Credible Enforcement Policies Under Illegal Fishing: Does Individual Transferable Quotas Induce to Reduce the Gap Between Approved and Proposed Allowable Catches?

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Abstract In general, approved Total Allowable Catches (TACs) are higher than proposed TACs by the scientific assessment and reported landings approved are higher than approved TAC. We build a simple enforcement agency's behavior model that generates—as a rational behavior—those two facts. The model has two ingredients. First, there exists illegal fishing generated by an imperfect enforcement technology; second, the enforcement agency cannot commit on announced penalties. We show that lack of commitment increases the potential benefits for national enforcement agency of deviating from proposal (scientific optimal) quotas. Although the enforcement agency wants to announce a low quota target to induce a low level of illegal harvest, it will find optimal to revise the quota announced in order to reduce penalties and improve fishermen welfare. Therefore, agencies find it optimal to approve higher quotas than that proposed by the scientific advice. Our main result is to show that when full compliance is not possible, and national agencies cannot commit, the introduction of Individual Transferable Quotas increases the potential benefits for agencies of deviating from the optimal proposed TAC by the scientific advised.

Keywords Enforcement policies · ITQs · Modern fisheries management

INTRODUCTION

It is well known and established in the scientific literature that excessive fishing effort leads to overexploitation and

economic waste of common-pool resources (Ostrom 2000; Van Long and McWhinnie 2012). This result is often considered as a crisis of governance of the oceans (Gutiérrez et al. 2011). The potential of Individual Transferable Quotas (ITQs) to provide an efficient solution to the problem of overcapacity and degradation of marine social-ecological systems is well known within the scientific community.

Although there are several examples of fisheries in which the problem of non-compliance is widespread (Da Rocha et al. 2012a, b; Nøstbaken 2013), little research has been done on the impact of ITQs systems when full compliance cannot guarantee by the enforcing agency.

In this paper, we analyze the impact of ITQs on the enforcement agency behavior when allocating total allowable catches with and without ITQs. We assume that the enforcement authority cannot commit on the initial quotas recommended by scientific committees. We build upon Strandlund and Dhanda (1999), Chavez and Salgado (2005), and Chavez et al. (2008) to analyze the enforcement authority behavior in a simple game theoretic model where the fisherman level of quota violation, non-compliance, is endogenous. As Strandlund and Dhanda (1999) quota violation is induced by an enforcement technology which is insufficient to guarantee full compliance. Unlike previous works, we assume that the enforcement authority chooses sequentially. That is, fisherman's choices are based on their expectations about the enforcing policy.

The enforcement authority is ex-ante interested in reducing illegal captures for increasing the resource productivity. Therefore, the authority's optimal policy is to use of sanctions because imperfect enforcement technology induces illegal fishing (Nielander and Sullivan 2000). Once quotas have been announced, setting sanctions does not alter fleets' capture levels. As result, the establishment of

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quotas only reduces fleets' welfare, given that decisions on capture levels were taken beforehand. Furthermore, once quotas were announced, the enforcement authority has incentives to reduce sanctions by increasing the quotas announced and legalize some of the illegal captures.

The Potential Use of ITQs in Fisheries Management Systems

The management of marine resources is moving away toward new fisheries management and several types of property rights regimes have been proposed to eradicate the overexploitation problem in which a range of flexible, multilevel, and polycentric mechanisms are used (Ostrom 2000, 2006; Gutiérrez et al. 2011). These include territorial use rights (TURFs), individual catch quotas, ITQs, and community fishing rights, among others (Arnason 2002).

ITQs have shown themselves to be fairly effective in generating economic rents in fisheries (Arnason 2002, 2006; Hannesson 2013). Many studies of ITQ systems in operation around the world demonstrate that economic efficiency does indeed improve with the implementation of ITQ schemes (Grafton and McIlgorm 2009). Bjørndal and Gordon (1993) stated that transferability of current fishing vessel quotas may improve flexibility and efficiency through its potential reduction of harvesting costs. Another benefit is enhanced safety, because the fixed catch shares prevent incentives to "race to fish" early in the season (Clark 1990).

Costello et al. (2008) recently compared the historical performance of 121 fisheries with ITQs relative to over 11 000 non-ITQ fisheries. ITQs were associated with a reduced chance of stock collapse, defined by an annual catch falling to 10 % of the recorded maximum for that fish stock. The authors argued that ITQs are a "win-win" proposition: fishermen can increase their profitability while halting, or even reversing, the global trend toward widespread collapse. Other positive effect of ITQs observed in the Canadian sablefish fisheries is that fishing effort has corresponded with a decrease in the fish mortality associated with ghost-fishing, by-catches, and discards (Furness et al. 2010).

However, some controversial issues remain unexplored and unresolved. For example, Sumaila (2010) stated that whatever the potential economic benefits of ITQs, the system acts contrary to principles of equity and social justice in fishing communities wherever they have been tried, and therefore are not appropriate for managing certain fisheries. In particular, as long as only retained catch must be reported rather than total catch, ITQ programs may encourage high grading. The fisherman has the incentive to "high-grade" the catch, by discarding lower quality fish that count against the quota (Banks et al.

2011). In addition, ITQ programs may require substantial enforcement expenses and could cause high unemployment and socioeconomic dislocations in coastal communities (Buck 1995). Another concern is related to the initial allocation of quotas (Arnason 2002, 2006; Sumaila 2010). Even in the very liberal New Zealand ITQ system that issue has been addressed administratively by generally limiting the quota concentration of each stock to 30 % (Machal et al. 2009).

Regarding the relationship between fisheries management and enforcement, Hatcher (2005) demonstrated in an ITQ fishery that while lower quota prices are implied unequivocally by expected penalties which are a function of the absolute violation size, the expectation of penalties based upon relative violations of quota demands can, under certain situations, produce higher quota prices than in a compliant quota market. Parslow (2010) also stated that ITQs in themselves will not prevent a "tragedy of the commons," unless there is sufficient compliance monitoring and enforcement to deter hidden catches. At empirical level, Vélez et al. (2012) also recently carried out a local experiment in Colombia in which they conclude that if the quota is not enforced well, individual harvesters will always prefer increased enforcement—either increased monitoring or increased penalties—of the quota.

In Europe, marine populations are still in trouble due to the historical overfishing problem in spite of the improvements made by the European Commission during the last years. Overfishing stems primarily from the overcapacity of the European fishing fleet (Villasante 2010; Villasante and Sumaila 2010; European Commission 2011), which generates a massive overuse of natural resources that would generate higher economic benefits for the society (Antelo et al. 2012; Da Rocha et al. 2012a). In fact, the excess of fishing effort may cost the world in net economic losses, contributing to the decline of fish stocks. Sumaila et al. (2012) recently estimated that resource rent net of subsidies from rebuilt world fisheries could increase from the current negative US\$13 billion to positive US\$54 thousand million per year, resulting in a net gain of US\$600 to US\$1400 thousand million in present value over 50 years after rebuilding. According to the study, the European Union (EU) is the most affected area in the world, with a potential annual catches losses of 2.8 million ton and a negative resource rent of 4.8 billion year⁻¹.

As a result, the European fisheries need a substantial reform due to the unsuccessful outcomes of the common fisheries policy (CFP) in the ecological, economic, and social dimensions (Froese and Proelss 2011; Da Rocha et al. 2012a). Collusion between national fisheries advisers and industry has been suggested as one of the determinants of CFP failure (Froese and Proelss 2011; Da Rocha et al. 2012a). Enforcement—known as adherence to rules and

agreements and punishing infractions when they are detected—is an essential component of a successful fisheries management policy (Ostrom 2000; Arnason 2006; Nøstbaken 2008).

Da Rocha et al. (2012a) showed that there is a clear pattern between the approved TACs and the reported landings. There is a regular lack of enforcement at national fisheries authority level which affects most of the stocks analyzed. Member States fisheries enforcement is lax, with cases where actual catches exceeded the agreed amount by more than 100 % (Froese and Proelss 2011).

As a solution to solve some of these problems, a number of countries have introduced ITQs in selected fisheries. Canada was among the first countries to implement ITQs in the late 1970s, followed by Zealand (1984) and Iceland (1991) to move toward ITQ-based fisheries management (Arnason 2006). In Europe, the Netherlands adopted an ITQ scheme for the important sole and plaice fisheries as early as 1976. In Denmark, an ITQ system for the entire fishery has been in force since 2007.

The Use of Game Theory in Fisheries Economics

Game theory is a common method in economics to examine interaction between and among players (i.e., individuals, firms, or States) (Barret 2007). Game theory has been widely recognized as an important tool in many fields of research. The theory is commonly used to investigate the role of cooperation in economics, and until eight game-theorists have won the Nobel Memorial Prize in Economics Sciences.¹

In the field of fisheries economics, Professor Munro's work was the most stimulating and original contribution to game theory applications to shared fishery resources before and after the UNCLOS era (Villasante et al. 2014). Since that, the application of game theory to the international management of fisheries increased rapidly in the 1990s after, creating a valuable work area for the analysis of cooperation in common-pool resources (Ostrom 2000; Dasgupta 2009; Walker et al. 2009).

The theory focuses on the characteristics of each player's strategy, and allows researchers to predict the possible solutions to the game in the form of more or less lasting coalitions (Villasante et al. 2014). When players do not cooperate they usually behave entirely by self-interest (Dasgupta and Heal 1979; Ostrom 1991). The literature shows that the non-cooperation between players usually leads to a significant overexploitation of marine social-ecological systems (Munro et al. 2005). As a result, the overall outcome is an example of what is probably the most

famous of all non-cooperative games, the so-called “prisoner's dilemma” (Munro et al. 2005).

MATERIALS AND METHODS

Before presenting the game theoretical model used to investigate the conflict of the enforcement authority under ITQs when there exists a lack of commitment, we first use a case study approach by selecting some of the most important species for European fisheries. We gathered data of approved quotas and catches for relevant commercial fisheries that were subjected to TAC regulation under the CFP in European waters for the 2001–2010 period in order to test the lack of enforcement in them:

- Approved TACs and reported catches/landings* we construct a temporal series to combine approved TACs and reported catches or landings depending on the available information provided by ICES,
- Species covered* the selected species include in this study are the Atlantic cod in ICES areas IIIa, IV, and VIIId, 22–24, and 25–32; Hake Northeast Atlantic in areas VIIIc–IXa; Haddock in IIIa and IV, Herring in North Sea and areas 25–29 and 32, Mackerel Northeast Atlantic IIa–IIIabd–IV–Vb–VI–VII–VI–IIabcde–XII–XIV–IXa; Nephrops VIIIab; Nephrops in Skagerrak, Norway pout in IIIa and IV; Sprat in areas 22–32, Whiting in IV and VIIId,
- ICES divisions* here we include species from ICES areas VIII and IX, Baltic and North Sea,
- Illegal, unreported and unregulated (IUU) catches* we do not include data of IUU catches because ICES rarely provide information for European fisheries.

Figure 1 shows that the lack of enforcement is also observed in a high number of the species included in this study. However, the enforcement problem seems to be lower in the Baltic Sea rather than the North Sea species, in particular in pelagic fish stocks. As described in the previous sections and as shown here, two facts in European fisheries are observed:

- In general, approved TACs are higher than TACs proposed by the scientific assessment.
- Reported landings are higher than approved TAC.

In this section, we build a simple enforcement agency's behavior model² that generates—as a rational behavior—those two facts. The model has two ingredients. First, as facts suggest there exists illegal fishing generated by an imperfect enforcement technology. That is, as in Chavez

¹ See http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/.

² See the [Electronic Supplementary Material](#) for the detailed description of the model used here.

Fig. 1 Approved TACs vs. reported catches/landings for selected commercial fish stocks: 1 Herring North sea, 2 Mackerel Northeast Atlantic IIa–IIIabd–IV–Vb–VI–VII–VIIIabcde–XII–XIV–IXa, 3 Atlantic cod Baltic sea (22–24), 4 Atlantic cod Baltic sea (25–32), 5 Herring Baltic sea (25–29 and 32), 6 Sprat Baltic sea (22–32), 7 Norway pout III and IV, 8 Atlantic cod North Sea (IIIa, IV, VIIId), 9 Haddock North sea (IIIa, IV), 10 Nephrops Skagerrak (IIIa), 11 Whiting North sea (IV, VIIId). Source: own elaboration from ICES and fisheries law

and Salgado (2005), both penalties and the technology of detection are not sufficient for guarantying full compliance.

Second, the enforcement agency cannot commit on announced penalties. Although it wants to announce a low quota target to induce a low level of illegal harvest, it will find optimal to revise the quota announced in order to reduce penalties and improve fishermen welfare. Given the existing lack of commitments, the enforcement agency finds a “time consistency problem,” that is, quotas announced and quotas authorized after harvesting will be different. The next subsection shows how in this environment optimal enforcement agency’s behavior results in quotas (approved TACs) higher than ex-ante optimal quotas (proposed TACs by scientific advice).

A Simple Fishery with Illegal Fishing

Assume there is a continuum of identical fishermen, each of whom take the average fisherman’s choices as given. Moreover, we assume that fishermen’s behavior can be summarized as a competitive equilibrium that responds non-strategically to the enforcement agency’s behavior, i.e., the only strategic agent in the model is the enforcement agency.

Fishermen’s profits are given by

$$h(e) - \frac{c}{2}e - \theta f(v) + T,$$

where the harvest level $h(e) = \sqrt{Ae}$, which is strictly increasing in fishing effort, the marginal cost of harvesting is constant and equal to c , v is the quota violation, $v = h(e) - q \geq 0$ and, finally, T is a lump sum transfer received by fishermen from the enforcement agency. Note that the average quota per vessel is non-transferable.

We assume that total factor productivity, $A > 0$, is a public good. Although fishermen take it as given, it is determined by total harvesting. We assume that stock productivity decreases as total harvesting increases, that is $A = h^{-\beta}$.

Assume that the technology of detection, v , is not sufficient for guarantying full compliance and that penalties, $f(v)$, are imposed by courts (with backdating being forbidden). As in Strandlund and Dhanda (1999) and Chavez and Salgado (2005), we assume that the penalty function, $f(v)$ is zero for zero quota violation, $v = h(e) - q = 0$, and strictly increasing and convex for a positive quota violation, $v = h(e) - q > 0$. We assume as Chavez et al. (2008) that $f(v) = (\frac{\gamma}{2})v^2 + \gamma v$, with γ greater than zero. Therefore, the enforcement agency only chooses that average quota per vessel, $\bar{q}$.

When a fisherman believes that the enforcement agency's choice is $\bar{q}$, the fisherman chooses his fishing effort e , and his quota violation v by solving

$$\max_{e,v} \sqrt{Ae} - \frac{c}{2}e - \theta f(v) + T \quad (1)$$

s.t. A , $\bar{q}$, and T are given.

A competitive equilibrium for this economy is a fishing effort e and quota violation such that:

- Given fishermen's (rational) expectations on $\bar{q}$ and A fishing effort e and quota violation v solve the fishermen problem Eq. (1).
- Total factor productivity is given by total harvest, i.e., $A = h^{-\beta}$.

Note that a competitive equilibrium satisfies fisherman's choices, $h = v + \bar{q}$, and is the best response for the enforcement agency's choice, $\bar{q}$. Then the fisherman's best response to the enforcement agency's choice is given by

$$1 - c(v + \bar{q})^{1+\beta} - \theta f'(v) = 0.$$

As in Chavez and Salgado (2005), as quota increases, illegal fishing decreases but total harvest increases. Moreover, average productivity of the resource decreases as the quota increases. As a result, there exists an interior quota for which the private marginal benefits of increasing harvest are equal to the marginal social cost (associated with lower total productivity of the resource). That is, there exists an optimal quota that maximizes total welfare of the fishery. We will call this quota "the Ramsey quota," which can be understood as the "scientific" recommendation or proposed TAC.

Does the Enforcement Authority Approve the Allocated Quotas Proposed by the Scientific Advice?

In this simple model, it can be shown that the government agency finds it optimal to increase quotas so as to reduce the fines associated with the illegal fishing. Given the existing lack of commitments, the enforcement agency finds a "time consistency problem." That is, if the enforcement agency announces the "optimal quota" and induces fishermen's to choose a low level of illegal fishing, they will find optimal to deviate from the announce after fisherman choose the level of harvest.

Note that the government incentive to deviate is motivated by the fact that the collection of fines will only have a negative effect on fishermen's welfare and no effects on fishermen's harvest choices. Therefore, the enforcement agency finds it optimal to legalize illegal fishing by approving higher quotas.

Given that the enforcement agency finds a "time consistency problem," proposed TACs are non-credible. That

is, although the enforcement agency announced a low quota (the optimal) fishermen forecast that the agency will set a high quota in order to legalize illegal fishing. Therefore, Nash equilibrium is the natural outcome. In other words, fishermen forecast that the agency will respond to illegal fishing by setting higher quotas.

Figure 2 shows the welfare outcome values associated with Ramsey (proposed TACs based on scientific advices from the International Council for the Exploration of the Sea), Nash equilibria (the final approved TAC), and the "time consistency" problem. Note that the welfare outcome associated with Nash is smaller than outcome values associated with Ramsey. That is, the enforcement agency tends to find optimal to approve higher quotas than those proposed by scientific advices, which in turn may contribute to the overexploitation of the fishery resource.

Do ITQ's Increase Welfare Under Illegal Fishing When Agencies Does Not Commit on Enforcement Policies?

Consider now that individual quotas are transferable. That is, as in Chavez and Salgado (2005) fishermen's profits are given by

$$h(e) - \frac{c}{2}e - \theta f(v) - \omega q + T,$$

where q is the individual quota demand and ω is the quota price. When a fisherman believes that the enforcement agency's choice is a given quota, the fisherman chooses his fishing effort, his quota demand and his quota violation v by solving

$$\max_{e,v} \sqrt{Ae} - \frac{c}{2}e - \theta f(v) - \omega q + T$$

s.t. A , $\bar{q}$, and T are given.

and $v = \sqrt{Ae} - q$. A competitive equilibrium for this economy comprises a fishing effort e , quota demand q , and quota violation v such that:

- Given fisherman's (rational) expectations on $\bar{q}$, fishing effort e , quota demand q , and quota violation v solve the fisherman problem Eq. (1).
- The quota market clears, i.e., $q = \bar{q}$.
- Total factor productivity is given by total harvest, i.e., $A = h^{-\beta}$.

Note that as in Chavez and Salgado (2005) quota price, ω , is decreasing in illegal fishing. The existence of ITQs modifies the agency problem.³ Then, it can be proved that the introduction of ITQs increases the incentive to deviate. Where there are no ITQs, the enforcement authority of the

³ See Da Rocha et al. (2012b) who describe in detail the formal description.

Fig. 2 Optimal TAC proposed by scientific advice (Ramsey outcome) is marked with a *circle*. Deviation from Ramsey outcome, the “time consistency” problem, is identified with *asterisks*. Final approved TAC (the Nash equilibria) is represented with a **bold circle**

government that cannot commit has the incentive to legalizing a fraction of the illegal fishing and reduce fines. With ITQs, the government agency faces a new incentive to legalizing the illegal fishing: by doing so can reduce ITQs prices. When this new incentive appears, the Nash equilibrium under the ITQs regime is worse than the one without ITQs (Fig. 3). As a result, the welfare outcome of fishermen and fishing companies associated to the Nash equilibrium is lower with ITQs than without them. Another relevant result derived from our study is that, under ITQs, the approved quotas relative to proposed quotas will be also higher than without them.

DISCUSSION

Are ITQs the Best Tool to Solve the Problems of Modern Fisheries Management?

Although the use of catch shares (TURFs, IQ, ITQs, etc.) is growing and there is an increasing interest to investigate

their ecological, economic, and social implications (Costello et al. 2008; Essington 2010), it is important to mention that catch share should be used with caution (Essington et al. 2012; Melnychuk et al. 2012).

Recently, Jardine and Sanchirico (2012) investigated the implementation of catch share programs in developing countries and the correlation with a number of dimensions, namely, governance, resource value, type of catch share, and species characteristics. The authors found interesting results because countries which have catch shares showed higher governance rankings, stronger economies, high-value fishing industries, and fewer people employed in fisheries.

Nevertheless, in spite of catch share systems seem to provide benefits such as the stabilization of fishing mortality (Essington 2010), there other relevant consequences that remain unresolved and need further research (Essington et al. 2012; Melnychuk et al. 2012). For example, although harvest rates tend to decrease over time after the implementation of catch shares, the response is too weak to eliminate overfishing (Essington et al. 2012). Therefore, it

Fig. 3 Welfare outcomes with and without ITQs. Final approved TAC (Nash equilibria) deviate more from proposed TAC (Ramsey) with ITQ than without ITQs

is important to be cautious and do not provide definitive conclusions or even unfounded progresses (at least in the case of ITQs) since most of them were recently adopted and are still in progress (Melnychuk et al. 2012). For example, it should be also noted that the implementation of ITQs in developed (Iceland) and developing countries (Argentina and Chile) are (were) being still controversial.⁴

Do ITQs Provide Adequate Incentives for the Sustainability of Fish Stocks?

The adoption of adequate incentives is a key factor when navigating in the successful transformation of a given marine

social–ecological system (Hilborn 2004), even when including the implementation of an ITQ program. In this paper, we provide new insights that hopefully help to better understand the potential use of ITQs programs in global fisheries. While Chavez et al. (2008) investigated the impacts of an ITQ program in the shrimp fishery in Chile under an imperfect enforcement system; this study shows that IUU catches exist under ITQs. Even more, the enforcement agency has the incentive to deviate approved quotas relative to proposed quotas. This motivates that this deviation will be also higher with ITQs programs than without them.

We mainly showed that the enforcement agency has a rational and large conflict when trying to find a balance between approved TACs, landings, and IUU catches. The conflict of the enforcement agency plays against itself by taking the form of systematic deviations of initial approved allowable catches. Under this scenario, the implementation of ITQs may aggravate this conflict due to the fact that fishermen (and/or coastal States) would prefer higher volume of allowable catches when IUU catches exist.

In theory, providing a tradeable and guaranteed share of TACs could act as an efficient incentive to ensure the

⁴ For example, 70 % of the population in Iceland has a negative perception toward the ITQ system, in spite of it was adopted almost 30 years ago in the country. Probably, because since the start of the financial crisis the economic value of the ITQs (ca 200 thousand millions Iceland Kronas) decreased 50 %. This reduction of the economic value represents the value of catches during the last 50 years in Iceland (Einarsson 2013). For the case of Argentina see http://revistapuerto.com.ar/RP_Otros_Medios_Detalle.php?id=1373; and Chile <http://www.elciudadano.cl/2012/07/18/55158/se-aprobo-en-general-polemica-ley-de-pesca-mientras-movilizaciones-en-su-contra-continuan/>.

sustainability of fishery resources under ITQs systems (Grafton et al. 2007). Nevertheless, if one or some of the key characteristics of ITQs systems is diminished, then fishermen will have fewer incentives to act responsibly. When there is an incentive as the introduction of ITQs by the enforcement authority that tends to reduce the social welfare of fishermen, fishermen respond rationally by increasing their catch levels (or not respecting the quotas).

Third, given that marine stewardship involves changes in the human behavior, the fisher's perceptions, and attitudes toward a given ITQ system are key to help achieving progresses (Emery et al. 2010). In an analysis of the effects of non-compliance with quota demands and the equilibrium quota price in a given ITQ fishery, Hatcher (2005) found that expected penalties as a function of relative violations of quota mean that non-compliant fishing companies are never indifferent between cheating and buying quotas.

Here we also demonstrated that the ecological concerns about ITQs are not the only dimension to take into account when adopting this type of catch share program. Rather, the implementation of ITQs has also effects not only on its economic component of a given fishery itself but also on the ability to implement a successful control by the enforcement agencies. These two aspects, previously analyzed separately by the literature, represent two keys of any fisheries management systems.

Fourth, social norms are also important when analyzing the fisher's behavior and the potential strategy of a given enforcement authority. Ostrom et al. (1992) showed the existence of punishment opportunities in a common-pool resource use game. The fear of punishment has a positive effect on cooperation. In addition, disobedience to the norm may involve a loss of reputation. People prefer to achieve the reputation of being fair and they care about their reputation. They expect to be rewarded for good reputation, and they have to be willing to comply with the norm. In fact, the results presented here show that the enforcement agencies need to reconsider its rational behavior when allocating catches in order to construct reputation over time. As a result, it is probably necessary to set a number of solutions to the problem of norm compliance such as the punishment-based account or the reputation-based account (Teraji 2013).

Fifth, the European Commission has recently acknowledged in Europe that the CFP has failed to resolve the problem of overcapacity. Even when it has spent €2.7 thousand million between 1994 and 2013 to scrap fishing vessels, the real fishing capacity has increased continuously as shown by Villasante (2010) and Villasante and Sumaila (2010). In parallel, the European Commission proposed the introduction of transferable fishing concessions only within member States and for vessels above 12 m (European

Commission (EC) 2011). In principle, member States would set national or regional priorities allocating a given percentage of the national quotas share to the small-scale fishing fleet, and the remaining quotas share would be managed under transferable fishing rights.

As noted, the adoption of ITQs has a number of implications which involve ecological, economic, social, and institutional issues applicable at local and global scales. The adoption of ITQs systems provides an interesting component to the current scientific debate around the sustainability of fish stocks (Pauly et al. 2013). Although it is a more sophisticated version of the old but fascinating discussions between Thomas Huxley and Ray Lankester in the nineteenth century and William Thompson and Martin Burkenroad in the late mid-1940s, a new and distinguished debate has also emerged (Branch et al. 2010; Pauly et al. 2013). Considerable research has been done and a wide range of multiple potential solutions have been proposed to recover fish stocks. Nevertheless, this new scientific debate reincorporates a further stimulating but controversial question for what does not exist a unique solution: what would be the most appropriate fisheries management system for the recovery of fish stocks? With the results presented in this study, would it be advisable the widespread implementation of ITQs?

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