Complications of designing tenure rights programs for highly migratory fisheries Eastern Pacific Tropical Tuna Fisheries

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Abstract
This paper focuses on the realities of designing a strong user rights program for a highly migratory fishery with a high seas component. Its specific focus is the purse seine sector of the tropical tuna fishery in the Eastern Pacific, where the current weak user rights program based on vessel hold capacity and complementary measures is reaching its limit of effectiveness. Stronger forms of user rights have been considered by members of the Inter American Tropical Tuna Commission, the regional body responsible for setting region wide management measures for this fishery. Agreement on allocation and other design features to achieve a region wide solution is complicated by the multilateral decision making process, where member states who have a lot to gain are not always willing to compromise with those who want to enter or increase participation in the fishery and vice versa. A stepwise approach is proposed to allow participants to gradually change current behaviour and to learn and adapt the system towards the desired end goal. While the paper is focused on the Eastern Pacific case, these insights are relevant for other tuna producing regions depending on the context as tuna fisheries are heterogeneous across many dimensions including vessel size, catch composition on the high seas versus exclusive economic zones, value chain complexity, current value and potential post transformational value, strength and capacity of governance institutions and other enabling conditions for reform.

1. INTRODUCTION

1.1 Description of the fishery

Tropical tuna fisheries in the Eastern Pacific Ocean (EP) are trans-boundary spanning several coastal states' Exclusive Economic Zones (EEZs) as well as high seas areas (Figure 1). In accordance with international agreements, management and coordination of these fisheries are carried out by Regional Fishery Management Organizations (RFMOs), as they require regional cooperation to be successful at meeting ecological and socio-economic objectives. The Inter-American Tropical Tuna Commission (IATTC) carries out these functions for EP tuna fisheries and is currently comprised of 21 members, including coastal states and distant water fishing nations.[1] The IATTC was created by a treaty in 1949, also known as the 1949 Convention.[2] It entered into force in 1950 and was enhanced in 2010 after the adoption of the Antigua Convention.[3]

[1] The members of the IATTC are Belize, European Union, Nicaragua, Canada, France, Panama, China, Guatemala, Peru, Colombia, Japan, Chinese Taipei, Costa Rica, Kiribati, United States, Ecuador, Korea, Vanuatu, El Salvador, Mexico, and Venezuela. Bolivia, Honduras, Indonesia and the Cook Islands are Cooperating Non-Members.
[2] The 1949 Convention: http://www.iattc.org/PDFFiles/IATTC_convention_1949.pdf
[3] The Antigua Convention: http://www.iattc.org/PDFFiles2/Antigua_Convention_Jun_2003.pdf

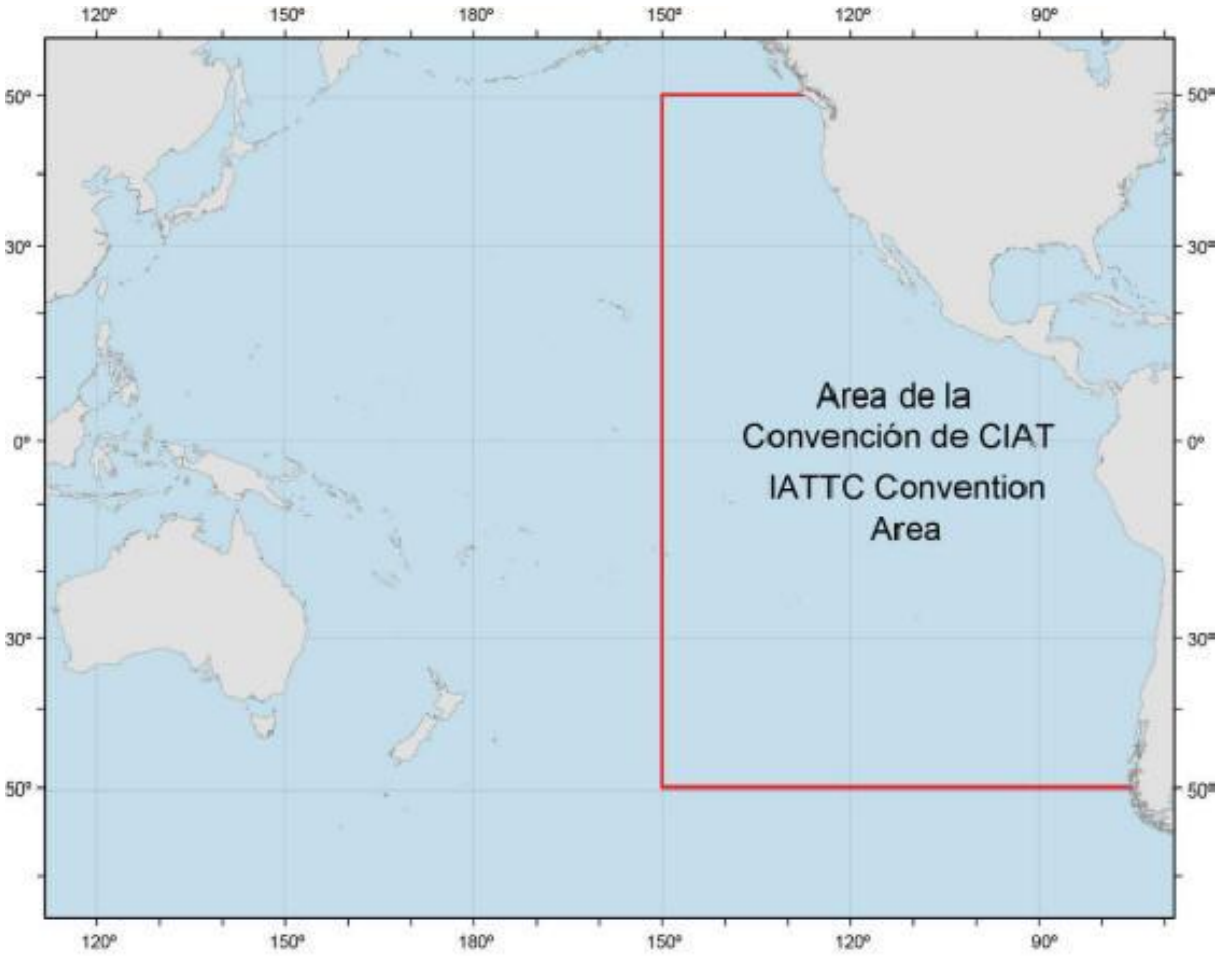

Figure 1. Agreement area for the Inter-American Tropical Tuna Commission as defined in the Antigua Convention.
Source: https://www.iattc.org/images/WebPics/EPOmap.jpg.

Tropical tuna catches from the Eastern Pacific Ocean (EPO) constitute about 12 percent of the world's total catch of tunas, and thus fluctuations in EPO catches have little to no effect on prices at the dock (Bucaram, 2016). The three most important tropical tuna species are yellowfin, bigeye and skipjack. Since 2011, yellowfin landings have declined to levels below that of skipjack due to the drop in catches by Mexican, Venezuelan and Ecuadorian flagged vessels (Figure 2).[4]

Purse seines are the dominant gear used, contributing about 91 percent of the total EPO landings in recent years (Figure 3). Purse seine tuna catches from the EPO ranged between 450 000 to around 640 000 metric tons during the period 2007 to 2016, and typically, skipjack tuna comprises the largest component (49%), followed by yellowfin tuna (39%) and then bigeye tuna (10%)

[4] From IATTC catch/effort public domain database http://www.iattc.org/Catchbygear/IATTC-Catch-by-species1.htm

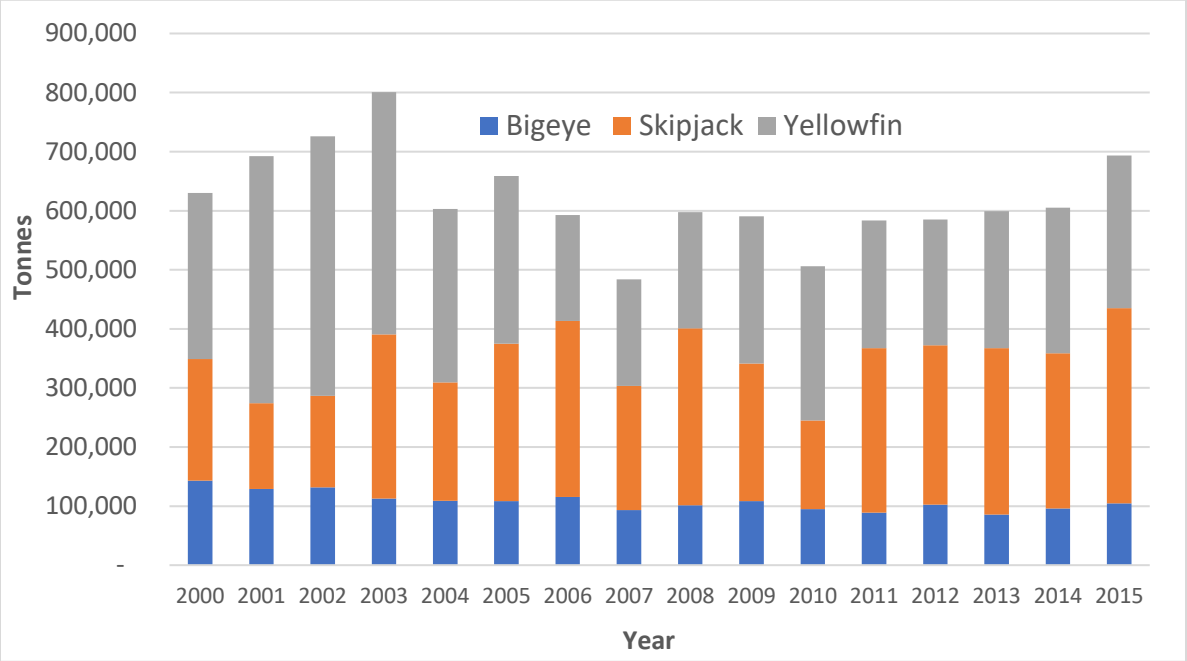

Figure 2. Total Catch of Yellowfin, Bigeye and Skipjack Tuna in the Eastern Pacific Ocean from 2000 to 2015.
Source: IATTC. Catch Reports Data. https://www.iattc.org/CatchReportsDataENG.htm.

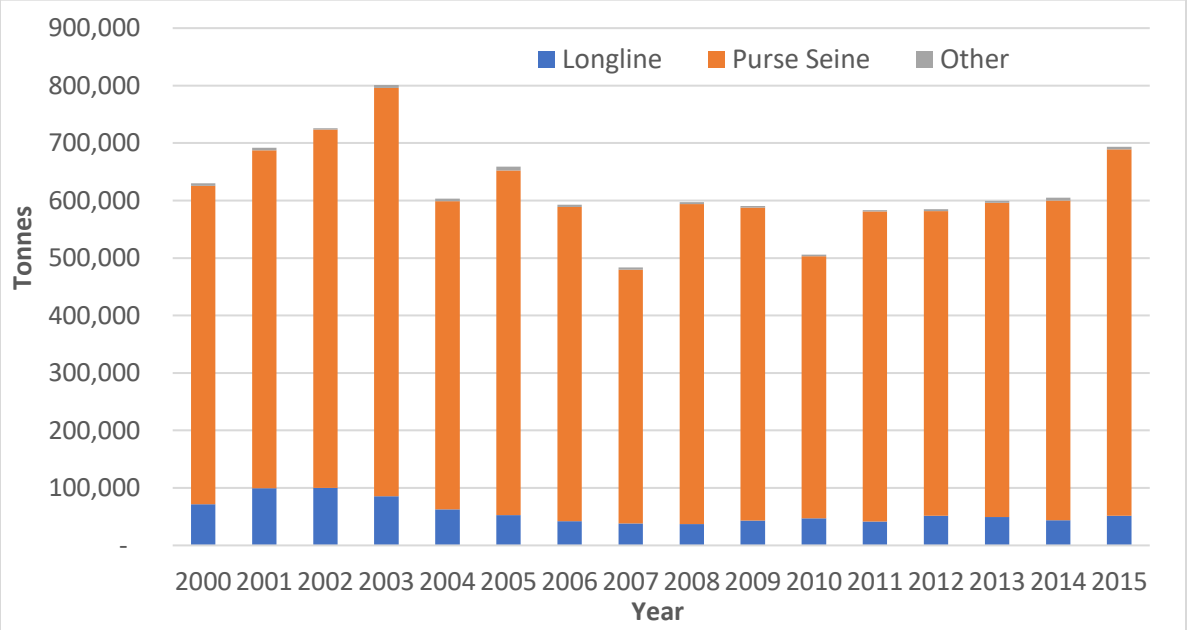

Figure 3. Total Catch of Yellowfin, Bigeye and Skipjack Tuna in the Eastern Pacific Ocean from 2000 to 2015 classified by Gear.
Source: IATTC. Catch Reports Data. https://www.iattc.org/CatchReportsDataENG.htm.

The purse seine fleet operates in the EEZs and on the high seas. In 2013, vessels flagged by five Latin American coastal states (Ecuador, Mexico, Panama, Venezuela and Colombia) took just over 80 percent of the purse seine catch (Maharaj, 2016). More recently, the US purse seine fleet authorized to fish in the

EPO became more active in this region and is now the third-largest operational fleet (Figure 4). The purse seine fleet is broadly divided into two categories. One category of vessels set mostly on fish aggregation devices (FADs) targeting skipjack tunas and incidentally capturing small sizes of bigeye and yellowfin tunas in which Ecuador is the major participant. The other category of purse seine vessels set on dolphins targeting larger sizes of yellowfin tuna in which Mexico is the major participant.

The longline sector primarily targets adult bigeye taken largely by distant water fishing nations (Japan, Korea, China and Taiwan) operating exclusively on the high seas. These vessels also operate in the Western Central Pacific and are subject to the rules of both RFMOs.

There is heterogeneity in the purse seine sector by mode of fishing and vessel size. While the fleet is highly industrialized, there is variability in vessel sizes (Figure 4), with most of the fleet in the Class 6 group (greater than 426 m^3). Currently, a larger portion of the fleet primarily fishes over FADs, and there is more variability in vessel sizes in this category of purse seiners (Figure 5).

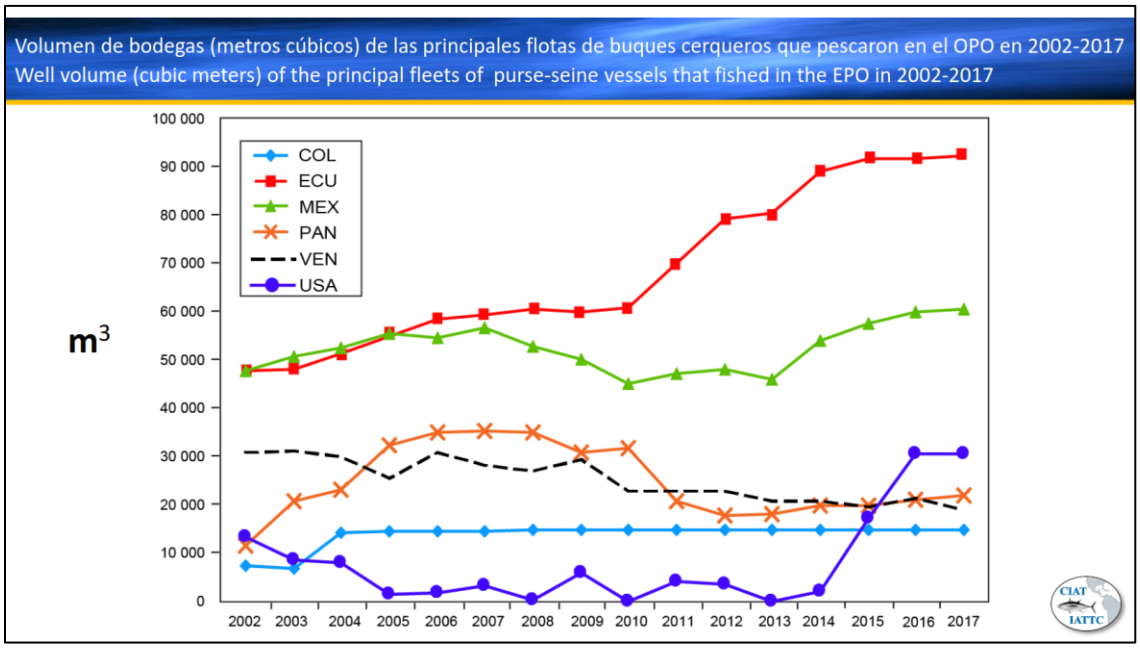

Figure 4. Operational Capacity of the major fleets in the Eastern Pacific Ocean.
Source: CAP-20-PRES (IATTC, 2018).

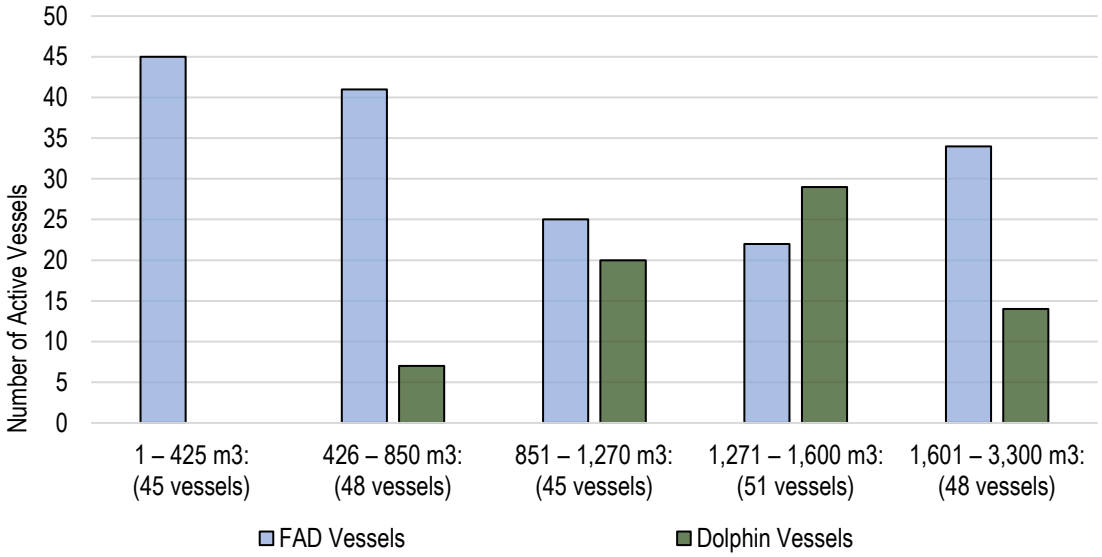

Figure 5. Distribution of Dolphin and FAD Vessels by Capacity Bins from 2016.
Source: Developed by Northern Economics using IATTC data (Northern Economics, 2018).

1.2 Economic contribution and social implications of the fishing activity

The purse seine catch is primarily destined for the canned tuna market, while the longline catches go to the high-end sushi market. Currently, most of the economic benefits from the tropical tuna fisheries are derived from the landings associated with the purse seine sector. The economic benefits derived from the EPO tropical tuna fishery not only accrue to actors along the value chain but also the communities dependent on this commerce.

The primary focus of this paper is the industrial purse seine fleet that has demonstrated fluctuations in net operating revenue, with what appears to be a decline since 2013 by nearly USD 200 million (Figure 6). There is also wide variability in profitability across the fleet and from year to year. To assess the variability in this fleet, vessels are categorized into whether they primarily fished over dolphins or FADs. In both subsectors of the fleet, on average a larger proportion of dolphin vessels are in the red where operating costs exceed revenue. The net operating revenue for most vessels does not exceed USD 2.5 million per year (Figure 7).

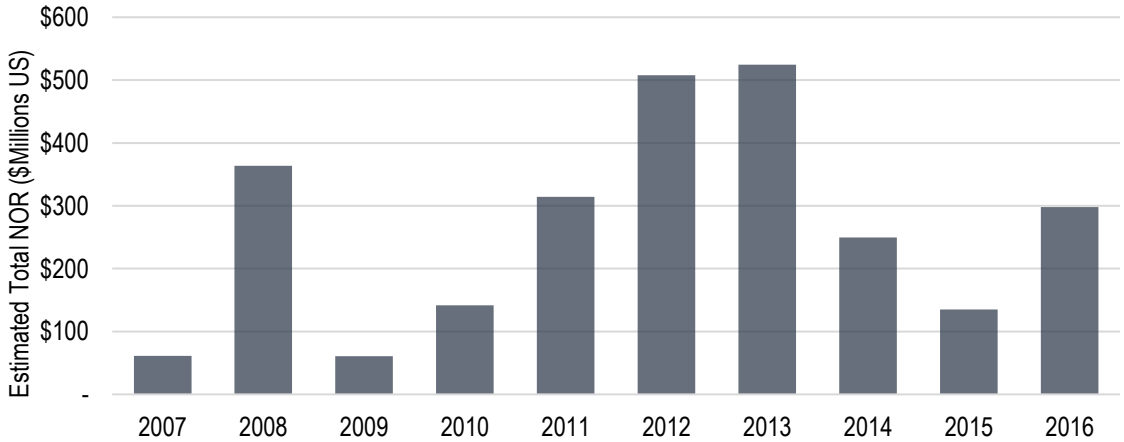

Figure 6. Estimated Nominal Fleet-wide Net Operating Revenue, 2007–2016.
Source: Northern Economics (2018).

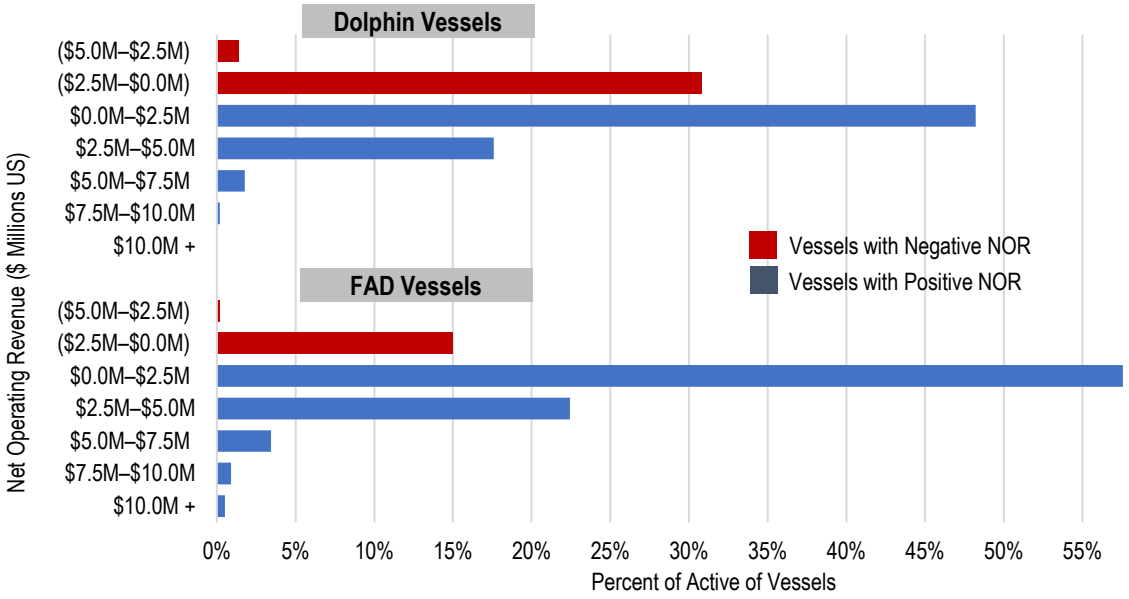

Figure 7. Distribution of Net Revenues per Vessel by Vessel Type, 2010–2016.
Source: Northern Economics (2018).

The canned tuna processing sector is a major source of employment in specific "hot spots" in Latina America. Ecuador is the second most important producer and exporter of canned tuna in the world (Bucaram 2016). Manta, Ecuador is recognized as the most important processing cluster in the Eastern Pacific, as its processing plants receive tuna landings not only from the Ecuadorian fleet but also by fleets from other countries that include Colombia, Panama, Costa Rica and the European Union (Bucaram 2016).

Prieto (2012) estimated that 73 203 direct and indirect jobs were in the harvesting and processing sectors in 2010. This value is an underestimate, as it does not include employment in Spain that depends on the EPO tuna fishery. The majority of these jobs are in the processing sector, as around 33 000 people are estimated to be employed directly in the various Latin American canneries in the region. An estimated 5 773 jobs are crewmembers on fishing vessels, which also provide around 500 000 days of temporary work in maintenance and unloading. The direct employment in other parts of the value chain was not captured in these figures. The number of direct jobs in the national and international distribution or administration of harvesting enterprises is significant.

The communities that have the highest index of dependence on the tuna fishery are Manta and Posorja in Ecuador, and both are the largest communities dependent on tuna as a source of employment. There are smaller communities with a high index of dependence, such as El Salvador, Guatemala and Costa Rica, where large tuna processing plants dominate the industrial sector (Prieto, 2012).

Employment in the harvest sector is male-dominated, and the processing sector is female-dominated. Crew members on fishing vessels are generally skilled with higher education levels compared to processing workers who rarely receive formal training (Prieto 2012). More recent interviews carried out by Bucaram (2015) revealed that vessel captains and crew members typically have good salaries and social standing.

2. MANAGEMENT OF THE FISHERY AND RIGHTS-BASED APPROACH

The member states of the IATTC are responsible for the management of this fishery and consensus is required for the adoption of management measures that apply to the Eastern Pacific. Ratification of this voluntary system is required at the national level by member states who are responsible for enforcing these measures. In addition to IATTC wide management measures, member states can also implement additional measures that apply to their respective flag vessels and EEZs.

2.1 Management of the fishery

Given the complexity of management under a multilateral regime, no single management tool is expected to address all issues in high seas fisheries. This is the case for the Eastern Pacific. Currently, the IATTC manages the purse seine fleet primarily through input restrictions and the longline fleet through output restrictions.

Since 2002, the primary means of management of the purse seine fishery has been through the limitation of capacity that is discussed further in the section below. The following additional measures apply to the purse seine sector.

1. *Seasonal Closure of 72 days*. All class 5 and class 6 purse-seine vessels must stop fishing in the EPO for a period of 72 days. Members and cooperating non-members (CPC) of the IATTC decide which of the following two closure periods to observe: from July 29th to September 28th, or from November 18th to January 18th. Class 4 purse-seine vessels are able to make only one 30 days fishing trip during the specified closure periods, provided that any such vessel carries an observer from the On-Board Observer Program of the Agreement on the International Dolphin Conservation Program (AIDCP).
2. *Area Closures*. Prohibition of fishing activity by purse seiners in the area located between 96° W and 110° W, and 4° N and 3° S, an area known as “El Corralito”, from 00:00 hours on September 29th to 24:00 on October 29th.
3. *Observer coverage:* There is a 100 percent observer requirement for all Class 6 vessels.

Purse-seine vessels of IATTC capacity classes 1-3 (182 metric tons carrying capacity or less), longline vessels less than 24 meters’ length, as well as pole-and-line, troll, and sport-fishing vessels are not subject to these measures.

The main target of the longline sector is bigeye tuna, and the IATTC manage this sector through bigeye tuna catch limits allocated by member country for vessels greater than 24m as follows:

Metric Tons	2014-2016
China	2 507
Japan	32 372
Korea	11 947
Chinese Taipei	7 555

2.2 Rights-based approach: allocation and characteristics

For the purse seine sector, IATTC Resolution C-00-06 in June 2000 established a Vessel Register with the intent that only those vessels that fished before June 2002 would be authorized to fish in the Eastern Pacific. This quasi limited entry measure to some extent, initially allocated the number of vessels by member states active in the fishery. Documented capacity, measured as vessel hold space, on the Register could be corrected. New vessels could only enter the fishery if vessels were removed from the Register and provided that the total capacity of any replacement vessel does not exceed that of the vessel or

vessels replaced. IATTC Resolution C-02-03 created a target capacity level of 158 000 m^3 of vessel hold space (capacity) and established the initial allocation of capacity by a member state. However, in order to obtain agreement across member states, provisions were made to:

- allow Costa Rica, El Salvador, Nicaragua, and Peru to collectively add 18 720 m^3 of capacity to the register; and
- allow up to 32 vessels from the U.S. that are authorized and licensed by other RFMO's (e.g. WCPFC) in the Pacific to take a single trip in the EPO not to exceed 90 days.

The intent of IATTC members was to strengthen measures to reduce fleet capacity after 2002. However, the capacity management plan has yet to be approved, and total potential capacity continually increased (Figure 8). This was primarily due to the settlement of disputes and correction of measurement errors after 2002 that allowed an increase of nearly 20 000 m^3 of vessel hold space. Capacity can be leased and sold across member states in the IATTC, and this resulted in disputes based on who owns the rights: the vessel owner or the flag state. The opportunity to sell/lease fleet capacity partly motivates the "new claims" by member states who want to participate in the fishery without developing or increasing the size of national fleets. Currently, claims and disputes account for 53 000 m^3.

Operative capacity has grown substantially since 2002, and that growth is directly related to the increase in fishing effort and mortality on the stocks (Figure 8). For example, in 2015, an additional 25 000 m^3 of capacity was activated, and this resulted in an increase of 10 percent of catches per year. Furthermore, measures to address effort creep were not put in place. As a result, effective effort per m^3 increased as more efficient vessels of the same size replaced older vessels and other unrestricted inputs usage increased, such as more effective FADs and larger nets that fish deeper in the water column.

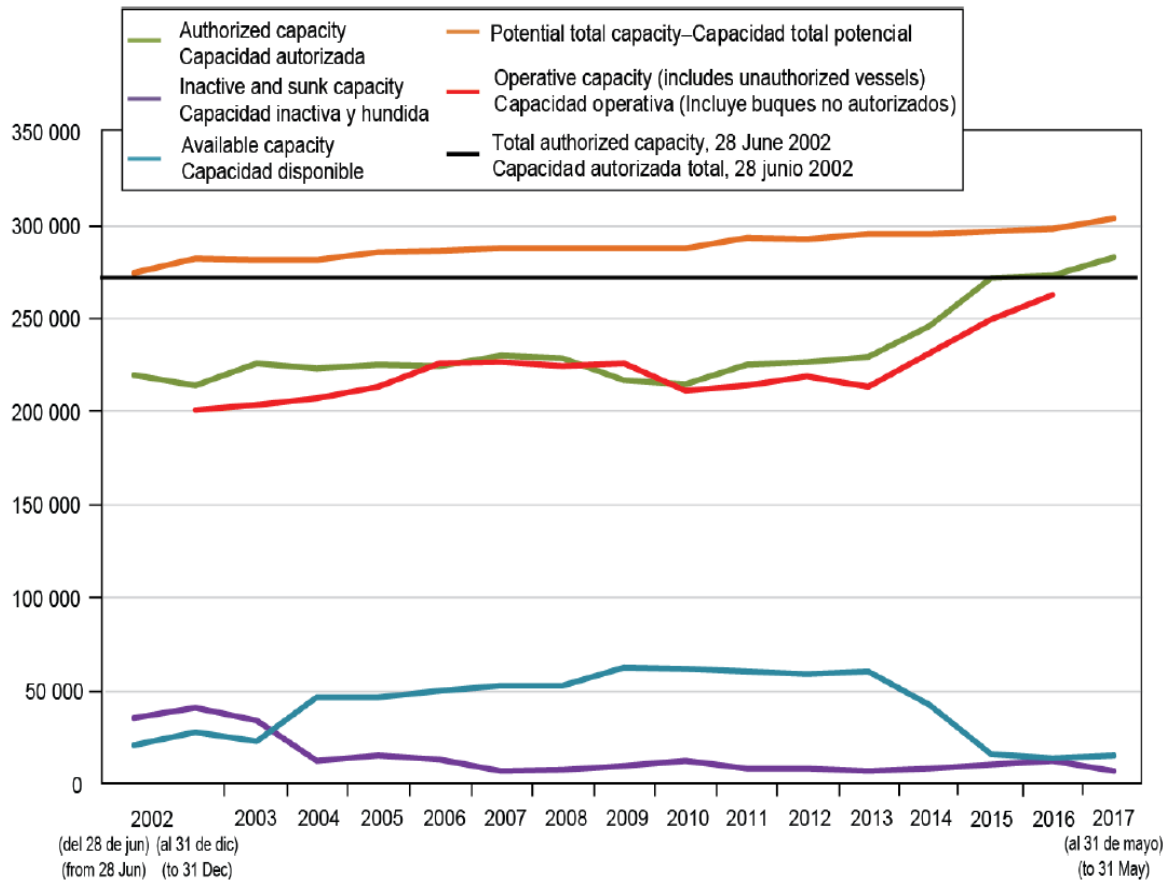

Figure 8. Authorized, Inactive, Available, Potential Total, and Operative Capacity (m3), 2002–2017.
Source: Reproduced from IATTC Document CAP-18-03 (2016).

3. CONTRIBUTION OF THE RIGHTS-BASED APPROACH TO ACHIEVING SUSTAINABILITY

3.1 Sustainable use of the resources

The IATTC estimated the Maximum Sustainable Yield (MSY) of bigeye tuna to be 113 700 tons. This MSY was reduced to about half its level in 1993, due to the expansion of the floating-object fishery, including fish-aggregation-devices (FADs), which increased mortality on the smaller sizes not yet at sexual maturity. Similarly, the IATTC estimated that the MSY of yellowfin tuna is 275 300 tones (IATTC, 2016). Reducing the catch of small bigeye and yellowfin will increase the MSY and overall productivity of these species. To achieve these increases in MSY, the number of sets on floating objects will need to be decreased, and the cost will be borne by the vessels that primarily use FADs. The beneficiaries will be the longline fleet that targets adult bigeye and the purse seine fleet that targets larger sizes of yellowfin tuna.

In recent years, sustainability issues arose with bigeye and yellowfin tunas and management recommendations are provided to the IATTC Commissioners to keep these species on a rebuilding trajectory or to end overfishing. It is important to emphasize that management measures are derived through consensus and that political economy plays a role in the speed at which the agreements are reached and whether the effectiveness of the final measures meet the scientific recommendations.

Due to the life history characteristics of skipjack tuna, the stock assessment results typically indicate uncertainty about stock health, and it is difficult to assess MSY reference points and biomass levels. Prior to 2017, the scientific staff concluded that there is no evidence to indicate a credible risk to the biological

health of skipjacks stocks. However, other indicators of stock health that the IATTC utilizes such as average size and catch per unit of effort caused some concern among the IATTC scientific staff in 2018. Further, the staff recommended limits on the number of sets on FADs and unassociated schools (SAC, 2018).

As described earlier, there are established complementary measures to control mortality of bigeye and yellowfin in the EPO. Usually, seasonal closures are adjusted to account for the effects of the increased fleet capacity and to reduce mortality of bigeye and yellowfin. The problem with this approach is the ever-increasing length of the closed season that reduces the net operating revenue across the fleet. In 2002, the IATTC implemented a 31-day closure period during the month of December for all purse seine vessels.[5] Since 2002, there has been a trend to continually increase this closure period. The closure period was expanded to 42 days in 2003, 59 days in 2009, 62 days in 2010 and 72 days in 2018. The real question is whether the current system of capacity rights and closure periods has proven effective at keeping the stocks healthy. If all EPO capacity became fully operational, the seasonal closure would need to be increased by at least another 20 days (Northern Economics, 2018). In that event, it is unclear whether there will be agreement across all parties to increase the seasonal closure to this extent. In addition, as the catches of adult yellowfin declines, this could result in an increase in sets over FADs by vessels that traditionally fish over dolphins, further exacerbating the mortality of sexually immature bigeye and yellowfin tunas.

3.2 Economic viability of the fishery

The economic viability of the tropical tuna fishery is described in the way the three subsectors (industrial longline, FAD purse seine, dolphin purse seine), interact and is threatened by the continued increase in purse seine fleet capacity and effective effort.

There is evidence that increased effort in FAD purse sector leads to reductions in the abundance of adult yellowfin and bigeye tunas and the MSY for these species. This change in population structure will have a negative impact on the economic performance of the purse seine fleet primarily fishing over dolphins that target adult and medium sizes of yellowfin tuna and the longline fleet that primarily targets adult bigeye. Increases in purse seine capacity and effective effort will also result in longer closed seasons that will have a negative impact on the profitability of the entire purse seine fleet. As described previously, in an effort to control the growth in purse seine operative capacity and resulting effort, the seasonal closure continually increased. The current closure is costing the purse seine harvest sector at least $46 million annually (Northern Economics, 2018). Increases in the seasonal closure would further undermine the economic performance of the purse seine sector and are likely once unused capacity becomes operational and “effort creep” continues. This continual downward spiral will not only result in losses to vessels owners but will also have impacts across other sectors of the canned tuna industry, undermining businesses and employment in vulnerable communities. There would be food security implications if stocks of bigeye and yellowfin decreased substantially due not only to overall health of the stocks but also to structural changes in the yellowfin and bigeye populations.

4. MAIN CHALLENGES AND WAY FORWARD

The overall assessment by this author shows that the input based right on hold space (capacity) may have slowed the growth of “effective effort” in the purse seine sector. As the current fleet capacity is nearly double the optimum estimates and the IATTC has not put measures in place to move the fleet to its optimum size as it agreed to do in 2003, the effectiveness of this system is likely at its limit. As discussed in previous sections, this situation creates a tendency towards the over-exploitation of the resources, with

[5] See IATTC Resolutions C-02-09 BET YFT, C-03-12, C-04-09, C-06-02, C-09-01, C-10-01, C-11-01, C-13-01, C-17-02 at https://www.iattc.org/ResolutionsENG.htm for additional details on closures.

the probability of worsening during the coming years. The latter opinion was shared by experts during a survey based on the fishery performance indicator methodology (Bucaram, 2016)

The IATTC has debated the use of more well-defined rights that could replace or complement the current system. However, allocation deliberations have not reached a settlement. Dissemination of information on the potential economic gains from stronger, more well-defined types of rights gained a lot of attention among stakeholders in the region. Gentner (2011) demonstrated that strengthening the current rights-based management through the adoptions of a transferable ITQ program could increase wealth in the tropical tuna fishery anywhere from USD 2.7 to 21.4 billion. Sun (2005) indicated that overall profitability would increase in the Eastern Pacific under an ITQ program from a reduction in small tunas in the FAD fishery and a resultant increase in the longline catch. Sun (2010) extended earlier an analysis, and the results indicate that the longline sector is likely to purchase a large share of the purse seine bigeye tuna if cross-sector trading was allowed. This is not likely to eliminate the purse seine sector but reduce its capacity, reward vessels that could avoid small bigeye and require those with bad avoidance skills to buy expensive quota. Bucaram (2016) demonstrated that net operating revenue would increase for the fleet under an individual quota program instead of an increase in the closed season sufficient to cover the cost of increased monitoring (even without the transferability provision). Northern Economics (2018) conducted a more recent analysis on an ITQ program for both bigeye and yellowfin and estimated the equilibrium fleet size to be 195 vessels with a total capacity of 211 003 m^3 and an increase in net operating revenue of 169.4 percent to the remaining active vessels.

4.1 Challenges for the fishery

As described previously, the challenges in the current system would most likely result in worsening of the biological health of bigeye and yellowfin. While stronger forms of rights will improve the overall economic performance of the fleet and improve the biological health of bigeye and yellowfin, challenges remain in the implementation.

Transferable catch based user rights assigned to individual vessels, groups of vessels or communities require improved monitoring (Bucaram, 2016). In the case of the EPO purse seine fishery, additional monitoring may entail increased observer coverage, use of camera systems on the vessels to avoid the tendency to discard bigeye and yellowfin. Increased monitoring of catches at the processing plants will be required to verify catches by vessel and correct misidentification of small tunas.

More well-defined types of input-based user rights have been analyzed as replacing or augmenting the current capacity right. These include vessel days at sea (Squires, 2018) and limits on sets over floating objects and unassociated schools (IATTC, 2018). Similar to the case of user rights for vessel hold space, “effort creep” is likely to occur in these input rights systems that will require adjustments overtime to avoid overharvesting of bigeye and yellowfin. Such adjustments could take the form of reduced total allowable effort and reduced total allowable sets. Costs of management could exceed that of a catch based system depending on the methodology chosen to control effort creep.

Allocation of better-defined rights is another major challenge, especially in this multilateral context where there are substantially higher seas catches. In this RFMO context, the allocation is a two-stage process: at the member state level and then at the level of participants in the fishery (e.g., vessels, groups of vessels, communities). The objectives of the state could be different from the participants in the fishery. These complications will likely entail a lengthy process to settle on allocation at the IATTC level and other design features of a new user rights system. Having said that, there is strong interest from certain members to move a catch based system forward as Ecuador, Colombia and others have presented proposals to the

IATTC to allocate catch rights to member states and with other design elements for vessel level catch systems.[6][7]

Typically, a socio-economic crisis tends to drive action by motivating stakeholders to come to the bargaining table and compromise to reach a solution. It is unclear whether member states of the IATTC are at that point. While some stakeholders are willing to take action due to expected improved economic conditions and concerns about the future of the status quo system, IATTC wide change will occur only if the majority of its members are incentivized to act.

4.2 Improving fishery sustainability in the future

There is no doubt that stronger forms of rights can resolve the negative ecological and socio-economic impacts in the Eastern Pacific tropical tuna fisheries. However, the first best solutions are unlikely given the complexity in deriving management resolutions across diverse interests among member states of the IATTC. Five-member countries account for 80 percent of tuna landings and around 60 percent of purse seine vessels are flagged to two member countries. Other developing coastal states want to achieve their aspirations to participate in the fishery or increase current participation and benefits from the fishery.[8] Nonetheless, significant improvements over the current weak user rights system can be achieved by creatively navigating this diversity in political economy.

Effective second-best solutions may require a stepwise approach to reach the desired end state. This gradualist approach must be sequenced appropriately, and intermediate steps should be carefully analyzed to avoid setbacks in the overall transformation process. A recent example to illustrate this point comes from the IATTC's setting of global quotas for bigeye and yellowfin in the tuna purse seine sectors. In 2017, member states agreed to Resolution C-17-019, which set a global catch quota for the purse seine sets over dolphins and purse seine sets over FADs as an intermediate step towards allocation to member states. Unfortunately, the result was a race to fish that almost resulted in a shutdown of the fishery that primarily operates over FADs in August of that year. Due to this experience, certain member states that previously championed this approach were reluctant to take allocation discussions forward.

The IATTC could divide the transformation into two phases. Phase 1 would include measures that reduce effort creep, allow learning from demonstration projects and control mortality for a portion of the fishery. The Phase 1 programs described below were selected from reviews of relevant proposals submitted by Commissioners of the IATTC, recommendations from expert meetings held under IATTC auspices and an OPP study to support the IATTC in the development of its capacity management plan of action:

1. Replacement vessel associated with a retirement of 20 percent of that vessel's capacity. The Japanese delegation presented a proposal to the IATTC along similar lines –whenever there is a request to reassign capacity, additional capacity must be removed from the vessel register. Japan's proposal (Prop-H-2-JPN) will slowly decrease both the technological and actual vessel hold capacity and may compensate for expanded use of unregulated inputs (effort creep). A modified proposal that would require new vessels to "retire" 40 percent of its equivalent capacity on the vessel register will reduce capacity to the optimum in 23 years assuming the current replacement rate.

[6] https://www.iattc.org/Meetings/Meetings2016/Oct/Pdfs/Proposals/IATTC-90-PROP-G-2-ECU-Tuna-conservation-2017-2018-CLEAN.pdf

[7] https://www.iattc.org/Meetings/Meetings2016/Oct/Pdfs/Proposals/IATTC-90-PROP-G-3-COL-Individual-Vessel-Quotas-IVQs.pdf

[8] This is clearly borne out by the claims for fleet capacity that currently amounts to 53,000 m^3.

[9] https://www.iattc.org/PDFFiles2/Resolutions/C-17-01-Tuna-conservation-2017.pdf

2. IATTC member states with the greatest capacity are rewarded for reducing capacity by reductions in the seasonal closure. Compensation could be paid to those who choose not to fish by vessel owners benefiting from the shorter closed season, or the vessels could be removed through an industry-funded buyback program. This demonstration project could motivate other member states to support permanent capacity reduction measures after observing the economic gains. Depending on the duration of this pilot, measures to control "effort creep" may be required.
3. Uniform threshold limit for small bigeye and yellowfin tunas in the purse seine sector. A similar alternative to IVQs is a uniform limit on small bigeye, and yellowfin tuna catches for all vessels in combination with improved monitoring on the vessels and at the processing plants. The uniform limit approach will constrain the least number of purse seine vessels and redistribute most of the costs of the closed season to vessels harvesting large quantities of small tunas. Such an approach would require improved catch monitoring at the processing plants and onboard fishing vessels.
4. Pilot IVQs to test monitoring of catch rights. Vessels volunteering to participate in this program would be exempt from the closed season and would be subject to increased catch monitoring onboard the vessel and at the processing plants. If successful, this program could be modified and expanded using a stepwise approach to full adoption across the entire fleet.
5. Ecuador could establish an IVQ program for bigeye tuna. Ecuadorian flagged vessels are the main contributor to the mortality of small bigeye tuna, and direct control of mortality can be accomplished through the action of one member state. If successful, this could be the precursor for the full adoption of catch shares for the main tropical tuna species.
6. Promote alternatives ways to benefit from the fishery without increasing fleet capacity. This is especially important for developing coastal states that want to currently participate in the fishery or gain some benefit from the resource.

A number of the above proposals could be implemented and as stated the "right mix" and sequencing are important in design. Once the appropriate phase 1 programs are demonstrating benefits and prompting the "right" behavioural response, phase 2 measures should be implemented. Phase 2 alternatives will apply IATTC wide and are expected to lead to significant capacity reduction through stronger forms of rights such as transferable catch share or transferable effort (days at sea, set limits) share programs.

Consistent with the findings in many fisheries around the globe, individual transferable quota (ITQ) approaches in the EPO can result in reduced fleet size that is close to the optimum (Northern Economics, 2018). The IATTC can sequence this system by addressing bigeye and yellowfin and then consider whether skipjack should be included. Transferable effort (days at sea, set limits) are an alternative to catch share programs and usually implanted when it is too difficult to verify catches at the vessel level. However, these programs will require complementary limits on other inputs such as net sizes and FAD usage in the Eastern Pacific. The transferability part of this program will also require a conversion to transfer effort across vessels of different sizes.

Allocation negotiations can take some time, and the first step is generating sufficient interest to initiate negotiations. As discussed previously, a number of delegations submitted formal proposals to establish ITQ systems. While these proposals were not settled, recent negotiations revealed specific interests and barriers across member states. For example, catch share allocation criteria seem to revolve around near term catch history and/or volume of well capacity (Northern Economics, 2018). Thus, even if allocation proposals are not initially adopted, deliberations can move negotiations to completion by the continual refinement of such proposals. Transferability is sometimes a concern and can be restricted to ensure that certain countries retain participation in the fishery or benefit from the fishery. The concentration of rights

in the hands of a few is another major concern associated with rights trading, and such concerns can be addressed through quota aggregation limits at the vessel and state levels. Trade is essential to reduce fleet capacity and secure the profitability of the industry.

Buybacks in combination with other measures (e.g., quotas) could be used to settle disputes, reach an allocation settlement and should only be used as part of a package of reform, as buybacks without subsequent measures to eliminate incentives for increased effort are unsuccessful. Other forms of side payments may also be needed to obtain an IATTC wide solution and should be explored. However, as in the case of buybacks, settlement of claims should only be considered if it is part of a larger suite of capacity reduction measures.

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