses both the historical development of fishing capacity management in tuna RFMOs and their state of the art practices. Despite the fact, that thus far, management measures have not yielded the expected results for capacity reduction, they provide a good basis for improved management of capacity at regional and global levels.

1. Introduction

Fishing overcapacity is a pressing problem that threatens marine fisheries sustainability due to overfishing while producing significant economic waste [1]. This phenomenon is widely seen as a major impediment to achieve sustainable productive fisheries [2]. The need to address the issue of overcapacity and to elaborate global guidelines to counteract this phenomenon was first raised by the FAO's Committee of Fisheries (COFI) in 1997. The International Plan of Action for the Management of Fishing Capacity (IPOA-Capacity) arose from this initiative and was adopted in 1999. The IPOA-Capacity is a voluntary instrument that urges countries and regional fisheries bodies to implement capacity management by assessing capacity levels, adopting management measures, periodically reviewing assessments, and devising contingency measures accordingly [3]. The IPOA-Capacity has been widely endorsed [4], however, comprehensive and global implementation of this instrument has not yet been achieved. In spite of this, many countries and regional bodies have devised diverse measures to counteract capacity accumulation in their respective fisheries.

Regional Fisheries Management Organizations (RFMOs) are regional fishery bodies which play a major role in the governance of international fisheries. Since the late 1950s, tuna RFMOs provide scientific advice and management for stocks of tunas and tuna-like species. These organizations face the challenge of managing some of the most economically valuable fish stocks which are subject to increasing fishing pressure. Tuna and tuna like resources amount to 6.3 million tons, a significant proportion of the total volume of world marine catches, which is around 80 million tons [5]. They are resources of key importance for the economy of many nations, especially for many coastal states and small island developing states (SIDS).

High levels of capacity in tuna fisheries are seen as a threat to fisheries sustainability by the governments involved, RFMOs secretariats, stakeholders associations, international agencies and non-governmental organizations. RFMOs have independently adopted various management measures to counteract overcapacity. Coordination has also arisen amongst tuna RFMOs through joint initiatives such as the Kobe process.[1] This process addresses diverse management and conservation topics and develops courses of action, including fishing capacity issues, which are being addressed by promoting improved coordination and collaboration.

This work reviews current practices of fishing capacity management in four of the five tuna RFMOs: Inter American Tropical Tuna Commission (IATTC), International Commission for the Conservation of Atlantic Tuna (ICCAT), Indian Ocean Tuna Commission (IOTC) and Western and Central Pacific Commission (WCPFC).[2] The article is organized as follows. The first section

[1] The Kobe process is named after the first joint tuna RFMO meeting held in Kobe (Japan) in 2007, continued in San Sebastian (Spain) in 2009 (Kobe II), and in La Jolla (USA) in July 2011 Kobe III.

[2] The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is not described since it has not established management measures for fishing capacity. Such measures are devised and implemented at the discretion of CCSBT's member states, which have autonomy in establishing the rules to manage their fleets.

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doi:10.1016/j.marpol.2012.01.006

provides an introduction to this topic. The second section provides a brief theoretical review of the issue of fishing overcapacity and the means to counteract it. The third section reviews the development of fishing capacity management in tuna RFMOs. Finally, the fourth and fifth sections discuss the fishing capacity management approaches, analyze the joint initiatives taken by RFMOs, distill the conclusions and provide the final remarks.

2. Causes of overcapacity and management measures

It is widely recognized that pure and regulated open access are amongst the drivers behind overcapacity. Grevòbal and Munro [6] define pure open access as the state where access rights do not exist or are insufficiently defined. In a regulated open access, access rights are weakly defined and the management system attempts unsuccessfully to enforce a Total Allowable Catch (TAC). Fishers have the incentive of competing for a larger share in such a common pool situation. This race for fish encourages fishers to invest in larger and more modern vessels to ensure larger individual shares. Other factors that may trigger capacity accumulation are *inter alia* technological creep and the growth of fish markets [7]. Open access can still be seen in certain maritime areas where access to fishing has not been historically restricted such as the high seas [8]. This is especially notable in tuna and tuna-like fisheries where a large share of catches is taken in the high seas under open or weakly regulated open access.

A clear understanding of the meaning of capacity is essential to evaluate its extent and to devise management measures to control it. Moreover, it may facilitate collaboration amongst the actors concerned to prevent or counteract capacity accumulation. FAO [1] provides a widely accepted definition of fishing capacity. This is the amount of catch or effort, that can be produced by a vessel (or fleet), if fully utilized, during a period of time, given the state of the resources, the level of technology utilized and provided that effort or catch are not constrained by management measures. In spite of the FAO definition, managers and stakeholders tend to be more familiar with the physical dimension of capacity, including features such as GRT, well capacity (fish storage space), engine power, among others [9]. An example of the use of physical features to measure fishing capacity is seen in the IATTC, which have officially adopted well capacity in cubic meters as the primary measure of capacity [10].

The management of fishing capacity is defined as the implementation of policies and technical measures to ensure a balance between fishing inputs and production from fisheries [7]. Strategies to counteract overcapacity are categorized in two major groups [11]: (1) *incentive blocking measures* and (2) *incentive adjusting measures*. The former strategies aim at blocking fleet capacity building. They include some of the traditional fisheries management measures such as limited license programs, vessel buyback programmes, gear and vessel restrictions, individual non-transferable catch and effort quotas and TACs. According to Grévobal and Munro [6], traditional strategies, such as input controls, may not control capacity efficiently. On the contrary, incentive blocking measures may induce redistribution of effort across fisheries or accumulation of capacity. In this context, non-compliance may also emerge as the main impediment for successful management of capacity. Should a fisher be prevented from increasing profits by a certain regulation, he would have the incentive to find the means to increase capacity by increasing or replacing inputs. This is prone to occur where penalties and mechanisms of enforcement are not strong enough to discourage non-compliance. This is especially evident in the high seas, where access can be difficult to restrict and enforcement actions cannot be comprehensively applied due to the lack of jurisdictional powers of regional bodies [8,12].

On the other hand, *incentive adjusting measures* offer long-term strategies to reduce capacity by creating a sense of ownership, thus the race for fish may be reduced by fishers themselves through voluntary capacity reduction. They are, however, hard to implement since they require a drastic change in the management system. These measures comprise *inter alia* individual transferable quotas (ITQs) and collective fishing rights [10]. ITQs are reported to be the most effective management instruments to counteract the race for fish, hence, triggering rationalization of capacity [13–15].

In the context of tuna fisheries, the introduction of rights-based management, and especially of individual transferable rights, is being discussed in international fora such as the workshop organized by IATTC and the World Bank in 2008 [16], the Kobe process [17,18] and the Bellagio framework [19]. However, in fisheries where a significant share of catches are harvested in the high seas, such as tuna fisheries, legal and technical difficulties such as defining rights of access, lack of effective Monitoring, Control and Surveillance (MCS) and enforcement mechanisms appear to be strong impediments to a comprehensive implementation of rights-based management systems [8].

3. Fishing capacity management in tuna RFMOs

3.1. Inter-American Tropical Tuna Commission (IATTC)

3.1.1. Rules for fishing capacity management

In late 1990s, consensus within IATTC was that levels of fishing capacity were increasing steadily and that signs of overfishing were evident, especially in the yellowfin tuna fishery. This concern led to the creation of the working group on fishing capacity in 1998. The working group issued recommendations on capacity management that were crowned at the 62nd meeting in October 1998 by the resolution on capacity limits for 1999 [20]. This resolution commands participants[3] to restrict their fleet capacity to target capacity levels. The criteria to establish such reference target level was based *inter alia* on participants catches in the period 1985–1998, catches in their respective EEZ and contribution to IATTC's conservation programmes. The overall capacity target was fixed at 135,000 metric tons of fish carrying capacity. This is equivalent to 158,000 m^3 of well capacity, with this being the figure utilized in management until now. This resolution also contained exceptions for the limitations on capacity growth for nations with a long presence in the fishery but with limited fishing capacity. This first IATTC capacity resolution can be seen as a pioneer measure amongst tuna RFMOs for freezing capacity. According to Joseph et al. [21], the scientific staff of the IATTC noted that this carrying capacity was adequate to harvest the catches of tuna up to 1998.

In 2000, the Commission approved the creation and maintenance of a Regional Vessel Record (RVR) of purse seiners, and their characteristics, authorized by their governments to operate in the IATTC convention area [22].

In June of 2002, the Commission approved the Resolution on the Capacity of the Tuna Fleet Operating in the EPO, indicating that only vessels flagged by participants will be part of the RVR and specified that the incorporation of a new vessel (not coming from the RVR) into a given participant's fleet has to be balanced by equivalent capacity removal. This kind of *entry-exit* mechanism

[3] A participant is defined as a member of the IATTC, and states and regional economic integration organizations, and fishing entities that have applied for membership or that cooperate in the conservation programs of the Commission.

became the general rule to incorporate new fishing craft to the RVR. The 2002 Capacity Resolution provided five coastal states bordering the EPO the possibility to add vessels to the RVR, which amounted to an additional 20,000 m^3 [23]. IATTC vessel records were later improved by the creation of a list of long line fishing vessels over 24 m authorized to operate in the EPO [24]. Further rules on vessels transfers specified that participants transferring vessels cannot replace the departing fishing capacity with new vessels [25]. Joseph [26] sees the acceptance of vessel transfers amongst participant's fleets in the RVR as the emergence of a market for capacity trading in the EPO. In spite of this, there have been few vessel transfers up to 2010 [27].

In 2005, the Plan for Regional Management of Fishing Capacity was approved and confirmed the target level of fishing capacity at 158,000 m^3, as established in 1999 [10]. The plan established objectives, reaffirmed well volume as a measure of capacity in purse seine fleets, requested revisions of capacity targets, recognized the importance of the RVR and elaboration of lists of vessels engaged in illegal, unreported and unregulated (IUU) fishing, addressed the need to acknowledge the rights of coastal states and CPCs with a long standing interest to maintain their fishing industries in the region, recognized the importance of addressing capacity in long line fleets by establishing targets and limits, and outlined the importance of cooperation and data exchange with international agencies and RFMOs. In early 2011, the Permanent Working Group on Capacity (PWGC) concluded that purse-seine capacity is well above the level that facilitated longer fishing seasons and better economic returns. In 2011, the PWGC also recommended capacity limits for long-line fleets, a measure that has been suggested since 2005. This working group requested further reductions in purse seiner capacity based on scientific advice [28].

The PWGC [29] also reviewed the 2005 Regional Plan for Capacity and found that, up to 2010, the registered active capacity reached 214,000 m^3 of which 210,000 m^3 were actually utilized. It recognized that there is 73,000 m^3 of capacity not listed as active. This comprises of sunk vessels still recorded in the RVR, authorized capacity increments not yet utilized and other unused capacity. Hence, the potential capacity is 287,000 m^3, which is 80% larger than the target of 183,000 m^3. The revision of the plan has not modified the objectives and principles of the 2005 plan but improves the RVR issue by recommending collaboration with other international organizations and highlighting the need for rules regarding the transfers of long-line vessels amongst participants. It also points out that the principles related to the rights of coastal participants and participants with long-standing interests in the fisheries of the EPO should be taken into account when establishing a plan to reduce capacity in the purse seiner fleet or establishing limits for long-line fleets. The PWGC also committed itself *inter alia* to discuss and propose to the Commission a program for reducing the capacity of purse-seine vessels and to set up a capacity limit for long line vessels [29].

3.2. International Commission for the Conservation of Atlantic Tunas (ICCAT)

3.2.1. Rules for fishing capacity management

In 1993, the first fishing effort limitation was introduced by recommendation 93-4 to the yellowfin tuna fishery [30]. This measure addressed concerns on possible overcapacity in the fishery [31].

In 1997, recommendation 97-13, regarding the management of the bigeye tuna fishery, requested a list of the vessels over 80 GRT, declaring technical characteristics and data on ownership from the CPCs. These measures excluded parties with catches below 200t [32]. In 1998, resolution 98-3 limited the number of vessels above 24 m length-overall (LOA) for 1999 and thereafter, excluding recreational boats. Such a limitation is based on the average number of vessels in 1991–1992. Recommendation 98-3 contains the Commission's first provision to associate the number of vessels to GRT in order to avoid input substitution. This measure excludes CPCs which had on average caught less than 2000t in previous years [33]. ICCAT's recommendation 98-8 implemented direct measures to address the issue of overcapacity in the fishery of Northern albacore [34]. This recommendation specifies that Contracting Parties, non-contracting parties and fishing entities, hereinafter (CPCs), targeting northern albacore shall limit the fishing capacity of vessels, excluding recreational boats, from 1999 onwards, through a limitation of the number of vessels to the average recorded during the period 1993–1995. It also specifies that CPCs shall declare the vessels to participate yearly in the fishery. CPCs with catches below 200t are not considered for this measure. It also contains a request to the SCRS to carry out an evaluation of the fishing capacity in this fishery with a view to establishing fishing effort correspondence.

In 2004, the Multi-year Conservation and Management Program for Bigeye tuna maintained limitations on the number of vessels above 24 m LOA. A limit on vessel numbers was established for CPCs which were allocated a catch limit.[4] Such a limit was established in 2005 and for subsequent years, taking as a baseline, the number of vessels notified to ICCAT in 2005. CPCs are also requested to manage the inclusion/exclusion of its vessels in/from the ICCAT record. This multi-year plan contains the first provision on *entry-exit* rules on fishing capacity by allowing leaving capacity to be replaced by boats of equivalent capacity [35].

In the case of bluefin tuna, the adoption of a 15 year recovery plan in the Eastern Atlantic and Mediterranean took into account that the phenomenon of overcapacity was being experienced in the fishery and that effective actions were required [36]. This recommendation was amended by resolutions 08-05 and 09-06 in 2008 and 2009, respectively. These amendments provided more precise actions against overcapacity *inter alia* a request for CPCs to adjust capacity to fishing possibilities, to submit a Capacity Management Plan for the period 2010–2013 and to develop vessels lists and provisions for CPCs' quota management [37,38]. In 2008, ICCAT's recommendation 08-04 established restrictions on geographical mobility of vessels in order to reinforce capacity limits [39]. The fishery for blue-fin tuna is the only fishery for which annual capacity plans are required to be submitted. Fishing capacity is limited by number of vessels and GRT of the period January 2007–July 2008. For the sake of fisheries development, capacity freezing may not apply to certain developing states that demonstrate the need to develop their fishing capacity to fully exploit their quotas [31]. In 2009, the Commission called on CPCs to further adjust their current capacity to be relative to fishing opportunities of bluefin tuna [38].

3.3. Indian Ocean Tuna Commission (IOTC)

3.3.1. Rules for fishing capacity management

In 1999, the IOTC committed itself to taking concerted actions to limit capacity of large scale fishing vessels (LSFV) targeting tropical tunas in the Commission's area of competence. A request was made by the Commission to the Scientific Committee to provide the best estimate, of the optimum fishing capacity of the fishing fleet. Such a request was intended to provide the scientific basis for the limitation of fishing capacity from 2000 [40]. According to Joseph et al. [21], due to a lack of information the Committee was unable to address the recommendation.

[4] China, EC, Ghana, Japan, Panama, Chinese Taipei.

In 2002, the first measure to limit access was outlined by resolution 02/05 [41]. Access limitation was attempted through the creation of the record for authorized vessels above 24 m (aka LSFVs). In 2003, the Commission requested by resolution 03-01 that contracting parties and non-contracting parties (CPCs), which have more than 50 vessels on the 2003 Record of Authorized Vessels (RAV), limit the number of vessels from 2004 [42]. The target number of vessels above 24 m LOA was fixed to that corresponding to 2003. This limitation on number of vessels shall be commensurate with the corresponding overall tonnage. The resolution established an *entry-exit* rule for eventual vessel replacements. It contained meaningful provisions for the sake of fisheries development in developing CPC countries. These allow CPCs which are largely dependent on tuna fisheries, to draw a Fleet Development Plan (FDP). This plan was to be submitted to the Commission and define *inter alia* the type, size and origin of the vessels and the programming of their introduction into the fisheries. Provisions for FDPs have been maintained in a range of resolutions over the last 10 years. Even though resolution 03-01 contains some exceptions on restriction to capacity growth the approval of this resolution it is seen as significant and positive move towards fishing capacity limitation [26].

In 2005 the Commission broadened, by resolution 05-02, capacity limitations to vessels below 24 m LOA if they fish in the high seas of the Commission's area of competence [43]. These measures for vessels above and below 24 m LOA were meant to reduce the number of vessels operating in the Commission's area of competence. These measures, however, did not result in a reduction of the number of vessels authorized to fish in the Commission's waters [21]. In 2007, this resolution was enhanced and superseded with provisions against IUU fishing vessels by resolution 07/02 [44].

In 2006, the Commission's resolution 06-05 requested CPCs to limit fishing capacity for tropical tunas to 2006 levels [45]. In 2007, the resolution 07-05 requested CPCs to limit capacity for longline vessels targeting swordfish and albacore to 2007 levels [44]. In 2009, the Commission implemented the above mentioned resolutions on capacity [46]. IOTC attempted to freeze capacity by adopting the *status quo* of capacity from 2006 and 2007. This can be considered an implicit form of allocation. In spite of this measure, FDPs are still allowed to be presented to the commission, which still allow CPCs to increase capacity. It has become clear than capacity limits cannot maintain stocks at target levels, especially in the context of on-going FDPs. Thus, in 2010 area closures were adopted as additional forms of effort control. Discussions have been held on unallocated catch limits without agreement amongst CPCs. For 2012, the prospect of introducing new effective management measures has demanded the organization of technical meetings on allocation [47].

According to IOTC [48], the targets in the limitation of fishing capacity have been consistent with the advice supplied by the Scientific Committee in recent years, although further controls might be necessary if a full implementation of the proposed FDPs results in an increase of capacity in the region. The Scientific Committee has established a Working Party on Fishing Capacity that will explore the technical issues relevant to the use of fishing capacity management tools. In 2010, a study was carried out by the IOTC's staff to assess with more precision the current level of fishing capacity in the Indian Ocean. This study addressed an old request from the Commission, dating back to 2003. Gillet and Herrera [49] applied a simple measure of capacity, expressed as number of vessels, to provide a figure of the extent of capacity in the IOTC area of competence. The study focused on tropical tunas, albacore and swordfish by gear technology for years 2006–2007. A combined figure of around 4000 vessels per year comes out of this study. This figure is an approximate picture of the entire capacity.

The authors state that this should be considered as a preliminary attempt due to the inaccuracy of the data, especially for smaller vessels. Furthermore, vessels included in this study are responsible for only approximately 68% of total catches, thus a significant number of vessels, especially artisanal, are not included.

3.4. Western and Central Pacific Fisheries Commission (WCPFC)

3.4.1. Rules for fishing capacity management

In 1999, participants in the fourth session of the Multilateral High Level Conference (MHLC), one of the key steps in the formation of a fisheries management organization in the WCPO, agreed to a resolution known as the "capacity resolution", that urged states to restraint expansion of fishing effort and capacity in the region. The "capacity resolution" was consistent with scientific advice, particularly in relation to bigeye tuna. It also focused on limiting the expansion of the equatorial purse-seine fleet [50]. In 2002, the "capacity resolution" was reinforced by a similar commitment in the third session of the Preparatory Conference for the establishment of the WCPO's highly migratory species commission aka 2002 PrepCon. In addition, the 2003 PrepCon urged states, territories, and fishing entities who have continued to circumvent these resolutions since 1999 to reduce any overcapacity they have created [51]. According to Langley et al. [50], the "capacity resolution" and subsequent resolutions failed to achieve the stated goal of limiting the expansion of fishing capacity and mortality in the WCPFC Convention Area. This was seen by some Distant Water Fishing Nations (DWFNs) as being in contravention of the "capacity resolution". On the other hand, members of the Parties to the Nauru Agreement (PNA) viewed additions to their fleets as a legitimate way to achieve development aspirations.

In 2004, the WCPFC convention entered into force, thereby establishing the WCPFC. Article 5 of the convention text contains explicit recommendations to prevent and counteract overfishing and eliminate redundant capacity. Article 10 also states that one of Commission's functions is to limit fishing capacity, including measures relating to vessels numbers, types and sizes [52]. However, fishing capacity in the region continued to expand. The issue was addressed at the second session of the WCPFC through the adoption of resolution 2005-02 that urged members, cooperating non-members and participating territories (CCMs) to reduce overcapacity [51]. This resolution sought to reduce the overcapacity created in the period 1999-2005 by withdrawal of equivalent fishing from the Convention Area.

Since its creation the WCPFC has implemented diverse conservation and management measures (CMMs) developed to address overfishing, especially through effort limitations, and reducing threats to a number of stocks, in particular, bigeye tuna and yellowfin tuna. According to Parris [53] there is growing dissatisfaction with the performance of these CMMs. CMMs related to albacore and tuna-like species and the initial measures for bigeye and yellowfin tuna have not contained clear provisions to prevent input substitution. As an example, in the longline fishery for northern albacore, terms such as 'fishing effort' remain undefined. Consequently, vessel operators have the possibility of increasing the number of hooks.

In 2008, the Commission adopted CMM 2008-01 for yellowfin and bluefin tuna management, which comprised several rules for both longline and purse seine fleets. This CCM was developed to replace previous CCMs for yellowfin and bluefin tunas (2005-01 and 2006-01). According to Parris [53], the previous CCMs were written in simple terms and were prone to being circumvented by input substitution. The overall aim of CCM 2008-01 was a reduction of bigeye mortality by 30% in a three year period

starting in 2009 and the freezing of yellowfin tuna fishing mortality. Other measures comprised *inter alia* Fishing Aggregating Devices (FAD) closures and closure of high sea pockets [54]. In spite of these measures there is evidence to indicate that fishing capacity and fishing mortality continues to increase beyond 2004 levels and thus management efforts have been unsuccessful [50,53].

Besides WCPFC attempts to address overcapacity there have been regional initiatives in the WCPO to establish limits to fishing capacity. In 1990, the Palau Arrangement introduced a 164-vessel provisional limit for purse seine vessels fishing within the Exclusive Economic Zones (EEZs) of the PNA. This limit was increased to 205 vessels in 1992. In late 2007, the restriction on vessel numbers was replaced by a program of limited days fished aka Vessel Days Scheme (VDS) [55]. The PNA established the total number of days that can be fished in their waters and each party's allocation. The allocations of days for the fisheries of bigeye tuna, skipjack tuna and yellowfin have a validity of one year and can be set up three years in advance. To prevent technical creep that may lead to increases in catchability, the VDS establishes a relationship between vessel length and a fishing day that can be modified over time to account for changes in technology [55]. According to Joseph et al. [9] limitations of fishing effort in the WCPO do not directly address overcapacity, thus economic resources that could be directed to other uses are wasted.

4. Discussions

4.1. Lack of definition of capacity

It is notable that there is a lack of a general and precise definition of fishing capacity in the RFMOs examined. The IATTC has progressed more than its counterparts in this issue by defining capacity and the ways of measuring it. The IATTC defines capacity as vessel well volume, which is considered a consistent, objective and clear definition [25]. This definition facilitates understanding amongst managers and participants to devise and launch management measures. In contrast, other RFMOs have not explicitly defined fishing capacity. The WCPFC's Convention text, for example, does not provide a definition of capacity. But it suggests that fishing capacity shall be measured in accordance to vessels physical features (Article 10). In spite of this, the predominant management measures of WCPFC fisheries are fishing mortality and effort.

Addressing overcapacity as a global threat for tuna populations may require an unambiguous definition of fishing capacity to be used amongst all the tuna RFMOs, on a fishing gear basis, at least for RFMOs with transboundary issues such as IATTC and WCPFC. Also, the success of capacity limitation depends on the ability to relate capacity estimates (measured in tonnage, number of vessels or some other measure) with fishing effort, and thus fishing mortality, and to use it to support management advice. In other words, in most Tuna-RFMOs optimal levels of fishing mortality are commonly being calculated, but the relationship between F and effective effort or fishing capacity is difficult to evaluate.

4.2. Current capacity limits

It is widely agreed that managment of fishing capacity is more complex than limiting the number of fishing vessels due to factors such as capacity creep and technical efficiency, among others [56,57]. In order to address capacity issues, detailed information is needed on both the tuna resources and their characteristics, and the number and characteristics of all vessels in all categories targeting these resources. In spite of these drawbacks the limitation of input based measures of capacity such as number of vessels, carrying capacity or days at sea seem to be the most straightforward ways of implementing fishing capacity management. IATTC, for example, seems to feel comfortable with the input based measure applied to purse seiners and it is considering its application for the longline fleet [58].

Currently, a diversity of input based measures is applied in tuna RFMOs. For example, well volume is applied as a core management measure in the IATTC; vessel numbers are utilized in the Eastern bluefin tuna fishery and the Northern albacore and bigeye fisheries in ICCAT; and days at sea are used in the PNA, a subset of the WCPFC. The ICCAT approach to capacity evaluation (i.e. the fishing mortality (F) to fishing mortality at MSY ratio, often used to assess the status of stocks) is seen as useful to limit capacity even though it is not seen as a valid approach to fishing capacity management. It has been the preferred approach to limit capacity in spite of extensive quantitative analyses of capacity by the Working Group on Stock Assessment Methods [59].

Restrictions on fishing mortality may not yield effective results since the relation between capacity and mortality is difficult to establish [57]. Thus, its use may complicate the process of setting up management actions to control capacity.

Limitation of capacity in terms of vessel numbers or carrying capacity may be the simplest way of addressing the overcapacity issue until new methodologies are researched and agreed. As commented earlier in this paper, *incentive blocking strategies* are prone to being circumvented by input substitution. For example, Miyake [60] reports that limitations on the ability to build long-liners larger than 24 m in length has encouraged fishers to build smaller long-liners with high navigational autonomy to fish in the high seas and freezing facilities to ensure the freshness of tuna for the sashimi market. Such a circumvention of the regulatory framework may contribute to the overcapacity problem in tuna fisheries [9]. To enhance the effectiveness of capacity limits it may be useful to complement such limits with other technical measures, comprising catch limits and area and time closures [57]. Examples of seasonal and area closures are found as complementary measures for input based capacity management in IATTC [28,57].

4.3. Vessel registers widely implemented

In all cases examined, Regional Vessel Registers (RVRs) are currently in use although restricted to vessels of certain length and types, especially purse seiners. RVRs can be considered a good starting point for limiting fishing capacity by registering and keeping control of number of vessels and carrying capacity. The case of IATTC is the most representative case where limits are imposed to the participants of the RVR thus it performs as a limited entry system. However, IATTC has not succeeded in controlling fishing capacity growth since the target of 158,000 m^3 of well capacity has been largely exceeded.

In a limited entry system, an issue that requires more attention is that of the *entry-exit* rule and the control of transfers amongst participants, ensuring that transferred vessels are immediately reflagged in the registry. Hence, the system would not count a given vessel twice. In addition, measures have to be devised to prevent a CPC from transferring capacity to others by finding loopholes in the system enabling them to replace the transferred vessel with new craft. The use of management measures that link input-capacity to vessel physical features with the aim of preventing input substitution are other options to be explored. The IOTC requests, for example, that input-capacity expressed as number of vessels has to be commensurate with overall tonnage. The PNA associates days at sea with the length of

the vessel. Coupled vessel and catch limits have also been devised, as seen in the case of the bigeye tuna multi year program of ICCAT.

4.4. CPCs aspirations for fleet development

RFMOs face the challenge of attending to the aspirations of developing nations, and especially of small island development states (SIDS), for developing their tuna industries. This claim may substantially increase fishing capacity in the diverse regions. All the RFMOs have issued formal considerations on this topic. In Kobe II and III, developing nations reiterated their positions towards this issue. This is a matter of disagreement especially between developing and developed states, which request global moratoria on vessel construction. It is possible that requests to limit or reduce the fishing capacity of developing states may constrain the development of their fishing industries. This request may not be consistent with the United Nations Fisheries Stock Agreement (Article 24) which prevents the transferring of a disproportionate burden of conservation to developing states [61]. Alternatives to constrain capacity expansion without substantially affecting development of fishing industries in developing states may comprise measures to transfer vessels from developed states to developing ones or chartering of vessels accurately registered by CPCs. Kobe III has addressed this issue by recommending a freeze on large-scale purse seine capacity for developed nations and to take into account the option of capacity transfers from developed to developing members within a given RFMO's area of competence [62]. Thus, it is necessary to identify whether fleets could still be developed and where capacity has to be frozen or reduced. Kobe III has resulted in an understanding of this need and recommendations on an annual evaluation of fishing capacity have been devised.

Again it is necessary to reinforce RVR and, as proposed by the Kobe process, to create a global register of tuna vessels to effectively monitor transfers between regions. The elaboration of fishing capacity plans allows the examination of potential expansions of capacity due to development needs. This tool allows RFMOs to envision further increases and withdrawals of capacity in its area of jurisdiction. IATTC, IOTC and to a lesser degree ICCAT request CPCs to submit fishing capacity plans.

4.5. Institutional structures to address capacity issues

Specialist working groups on fishing capacity within the tuna RFMOs are of key importance for dealing with agendas on the capacity issue and to provide sound recommendations to managers. Working groups such as IOTC's working group on capacity discussed definitions and identified data required to evaluate fishing capacity and the provision of advice. In a more global context, the Kobe process provides an arena to deal with the overcapacity issues through meetings and especially though technical workshops such as the Brisbane workshop on fisheries management held in 2010 in Australia. At this meeting, updated information on capacity was presented by diverse RFMO representatives and recommendations were devised.

4.6. Overcapacity still partially addressed

RFMO rules for capacity limitation are still partially implemented within each organization. Thus, the structural problem of overcapacity is not being comprehensively addressed. It is notable that most of the management rules implemented focus on purse seiners or for vessels above a certain tonnage or length. There are other rules that only apply to nations whose fleets capture above a certain quantity threshold. Artisanal and recreational fisheries are not usually taken into account in capacity management even though artisanal fleets might exert strong pressure on resources. In IOTC, for example, artisanal fisheries account for about half the catch [57]. The main reason for excluding artisanal fleets, and other segments of the fleet, from limitations on capacity seems to be the lack of data [57]. Lack of comprehensive data on vessels, effort and catch also impedes robust analyses of capacity.

4.7. Right-based management

In the world of tuna fisheries, rights-based management is under the spotlight and being debated in international fora (e.g. in the Kobe process). Some forms of limited rights-based management are already in place in tuna RFMOs at the regional level. The IATTC RVR provides a limitation on fishing capacity for CPCs and in a way allocates rights of access to tuna resources in the EPO. The exclusivity of such rights cannot be considered high due to new additions to the fleet and the threat of free riding into the fishery, especially in the high-seas. Flexibility mechanisms have been provided to facilitate transference of vessels within the RVR, a fact that may allow the emergence of a market for rights. However, few transfers of vessels have taken place in the EPO.

Other regional forms of rights-based management, although restricted to EEZs, can be found in the Pacific where the VDS allow transferability of rights (days at sea) amongst the purse seiners in the combined PNA's EEZs. In this case, transferable rights have been dissociated from the vessel thus allowing more flexible mechanisms for rights trade. However, the one-year validity of rights allocations does not allow the permanent transfer of rights that may leave some vessels without rights, thus, being prone to be decommissioned from the fleets. A more comprehensive implementation of rights-based management in RFMOs (e.g. ITQs) seems impractical currently since it faces the barrier of a lack of definition of rights of access in the high seas, unfeasibility of applying an effective MCS in a given whole RFMO jurisdiction and lack of enforcement powers [8]. Full implementation of rights-based management in tuna fisheries would better suit management at CPC level. In fact, it is being applied to manage certain CPC's TAC allocations.

5. Final remarks

Actions to counteract overcapacity in tuna RFMOs are still in a preliminary stage. A strong movement has been propitiated by FAO initiatives to combat overcapacity in the late 1990s, especially the elaboration of the IPOA Capacity. A diversity of steps has been carried out by tuna RFMOs on fleet limitation, creation of regional registers, capacity plans and collaboration on joined agendas. However, it is likely that capacity will continue growing at least in the short term due to the impossibility of restricting access to the high seas and deterring IUU practices. In fact, difficulties such as defining rights of access to highly migratory stocks, especially in the high seas, may encourage the building of fishing capacity especially by countries not affiliated to RFMOs. Lack of effective management measures and enforcement mechanisms may also encourage IUU practices. Such management measures could also be circumvented by investing in the upgrade of inputs such as hull, engine, gear which is often done to offset regulations to reduce fishing effort hence, triggering capacity creep. Claims by developing states are other factors that may further enlarge fleets despite the fact that they can be justified by legitimate aspirations for economic development. Evaluation of current capacity levels and the development of strategies to freeze capacity, or to redistribute it, when strictly necessary, are thus sorely required. In this context, joint RFMO initiatives

provide participatory platforms for governance of tuna fisheries that may help in finding solutions to these issues. Measures originally proposed to counteract IUU fishing can also benefit capacity management and are currently discussed in such fora. Creation of a global vessel register, port state measures and trade sanctions may complement current practices to discourage the building of capacity not affiliated to specific RFMOs.

Acknowledgments

This work was partially funded by the EU 7th FP project TXOTX (Technical eXperts Overseeing Third country eXpertise, no. 212188) and by the Department of Agriculture and Fisheries of the Basque Country government. It does not necessarily reflect their views and in no ways anticipates the European Commission's future policy in this area. This paper is a contribution no. 567 from AZTI Tecnalia (Marine Research Division).

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