From anecdotes to scientific evidence? A review of recent literature on catch share systems in marine fisheries

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In response to concerns regarding the global status of living marine resources, there has been a worldwide tightening of fishery access regulations. This has led to growing interest in individual transferable catch share programs, a market-based allocation approach to distribute fishing rights. However, the economic, ecological, and social benefits of these systems are the subject of continued debate. Here, we review empirical studies of transferable catch share systems published over the past decade. Our results show that, despite some of these systems having been in place for more than 20 years, systematic empirical assessments of their impacts are still rare. Furthermore, methods used to assess the impacts of catch share systems to facilitate comparisons remain under development, making it difficult to derive general conclusions from existing studies.

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With growing concerns about the status of fisheries worldwide (Nellemann *et al.* 2008; Worm *et al.* 2009; FAO 2010), the first response has been to adopt conservation measures aimed at restricting overall harvesting, to preserve the growth and renewal potential of commercial fish stocks. Analyses of the successes and failures of fisheries management show that while such measures are necessary for stock preservation, they have often failed to restore or maintain sustainability in fisheries, because they do not address the problems caused by the common-pool nature of fish stocks (OECD 2006). This has led to the widespread adoption of access regulations in marine fisheries, particularly programs based on individual transferable harvesting rights (often referred to as individual transferable quotas [ITQs] or transferable catch shares), a market-based approach to the allocation of rights to catch particular species (Moloney and Pearse 1979; Grafton *et al.* 2006).

In a nutshell:

- There have been ongoing, international debates about both the effectiveness and the limitations of individual catch share systems as fisheries management tools
- We review studies published between 2000 and 2010 that attempted to evaluate the effects of these systems in individual fisheries around the world
- This study shows that, over the period considered, catch share systems have not been evaluated in a way that allows general conclusions regarding their economic, ecological, and social benefits to be assessed
- There is a need to develop more detailed studies, as well as new data collection and standardized assessment approaches, to make such evaluations possible

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The actual and potential impacts of this worldwide institutional change, sometimes referred to as a process of "fencing the fisheries commons" (Holland 2000), have been and remain a subject of debate, including within the discipline of natural resource economics (Copes 1986; Bromley 2009; Clark *et al.* 2010; Grafton *et al.* 2010; Sumaila 2010). Scholars have also argued about the effects of catch share systems on the sustainability of targeted stocks (Costello *et al.* 2008; Branch 2009; Chu 2009; Essington 2010) and the ways in which the adverse impacts of fishing activities on associated and dependent species and habitats could be accounted for in these regulatory systems (Squires *et al.* 1998; Branch *et al.* 2006; Holland and Herrera 2006; Sanchirico *et al.* 2006). The social consequences of the introduction of catch share systems have probably been the most disputed issue (Figure 1; Copes and Charles 2004; McCay 2004; Olson 2011).

Given the limited reversibility of transitioning to catch shares (Olson 2011), it is important that the economic, ecological, and social impacts of these management regimes be systematically assessed, so that debates on their further implementation can be informed by scientific evidence. However, despite these systems having existed for several decades in numerous parts of the world, recent reviews have revealed a lack of empirical research dedicated to the systematic evaluation of the impacts of introducing ITQs (Hamon *et al.* 2009; Pinkerton and Edwards 2009; Essington 2010).

A review of recent studies on individual fisheries

We analyzed peer-reviewed studies published in the past decade that looked at the impacts of adopting ITQs on individual marine fisheries. The studies were selected through standard bibliographic search tools, with manual identification of additional studies (see WebPanel 1 for a complete description of the search methods). A subset of

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Figure 1. *Fishing vessels at port in Hobart, Australia. The effects of ITQs on the Tasmanian rock lobster fishery have been described in recent studies, focusing on changes in the structure of fishing activity and on the operation of the quota market.*

studies that focus on assessing the impacts of ITQs in individual fisheries was retained for further analysis. This led to a set of 46 references, published between 2000 and the beginning of 2011, that provide an assessment of the impacts of ITQs in 51 case studies in different regions of the world (Table 1; Figure 2).

For each of the case studies, we extracted information on the nature of the impacts considered and classified them into six broad impact domains: (1) economic status and structure of the fishing industry (Economic); (2) allocation of catch shares (Quota); (3) status of the target resources and associated fish populations and habitats (Biology); (4) interactions between the commercial fishing sector and other stakeholders (Interactions); (5) Stewardship; and (6) fisheries management systems (Management). In each of these domains, the methods of assessing the impacts of ITQs (issues) were identified, and the degree to which these impacts were quantified was assessed (quantification score). Where possible, the issues identified were coded as questions that sought to identify whether the typically anticipated effects of ITQs were observed (WebTable 1), the response to which could be positive, negative, or unavailable. We performed descriptive analysis of the data collected using principal component analysis. Additional details on the data collection, coding, and analysis are provided in WebPanel 1.

Results

Table 2 synthesizes the results of this review, illustrating the following key characteristics of the peer-reviewed literature, published during the period considered, on the impacts of ITQs. First, only a limited overall number (51) of individual case studies was identified, mostly in developed countries (WebTable 2). This is despite the growing number of ITQ schemes that have come into effect around the world, some having now been in place for more than two decades. This observation contrasts with the wide range of possible economic, ecological, and social impacts that have been cited in the debates on these schemes, which is apparent in the large number of issues (50) identified in at least one of the studies included in our analysis.

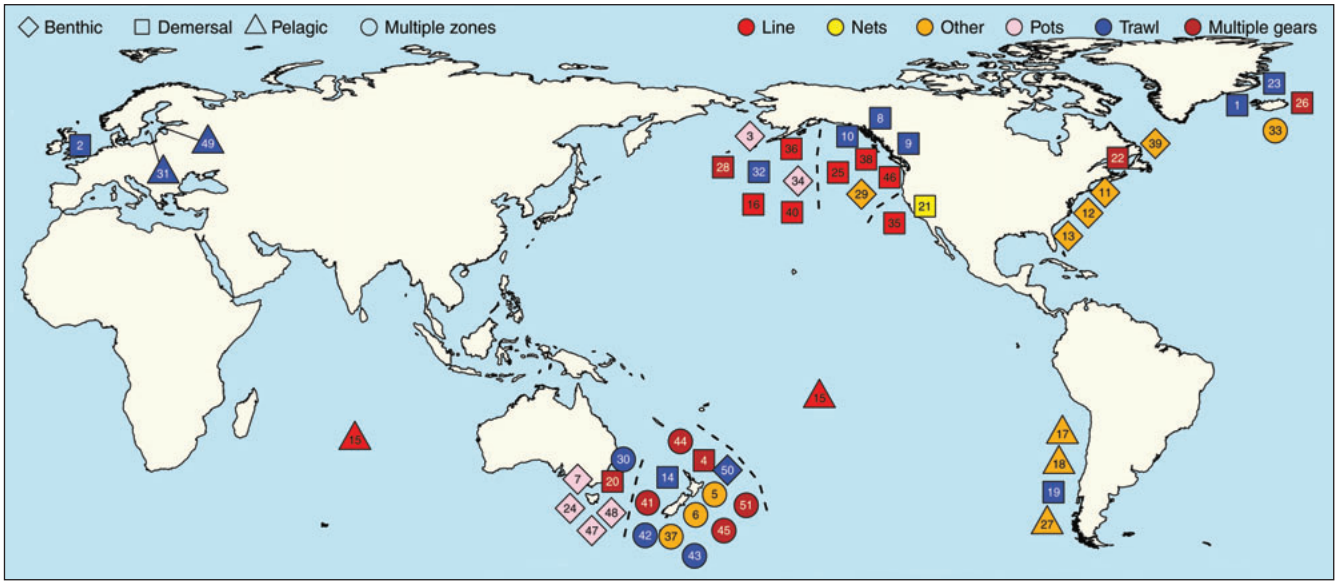


Figure 2. *Case studies included in the analysis. Numbers correspond to studies listed in WebTable 2.*

Second, these studies have largely focused on the economic impacts of ITQ systems, and to a lesser extent on the way in which the quota system evolves over time. Where attempts have been made to quantify these impacts, studies have usually confirmed the expected effects (ie 83% of quantified issues had a positive response). Interestingly, despite this economic focus, there have been remarkably few empirical studies of the quota markets themselves, and in particular the way in which quota selling and leasing prices evolve over time (Q-5 and Q-6, see WebTable 1), in spite of this being a central component of a market-based allocation system.

Third, there is marked heterogeneity in the nature of the issues considered to assess impacts across domains and studies. There are only a few impacts that seem to be examined systematically across all case studies (eg vessel numbers, E-7), and only a small proportion of studies considered all the domains simultaneously *and* sought to quantify impacts. In addition, a large proportion of studies considered only a limited number of issues in a particular domain, therefore providing less comprehensive analysis of the overall impacts of ITQs in that domain. See WebFigures 1–3 for further details on these last two observations.

Despite the growing international debate on the effectiveness of ITQs in marine fisheries, our review shows that, over the period considered, peer-reviewed empirical research on the observed impacts of these management instruments remained limited. In addition, most of the existing literature focuses on partial assessments of the economic, ecological, or social impacts of ITQs, rather than on the development of integrated assessments across these three dimensions, despite this being increasingly required in evaluating the effects of alternative fisheries management strategies (Pereau *et al.* 2012).

Perspectives

A growing number of scholars are calling for more research to be carried out on the real-world impacts of tradeable catch shares in marine fisheries. While there is a solid body of research on such approaches in other areas of environmental policy – particularly water allocation and pollution abatement strategies – only limited systematic analyses have been carried out in the marine fisheries domain. Our review confirms the need for more comprehensive, empirical research. Although many examples of established, tradeable catch share systems now exist, and some ex-post empirically grounded analyses are emerging (Brewer 2011; Emery *et al.* 2012; Grimm *et al.* 2012; Jardine and Sanchirico 2012; Melnychuk *et al.* 2012), this area of research is still developing.

We recommend that new research programs be developed in two directions. First, more detailed studies of some of the core components of the catch share systems themselves are needed; in particular, studies of how the quota systems actually operate and of the drivers of trading patterns and prices are required, because these are key to understanding the impacts of the policies and the contextual elements that influence them. Second, there is a need for analyses of specific case studies, where all the dimensions of an impact assessment of catch shares identified in this review are considered, including economic, ecological, and social concerns. Standardizing such integrated assessments so that comparisons of experiences at national and international levels can be made should be an objective of these studies (they can also provide useful information at local levels). Obviously, such research will not be possible without improved availability of data for all the categories identified, which may require broadening the scope of the information that is collected for assessing the status of marine fisheries managed with catch shares. For example, price data relating to quota trades are not collected in most ITQ fisheries but could provide valuable insights into issues such as how the market has evolved, the current economic state of the fishery, and perceptions on where it may be heading. Such research would also require a broader characterization of the economic, social, and institutional contexts in which the catch share systems have been implemented (Jardine and Sanchirico 2012), as this would allow better identification of the conditions under which these schemes may be considered an effective management instrument globally.

Undertaking such research will ensure that debates on the effects of catch share systems and conditions for their successful implementation are based on empirical evidence, rather than on anecdotes (Matulich and Clark 2003). The development of applied models that explicitly

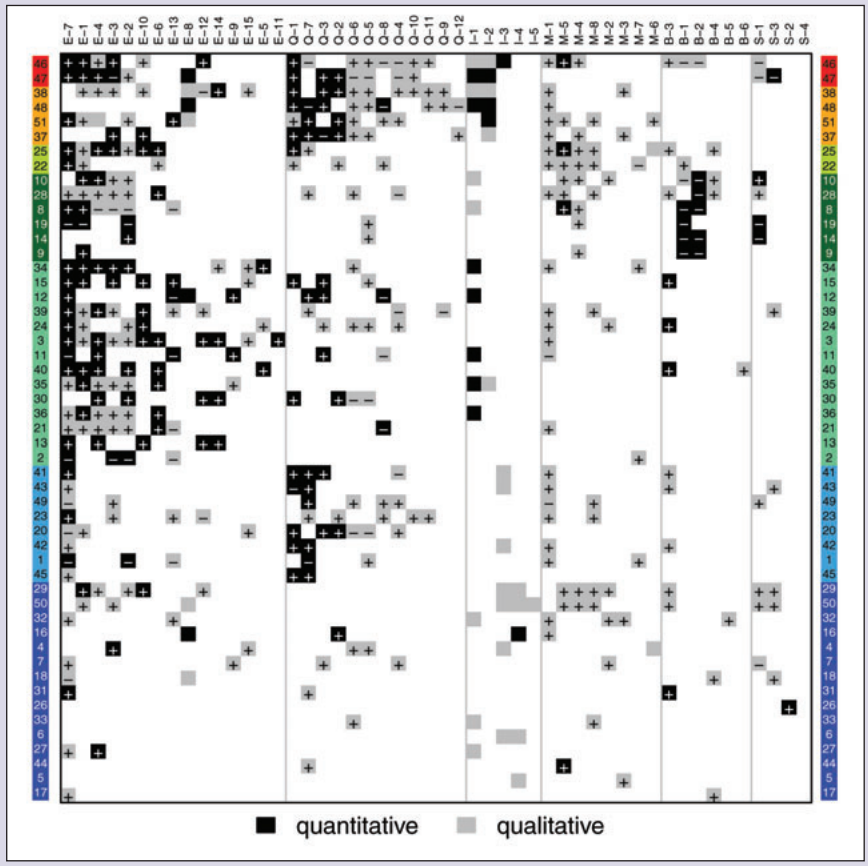
Table 1. Case studies included in the analysis, per type of fishery

Region	Σ_R	*Species*	*Line*	*Nets*	*Other*	*Pots*	*Trawl*	*Multiple*	Σ_{RS}
Indian Ocean	1	Pelagic	1						1
NE Atlantic	9	Benthic			1				1
		Demersal					3	1	4
		Pelagic					2		2
		Multiple			1			1	2
NW Atlantic	3	Benthic			3				3
NE Pacific	17	Benthic			1	2			3
		Demersal	7	1			4	2	14
SE Pacific	4	Demersal					1		1
		Pelagic			3				3
SW Pacific	17	Benthic				4	1		5
		Demersal					1	2	3
		Multiple			3		2	4	9
Grand total	51	Σ_G	8	1	12	6	14	10	

Notes: Σ_R = subtotals by region; Σ_G = subtotals by gear type; Σ_{RS} = subtotals by target species and region.

represent the processes by which incentives may influence behavior in fisheries is also very recent (Little *et al.* 2009; Fulton *et al.* 2011; Marchal *et al.* 2011; Nostbakken *et al.* 2011; van Putten *et al.* 2011). Quantitative analyses of the responses of fisheries systems to the adoption of individual transferable harvest rights have remained largely theoretical, and decision support tools currently used to assist in evaluating alternative scenarios for marine ecosystems usually ignore these dimensions. Developing empirical applications of such models is essential for establishing how the behavioral responses of the harvesting sector translate into modified patterns of fishing pressure exerted on fish communities. In turn, an improved understanding of these responses will strengthen the assessment of alternative management strategies in terms of their capacity to achieve sustainable economic prosperity and social benefits from fisheries, and in furthering the goal of marine biodiversity conservation.

Table 2. A synthesis of the empirical studies of the impacts of ITQs published since 2000 (see text for details)



Notes: The rows are labeled by reference number of the individual case study, colored by the cluster of studies to which the study was allocated, based on the results of the principal component analysis (see WebPanel 1). Clusters of case studies with a higher quantification score (ie those that assess a greater number of impacts quantitatively) are placed at the top of the table. Impact domains (E = Economic, Q = Quota system, M = Management, I = Interactions with other stakeholders, B = Biological, S = Stewardship) are ordered from left to right by decreasing average quantification score, measured at the level of the impact domain. Within each impact domain, the variables are also ordered from left to right by order of decreasing quantification score over all studies. The shade of entries indicates whether a particular impact was not addressed (blank), considered in qualitative (gray) or quantitative (black) terms. Where the impact was considered, symbols denote whether the assessment was in agreement with (+) or contrary to (–) the expected effects of introducing ITQs, or whether the evidence was inconclusive (no sign). Case studies are listed in WebTable 2. Source: own composition, based on results of the data analysis.

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