BULLETIN OF MARINE SCIENCE, 86(2): 221–234, 2010 MOTE SYMPOSIUM INVITED PAPER

FISHERIES IN CHILE: SMALL PELAGICS, MANAGEMENT, RIGHTS, AND SEA ZONING

Juan Carlos Castilla

ABSTRACT

Fishery-management policies based on the allocation of exclusive fishing rights, territorial use rights, and sea zoning are recurrent tools for achieving sustainability. In Chile, the 1991 Fishery and Aquaculture Law reformed division of the right to fish between the artisan and industrial subsectors, introduced sea-zoning (space-based) strategies, and established a differential individual transferable quota (ITQ) system. Here, I describe these arrangements and focus on the small-pelagic artisan and industrial purse-seine fishery. Results show that the reform and empowerment of the artisan fishers, due to new governance, has lead to increases in the artisan fleet and landings but to decreases for the industrial sector. The reform appears to have counteracted the inherent "race for fish" characteristic of common-pool resources in open-access systems.

Marine fisheries are in trouble, and prevailing rules and paradigms are evolving (Botsford et al., 1997; Caddy, 1999; Hilborn et al., 2003; Myers and Worm, 2003; Castilla and Defeo, 2005; Geoffrey and Schlenker, 2008; Townsend and Shotton, 2008), but the transition has not proven smooth (Pauly et al., 2002, 2003; Mace, 2004; Parma et al., 2006; Grafton et al., 2008). McClanahan and Castilla (2007) and Townsend et al. (2008) published a collection of 44 fishery management case studies, which includes a wide range of marine resources (benthic, pelagic), habitats (intertidal, inner-inshore), and fishing gears (diving, dredging). They review fishery management approaches with emphasis on sea-zoning (space-based) management, comanagement, partnership, and self-governance. Whether all the cases, ranging from subsistence or artisan (small) to mid-scale fisheries, can be labeled success stories is open to discussion. Nevertheless, they represent a unique collection of examples highlighting emerging sustainable fishery-management approaches. The two overarching management paradigms embraced in the studies are comanagement (Castilla and Defeo, 2001; Makino and Matsuda, 2005; Eggert and Ulmestrand, 2008; McClanahan et al., 2009) and sea-zoning approaches (Castilla, 1994, 2008; Castilla et al., 1998; Young et al., 2007). Both call attention to the need to move away from single-species management and top-down governance through command-control mechanisms. The new call, particularly in the case of sea-zoning arrangements, is to consider biophysical variables (including uncertainties), fisher/stakeholders views, socioeconomic information, societal values, and spatially demarcated areas, according to local jurisdiction and traditions. Indeed, the most promising avenue toward resolving the present marine fishery crises (Defeo and Castilla, 2005) is not only to consider that marine fisheries deal with common-pool resources, in which fishing is a privilege rather than a right, but the implementation of sea-zoning-linked management (see, e.g., Young et al., 2007; Douvere and Ehler, 2008) and the allocation of fishery rights: granted in exclusivity, leased, or sold to users (Castilla and Defeo, 2001; Hannenson, 2005). These strategies focus mainly on the development of mechanisms and incentives to operate fishery systems in socially acceptable ways (Hilborn et al., 2005; McClanahan et al., 2009). Moreover, fishery management and sustainability will always rely heavily on the ability to determine the biological surplus production of fished populations and on the correct administration of fishing effort.

In my view, unless socially accepted and sound biological and/or local ecological knowledge crystallize in established fishery legislation, or traditions, the so-called "race for fish" will continue. Robert E. Johannes pioneered these issues (Johannes, 1978, 1998a, 2002; Johannes et al., 2000). The present article honors his work and wisdom. Bob taught us that sea tenure and self-governance values were deeply rooted in societies embedded in a "sea-going culture" and that they were expressed as natural individual, societal, and cultural attitudes. He strongly argued that implementation of this kind of sustainable fishery management approach, even in data-poor fishery situations (Johannes, 1998b), was much needed around the world. In general, these attitudes are not recognized or respected in societies where a "sea-going culture" no longer exists or where behavior is rewarded that favors short-term rather than long-term fishery benefits. I believe that, in Chile, among other countries, we have confronted Bob's challenges and discovered progress along the path he signaled can be made (see Gelcich et al., 2009). The establishment of inner-inshore territorial use rights for fisheries, which take the form of management and exploitation areas for benthic resources, and the development of comanagement tools for artisan fisher communities are important examples for resources that show limited mobility (Castilla, 1994; Bernal et al., 1999; Castilla and Defeo, 2001). Undoubtedly, a more complex fishery-management task is to implement similar tools for highly mobile species, as in pelagic fisheries and among artisan and industrial fishers. The present article highlights some of the Chilean fishery policies for small pelagic species linked to the reallocation of rights to fish, sea zoning, and the division of fishery quotas between the artisan and industrial subsectors, rooted in the 1991 Fishery and Aquaculture Law. Within these fisheries, I report historical trade-offs for purse-seine vessel holding capacities, landings, and fishery values, and I highlight the implementation of promising comprehensive management and empowerment strategies for confronting the "race for fish."

Chilean Fisheries: Regulation, Zoning, Management, and Purse-Seiner Landings

Artisan and Industrial Fishery Regulations.—Since the early 1990s new fishery legislation has been passed in Chile. Here I summarize main regulations in the 1991 Chilean Fishery and Aquaculture Law (FAL, Ley de Pesca y Acuicultura N°18,892, DS N°439, Ministerio de Economía, Fomento y Reconstrucción, Subsecretaria de Pesca, Valparaíso, Chile), which included conservation, sea zoning, reallocation of the right to fish for the artisan and industrial fleets, and new management schemes. The FAL decreed two fishery fleet units: The first, the artisan fleet, is heterogeneous, ranging from deckless boats (V-shaped hulls without decks), usually less than 8–10 m in length, with or without outboard engines, to small and mid-size vessels ("lanchas"), with a maximum length of 18 m and 50 gross tons. An artisan fisher is defined as an individual who works on the sea as a crew member and/or owns a boat/vessel, or has a maximum of two boats/vessels, which jointly do not exceed 50 gross tons. The second unit, the industrial fleet, includes vessels above 50 gross tons. Industrial vessels are registered by owners, and every year the vessel must pay a fixed fee ("patente"), in addition to holding a license. For each major fishery, the number of licenses is limited, because they have been under a limited-entry system for about 20 yrs. In fact, before the 1991 FAL was passed, major Chilean fisheries, including those for small pelagic species, were administratively closed to new entries. The FAL decreed these fisheries to be "fully exploited fisheries," and new entries remained closed. A valid license can expire if the vessel does not demonstrate it has operated during the last year or if it has not paid the "patente." For the industrial fleet the "right to fish" is part of the economic value of the vessel. For the artisan subsector, FAL bestowed fishing rights on individuals, so when an artisan boat is sold, the fishing rights disappear unless the buyer is a registered artisan fisher. The FAL has created incentives for the entry of new artisan operators, particularly in the traditional purse-seine fleet. Artisan and industrial fleets are ascribed to separate Fishery Registers. Since 2000, each industrial and artisan ("lancha") vessel must be equipped with a vessel monitoring system (VMS).

Sea Zoning, Territorial Exclusive Zones, and Fishing Rights.—The FAL imposes three major sea-zoning schemes along the Chilean maritime territory. The first is the artisan exclusive zone (AEZ), a zone of 9.3 km (5 nautical miles) wide (water column and sea bottom) determined by coastal base lines, which extends about 2500 km along the coast and covers about 27,000–30,000 km^2, facing continental Chile between 18°21´W and 41°28´S. (Fig. 1) and Chilean oceanic islands. The AEZ can be seen as a fishing empowerment for the Chilean artisan fishery community (subsistence, small, and mid-scale fisheries), resulting in a reallocation of the right to fish between artisan and industry operators over an important portion of the sea. Although the AEZ was not demarcated on the basis of scientific or fishery-management criteria, but was a product of political transactions, in my view it has played an important fishery-management role in the country. In fact, the AEZ approximately coincides in width with the narrow Chilean continental platform, the mean width of which is 4.8–6.4 km in northern Chile and about 16 km in central-southern Chile, where upwelling is persistent and small pelagic species tend to concentrate (Bernal et al., 1982; Martínez et al., 1987). The industrial fleet cannot operate inside the AEZ (although regulations provide for the possibility in special cases); but the artisan fleet can operate beyond the AEZ border. Artisan fishers must be registered in one of the administrative regions of Chile, and their fishery activities are legally restricted within that space, although special permits can be procured to fish in an adjacent region. Fishing is not spatially restricted for either fleet south of 41°28´S (Fig. 1).

The second, and best known, spatial management regulation implemented in the 1991 FAL is territorial use rights for fisheries (TURFs). Within the AEZ, farther south, and around oceanic islands (Fig. 1), the law allocated extra exclusive fishing rights to subsistence and small-scale artisan communities (mostly divers operating from V-hull deckless boats) in the form of shallow inner-inshore management and exploitation areas for benthic resources (AMERBs, an acronym for their Spanish name), under a comanagement scheme (Fig. 1; see also Castilla, 1994, 1997; Castilla et al., 1998; Bernal et al., 1999; Castilla and Defeo, 2001). Currently 707 AMERBs have been approved along the Chilean coast, each having 1–4 km^2 and covering about 1100 km^2 (Gelcich et al., 2008a; SERNAPESCA, 2009).

The third form of spatial management regulation is marine reserves and parks. The FAL includes restrictive fishery zones intended to protect resource reproductive

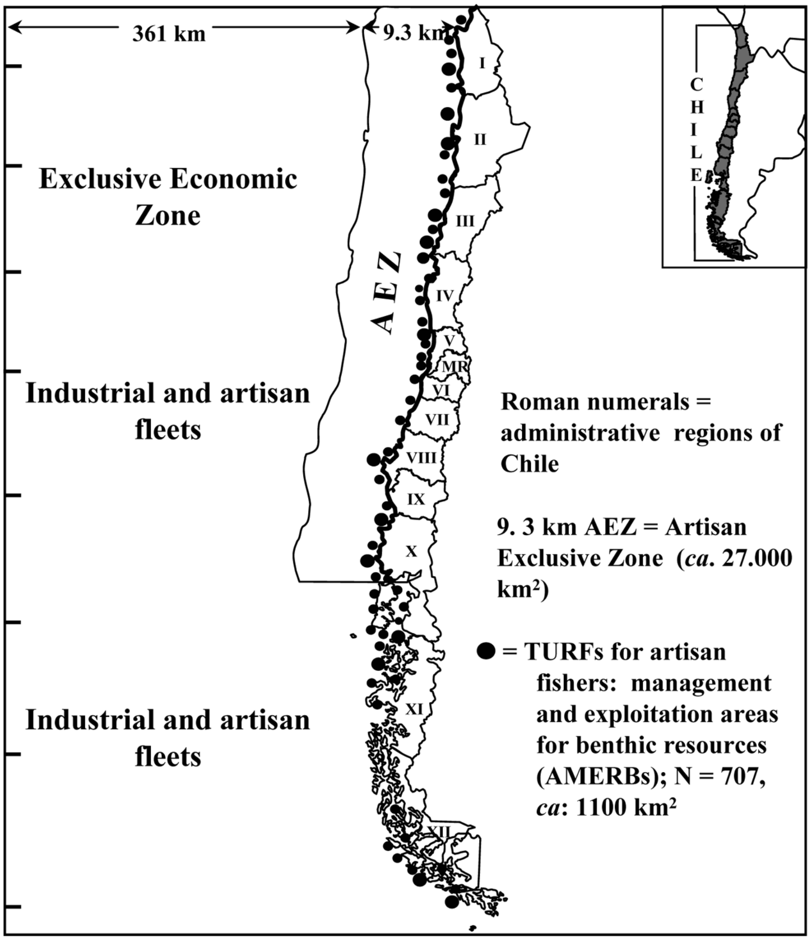

Figure 1. Map of Chile (not to scale) showing the exclusive economic zone (EEZ) and zones reserved for exclusive fishery access by the artisan fleet, as decreed in the 1991 Chilean Fishery and Aquaculture Law. The 9.3-km (5 nautical mile) artisan exclusive fishery zone (AEZ, for all resources) between 18°21´W and 41°28´S, covers about 27,000 km^2. Inner-inshore management and exploitation areas for benthic resources (AMERBs, shown schematically as black points) provide exclusive fishery rights over benthic species for artisan-organized communities.

stocks (genetic reserves), areas for restocking, and marine parks that preserve ecological units of scientific interest.

Total Allowable Catch and Quota Regimes.—The FAL established different fishery-management regimes according to the degree of species exploitation. For fully exploited species, vessels must be registered for specific fisheries, and management is based on total allowable catches, determined by the government, on the basis of stock assessments and quota allocations to individuals (artisans) and registered (industrial) vessels. The Chilean ITQ system has been subjected to key ad hoc restrictions (Peña-Torre, 1997; Gómez-Lobo et al., 2007), and it cannot be aligned with the traditional concept of fully marketable ITQs. Every year, for fully exploited species, 5% of the total allowable catch can be openly leased by the government. Quota transference in the industrial fishery subsector can be made only on the basis of fleet merging. Quota allocations are further based on consultations and recommendations by five macroregional fishery bodies, with the participation of local authorities, artisan and industrial representation, and academics, linked to a national fishery council. This process is subject to powerful lobbying from artisan and industrial-fishing interest groups (Peña-Torre, 1997). In 2001 a new management regulation for the pelagic fishery (Law N°19.731, 2001) was passed to regulate the maximum catch per vessel owner ("Límite Máximo de Captura por Armador"). Notably, this regulation was preceded by the implementation, during 1997–2000, of a "pseudoquota system" based on 47 "fishing research/experimental expeditions" (Gómez-Lobo et al., 2007).

Landings, Purse-Seine Vessel Holding Capacities, and Resource Values.—Fishery landings reported here were taken from national reports published by the Servicio Nacional de Pesca (SERNAPESCA, 1970–2006), Subsecretary of Fishery, Minister of Economy, Chile. The number of artisan and industrial seine vessels and their holding capacity (VHC) per region were obtained from the Departamento Sistemas de Información y Estadística Pesquera (SIEP), SERNAPESCA, Chile. Published official information is scarce regarding long-term statistics on fleet size, artisan spatial capture inside or outside the AEZ, fishing effort due to artisan or industrial purse-seine fleets (i.e., number of trips, number of effective fishing hours, and capture per unit effort), and sets of long-term data for quota allocations to fleets or individuals. Therefore, on the basis of available information, the work reported here focused mainly on historical landing (1970–2006) and the purse-seine fishery for the five most important small pelagic species: Pacific jack mackerel, *Trachurus symmetricus* (Ayres, 1855) ("jurel"); anchoveta, *Engraulis ringens* Jenyns, 1942 ("anchoveta"); South American pilchard, *Sardinops sagax* (Jenyns, 1842) ("sardina española"); Araucanian herring, *Strangomera bentincki* (Norman, 1936) ("sardina común"); and chub mackerel, *Scomber japonicus* Houttuyn, 1782 ("caballa"), in the two most productive fishing areas of Chile: (a) regions I and II in northern Chile and (b) region VIII in south central Chile. In 2006 these areas accounted for 71% of total small pelagic species landed in Chile. The first three species listed were declared fully exploited in 1993–1994 and the Chilean herring in 2000. Export values for Chilean fisheries were obtained from the Banco Central de Chile.

Results

Chilean Marine Fishery Landings and Export Value.—Figure 2A shows the total aggregated industrial and artisan wild species landings and export values in Chile between 1970 and 2006 (aquaculture production is not considered). A sustained increase from about 0.5–1.0 million metric tons (mmt) in the early–mid 1970s to about 7.8 mmt in 1994 is noticeable. Since then a sustained decline has been observed, ending in 1998. Between 1999 and 2006 landings became stable, around 4 mmt per year. A remarkable trend in Figure 2A is the sustained increase in artisan fishery landings (whole fleet), including fishes, algae, and invertebrates, which in 2006 reached a maximum of 1.89 mmt: 43% small pelagic species, 22.5% other fishes, 16% algae, and 18.5% shellfishes (out of which 2% are benthic resources managed in AMERBs). This increase contrasts with an almost sustained decrease in industrial

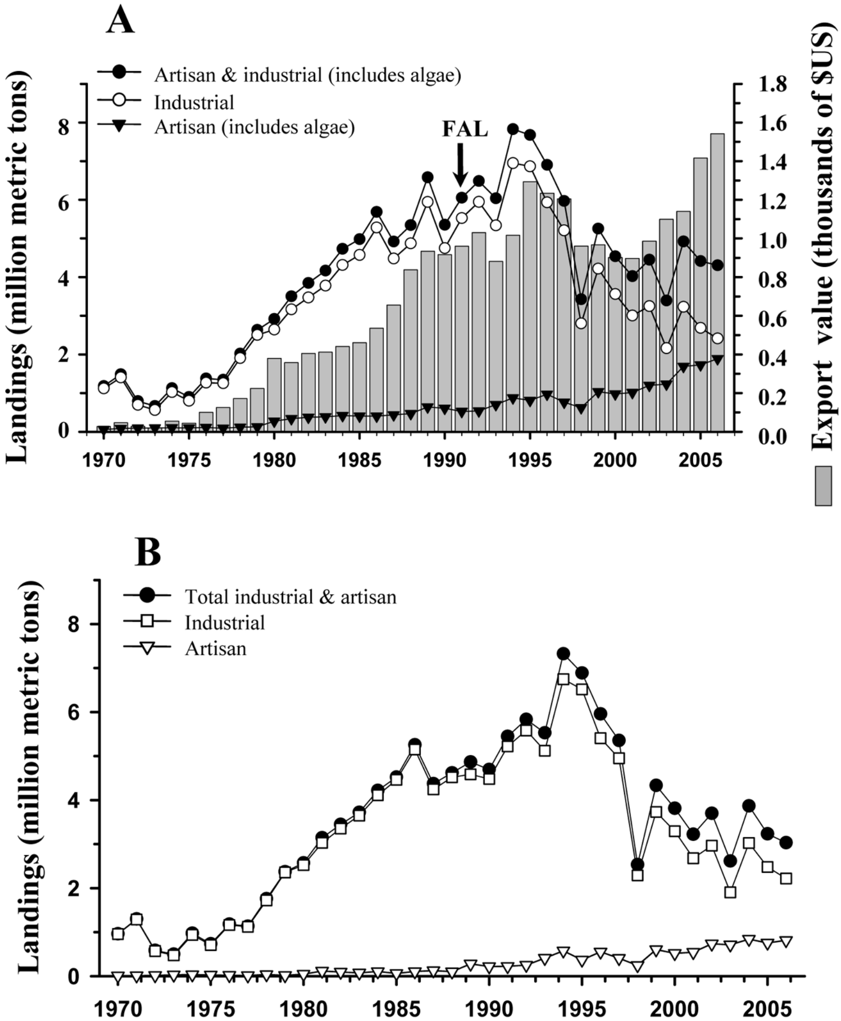

Figure 2. (A) Chilean total marine fishery landings and export values (without aquaculture) for industrial and artisan fleets, 1970–2006. FAL = Fishery and Aquaculture Law, Chile. (B) Chilean total industrial and artisan fleet landings for the five most important small pelagic species: Pacific jack mackerel, *Trachurus symmetricus* ("jurel"); anchoveta, *Engraulis ringens* ("anchoveta"); South American pilchard, *Sardinops sagax* ("sardina española"); Auracanian herring, *Strangomera bentincki* ("sardina común"); chub mackerel, *Scomber japonicus* ("caballa").

landings from 5.97 mmt in 1992 to 2.34 mmt in 2006: 95% small pelagic species and 5% other fishes. In 1992 the aggregated industrial landings represented 92% and artisan 8% of the total, whereas in 2006 industrial represented 56% and artisan 44% of total (Fig. 2A). Figure 2B shows industrial and artisan landings for the five most important small pelagic species in Chile between 1970 and 2006. In 1994 (at the peak of landings, 7.84 mmt); these five species accounted for 7.32 mmt (94%), whereas in 2006 they represented 71% of the total (Fig. 2A,B). Noticeably, between 1992 and 2006, artisan landings for these species increased from 0.25 mmt to 0.81 mmt, while industrial landings decreased from 5.58 mmt in 1992 to 2.22 mmt in 2006.

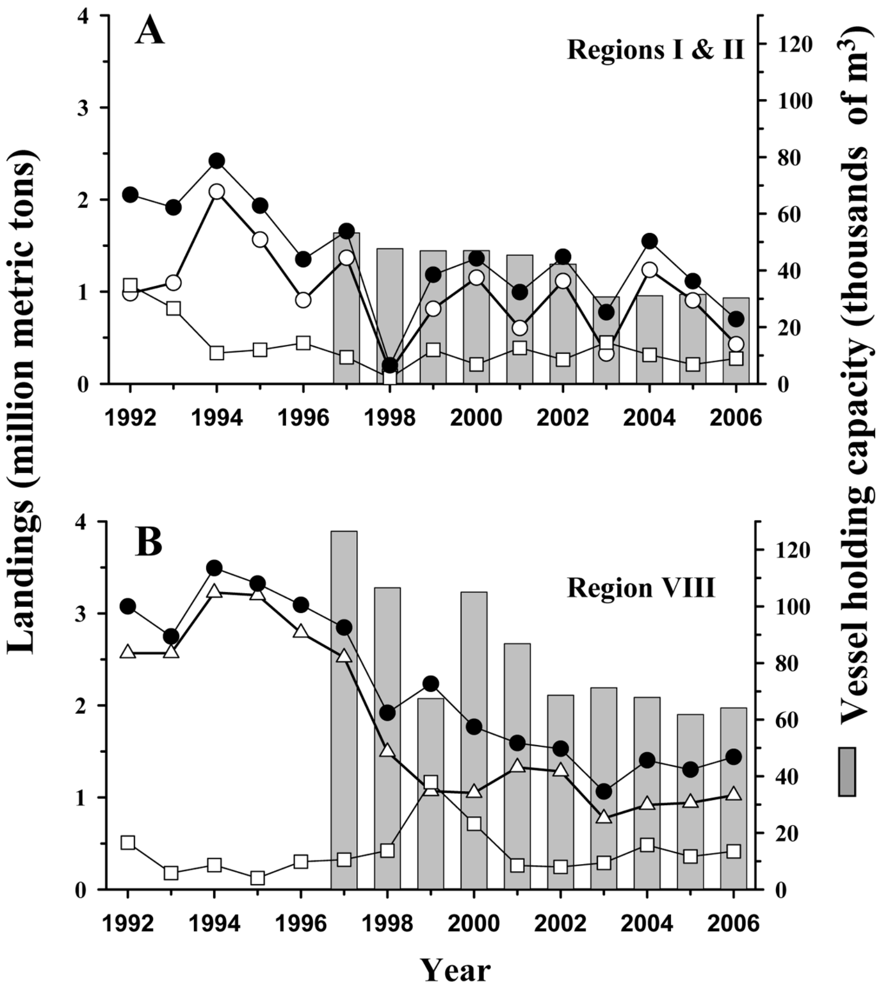

Figure 3. (A) Industrial Chilean landings of small pelagic species and vessel holding capacity (in grey bars) for the purse-seine fleet in regions I and II (about 20°13′0″S, 70°18′52″W, and 23°38′39″S, 70°24′39″W). (B) Region VIII (36°46′22″S, 73°3′47″W). Filled circles, total small pelagic fishes; open circles, anchoveta; triangles, Pacific jack mackerel; squares, other small pelagic fishes (Araucanian herring, South American pilchard, chub mackerel).

Industrial and Artisan Small-Pelagic Fisheries Landings in Major Northern and Southern Chilean Fishing Grounds.—In 2006 artisan and industrial fleets landed 3.03 mmt of the five small pelagic species mentioned above (71% of total fishery in the country, Fig. 2A,B). The northern regions (I and II) and southern region (VIII) of Chile accounted for 2.73 mmt. Figure 3 shows industrial landings (1992–2006) for these species and the VHC fleet evolution in both areas. Since the full application of the FAL (1992–1993), industrial fishery landings for these species have decreased in both areas. For example, in the northern area, anchoveta decreased from about 2.1 mmt in 1994 to 0.4 mmt in 2006; in the southern area, Pacific jack mackerel decreased from 3.3 mmt in 1994 to about 1 mmt in 2003–2006.

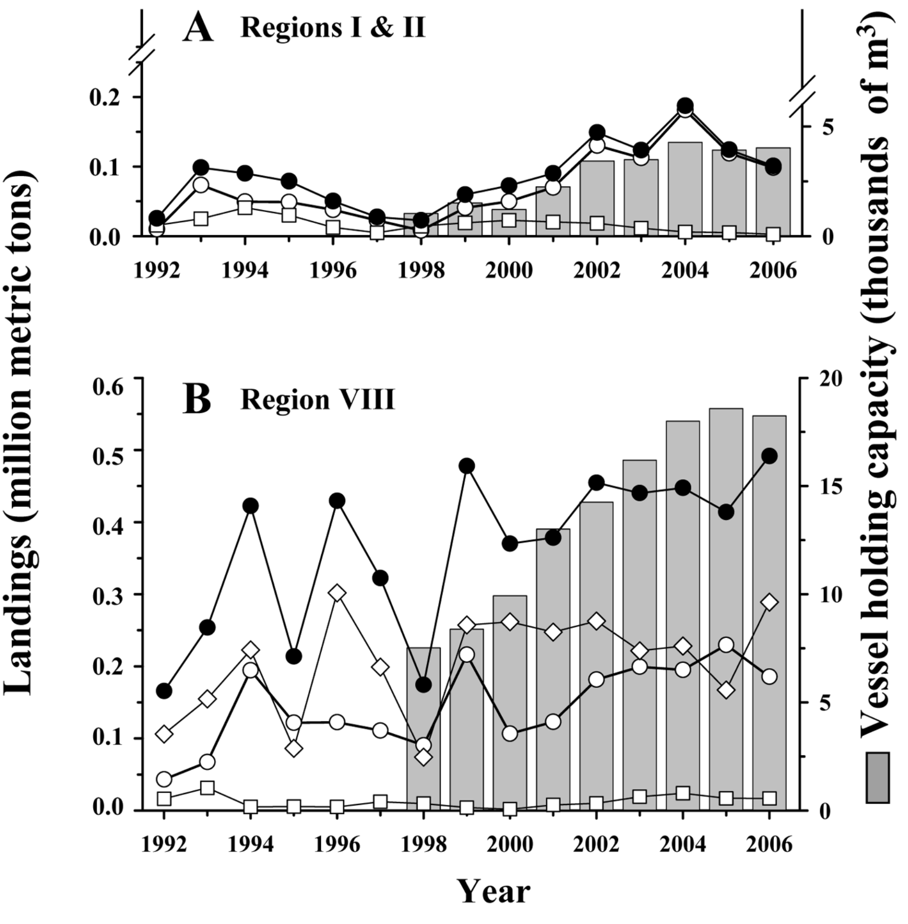

Figure 4. (A) Artisan Chilean landings of small pelagic species and vessel holding capacity (in grey bars) for the purse-seine fleet in regions I and II. (B) Region VIII. Locations and symbols as in Figure 3.

VHC for the industrial fleets has decreased about 35% in regions I and II and 50% in region VIII, reaching stable values of about 30,000 m^3 and 65,000 m^3 respectively.

Figure 4 shows artisan landings (1992–2006) for these pelagic species and VHC fleet evolution in both fishing areas. Since the full application of the FAL, artisan landings for these species have increased in both areas. For example, in the northern area anchoveta increased from 0.49 mmt in 1994 to 0.98 mmt in 2006; in the southern area the Araucanian herring increased from about 0.11 mmt in 1992 to about 0. 29 mmt in 2006. VHC for these fleets increased about 50% in both areas, reaching a stable value of 4800 m^3 in regions I and II and 18,000 m^3 in region VIII.

Discussion

Chile's marine fishery capture is among the highest in the world (FAO, 2006). An open-access regime was the prevailing management scheme in Chilean fisheries during the 1960s, 70s, and 80s. In the 1980s, this strategy, in conjunction with the adoption of neoliberal policies, trade liberalization, privatization, and incentives for exporting natural renewable resources, resulted in severe overexploitation of numerous marine benthic and pelagic species (Castilla, 1990, 1995, 1996, 1997; Peña-Torre, 1997). This overexploitation forms part of a global trend (Botsford et al., 1997; Pauly et al., 2003) in which fishery species and fishers have suffered major ecologic and socioeconomic setbacks (Pauly et al., 1998; Myers and Worm, 2003; Worm et al., 2005; McClanahan et al., 2009). On the other hand, for Chile, little information is available about oceanographic regime shifts (e.g., El Niño and the Pacific Decadal Oscillation) and their impacts on fisheries (but for the Pacific Ocean see Chávez et al., 2003). There as in other countries, fishery crises were the vectors forcing the implementation of new fishery governance and management tools (although in Chile at the end of the 1980s the advent of a new democratic era appears also to have played an important role in new legislation drafting). Furthermore, in Chile major forcing vectors were the artisan fishery crisis: overexploitation of world marketable resources [e.g., the loco, *Concholepas concholepas* (Bruguière, 1789)] and confrontations between the overcapitalized industrial-fleet owners and artisan fishers (small and intermediate fleets) (Castilla, 1994, 1996; Peña-Torre, 1997; Gómez-Lobo et al., 2007). The 1991 FAL therefore included the implementation of previously unthinkable fishery management tools, such as sea zoning, allocations of rights to fish, and exclusive fishery rights and comanagement for artisan fishers. One of the innovative management tools implemented was the allocation of TURFs and AMERBs (Castilla, 1994, 1997; Castilla and Fernández, 1998; Castilla and Defeo, 2001; Meltzoff et al., 2002; Defeo and Castilla, 2005; Castilla and Gelcich, 2006, 2008; Gelcich et al., 2006). Fisheries (subsistence, small-scale) for benthic species, showing spatially explicit population structure (Orensanz and Jamieson, 1998; Defeo and Castilla, 2005), have been rightly argued to be more appropriate for these management approaches than fisheries for pelagic mobile species. In fact, in Chile the allocation of TURFs for benthic species to local fisher communities does refer to small demarcated areas (usually 1–4 km^2, Gelcich et al., 2008a) and to species showing a spatially explicit structure. Nevertheless, the 1991 FAL also included the exclusive right to fish inside an AEZ (including both water column and bottom for all fisheries) for artisan fishers over large sea zones (hundreds to thousands of square kilometers) along the richest sea platform of the country. In addition it decreed the segregation of artisan and industrial fleets over that zone (Fig. 1). This management approach was challenging because it referred to all fished stocks, including small-pelagic fisheries. Further, a differential ITQ-based scheme of allocation between the artisan and industrial subsectors was adaptively implemented. Partly as a result, since the reform was passed, the total aggregate artisan capture of marine resources in Chile has increased over 120%, reaching a peak of 1.89 mmt in 2006 (Fig. 1A). In 2006 the Chilean artisan fleet landed over 1.24 mmt of fish resources and among them 0.82 mmt of small pelagic species. Proxies for effort (this article and unpublished information) indicate that between the early 1990s and 2006 the number of artisan fishers, small boats, and "lanchas" and purse-seine VHC have increased about 50% (see Fig. 4 for VHC artisan purse seine in analyzed regions). In contrast, industrial purse-seine VHC has decreased by 40%–50% (Fig. 3) and small-pelagic capture by about 62% (between 1992 and 2006). The allocation of exclusive fishing rights to artisan fishers over the AEZ translated for them into exclusive access to rich and productive fishing grounds, because of the narrowness of the Chilean continental platform (http://www.directemar.cl), where upwelling is persistent and strong and small pelagic resources abundant (Bernal et al., 1982; Martínez et al., 1987). Unfortunately, little information has been published regarding estimations for fishery efforts and the spatial distribution of fleets in Chile. This lack constrains further analyses and evaluation of the net effects of the sea-zoning management tool used. Furthermore, in the management of small pelagic species, the spatial management tools implemented were superimposed, in parallel, with the use of different ITQ allocation regimes.

I believe that one of the driving factors enhancing and facilitating the success of the above policies has been the existence, in Chile, of well-organized communities and federations of small and mid-scale artisan fishers (about 67,000 direct sea workers, of which 13,200 are divers; SERNAPESCA, 1970–2006), actively engaged in benthic, pelagic, and demersal inshore and offshore fisheries. This organization forced the implementation of participative and comanagement (bottom-up) strategies that incorporated fishers into adaptive management processes, counteracting industrial economic fishery powers. The above also served to influence and enhance environmental perceptions and responsibilities among artisan fishers (Shumann, 2007; Gelcich et al., 2008b), to generate conservation benefits while stocks are being managed (Gelcich et al., 2008a; also see Makino and Matsuda, 2005, for Japan), and, in the process, apparently, to help restrain the "race for fish."

In a nutshell, since fishery reforms were introduced in Chile, (a) the artisan-fisher subsector shows a consolidation of bottom-up governance structures, including sea zoning, resource tenure systems, and exclusive fishery rights; (b) the powerful industrial fleet shows a significant decrease in VHC and decapitalization, although, interestingly, some evidence exists that economic benefits have also accrued (e.g., for Pacific jack mackerel, see Gómez-Lobo et al., 2007); (c) noticeably, between 1997 and 2006, the total fishery capture in Chile has remained relative stable, at around 4 mmt per year, and the "race for fish" appears to have been counteracted and, further, fishery captures among artisan and industrial fleets are more evenly distributed.

For these fisheries, then, the use of collective and individual incentives under adaptive management processes appears to be aligned in the correct direction. A final lesson is that, in order to produce success, management tools had to be adapted to local legislation, idiosyncrasies, and "sea-going culture." In this sense, as pointed out above, in Chile, Bob Johannes's fishery challenges (Johannes, 1978, 1998a,b, 2002; Johannes et al., 2000) on sea zoning, resource tenure, right to fish, and use of local (and scientific) knowledge have been, so far, successfully addressed. Nevertheless, a long way remains ahead, particularly if we want to add the ecosystem-management dimension to the sustainability of marine resources (Castilla and Defeo, 2005; Gelcich et al., 2009).

Acknowledgments

I appreciate the invitation to attend the 2008 Mote International Symposium. I acknowledge information provided by the Departamento Sistemas de Información y Estadística Pesquera, SERNAPESCA, Chile. Thanks to B. Cubillos and E. Donoso. P. Bernal, UNESCO, and O. Defeo, Uruguay, who identified themselves as referees, suggested important modifications.

Thanks to them, the final manuscript was more comprehensive and readable. In the review process I learned from both referees and thank them sincerely. A. Parma pointed out critical literature and enriched my perspectives on fishery management. R. Bustamante, S. Gelcich, and P. Manríquez read early versions of the manuscript and suggested modifications. I most sincerely appreciate the help from V. Ortiz. This contribution is part of FONDAP-CASEB, FONDECYT-Chile Project Nº 1501-0001.

Literature Cited

Bernal, P., F. L. Robles, and O. Rojas. 1982. Variabilidad física y biológica de la región meridional del sistema de corrientes Chile-Perú. Pages 75–102 *in* J. C. Castilla, ed. Monografías biológicas. Bases biológicas para el uso y manejo de recursos naturales renovables: recursos biológicos marinos, volume 2. Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile.

________, D. Oliva, B. Aliaga, and C. Morales. 1999. New regulations in Chilean fisheries and aquaculture: ITQ's and territorial user rights. Ocean Coastal Manage. 42: 119–142.

Botsford L., J. C. Castilla, and C. H. Peterson. 1997. The management of fisheries and marine ecosystems. Science 277: 509–515.

Caddy, J. F. 1999. Fisheries management in the twenty-first century: will new paradigms apply? Rev. Fish Biol. Fish. 9: 1–43.

Castilla, J. C. 1990. Clase magistral: importancia y proyección de la investigación en ciencias del mar en Chile. Rev. Biol. Mar. 25: 1–18.

_________. 1994. The Chilean small scale benthic shellfisheries and the institutionalization of new management practices. Ecol. Intl. Bull. 21: 47–63.

_________. 1995. The sustainability of natural renewable resources as viewed by an ecologist and exemplified by the fishery of the mollusc *Concholepas concholepas* in Chile. Pages 153–159 *in* M. Munasinghe and W. Shearer, eds. Defining and measuring sustainability. United Nations Univ. and The World Bank, Washington, D.C.

_________. 1996. The Chilean dived-invertebrate resources: fishery, collapses, stock rebuilding and the role of coastal management areas and national parks. Pages 130–135 *in* D. A. Hancock, D. C. Smith, A. Grant, and J. P. Beumer, eds. Developing and sustaining world fisheries resources: the state of science and management. Proc. Second World Fisheries Congress, Brisbane, July–August, 1996. CSIRO Publishing, Melbourne.

_________. 1997. The sustainable use of marine coastal resources in Chile: co-management and the artisanal fishing community scale. Pages 138–147 *in* Proc. Third World Academy of Sciences, 6th General Conference, Rio de Janeiro, September 1997.

_________. 2008. Territorial user rights for small-scale fishery in Chile: a multi-scalar geographical approach. Page 299 *in* K. Tsukamoto, T. Takeuchi, T. D. Beard, Jr., and M. J. Kaiser, eds. 5th World Fisheries Congress: Fisheries for Global and Environmental Conservation, Yokohama, Japan.

_________ and O. Defeo. 2001. Latin American benthic shellfisheries: emphasis on co-management and experimental practices. Rev. Fish Biol. Fish. 11: 1–30.

_________ and ________. 2005. Paradigm shifts needed for world fisheries. Science 309: 1324–1325.

_________ and M. Fernández. 1998. Small-scale benthic fisheries in Chile: on comanagement and sustainable use of benthic invertebrates. Ecol. Appl. 8: S124–S132.

_________ and S. Gelcich. 2006. Chile: experience with management and exploitation areas for coastal fisheries as building blocks for large-scale marine management. Pages 45–57 *in* M. Hatziolos, J. Cordell, P. Christie, J. C. Castilla, and S. Gelcich, eds. Scaling up marine management: the role of marine protected areas. The World Bank Publications, Washington, D.C.

_________ and _________. 2008. Management of the loco (*Concholepas concholepas*) as a driver for self-governance of small-scale benthic fisheries in Chile. Pages 441–451 *in* R.

Townsend, R. Shotton, and H. Uchida, eds. Case studies in fisheries self-governance. FAO Fisheries Technical paper 504. Food and Agriculture Organization of the United Nations, Rome.

_________, P. Manríquez, J. Alvarado, A. Rosson, C. Pino, C. Espóz, R. Soto, D. Oliva, and O. Defeo. 1998. Artisanal "caletas" as units of production and co-managers of benthic invertebrates in Chile. Pages 407–413 *in* G. S. Jamieson and A. Campbell, eds. Proc. North Pacific Symp. Invertebrate Stock Assessment and Management. Can. Spec. Publ. Fish. Aquat. Sci. 125.

Chávez, F. P., J. Ryan, S. E. Lluch-Cota, and M. Ñiquen. 2003. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. Science 299: 217–221.

Defeo, O. and J. C. Castilla. 2005. More than one bag for the world. Fishery crises and keys for co-management success in selected artisanal Latin American shell fisheries. Rev. Fish Biol. Fish. 15: 265–283.

Douvere, F. and C. Ehler. 2008. The role of marine spatial planning in implementing ecosystem-based, sea use management (introduction). Mar. Policy 32: 759–761.

Eggert, H. and M. Ulmestrand. 2008. Tenure rights and stewardship of marine resources—a co-managed Swedish shrimp fishery in a marine reserve. FAO Fish. Tech. Paper 504: 21–30.

FAO (Food and Agriculture Organization of the United Nations). 2006. The state of the world fisheries and aquaculture. SOFIA, 2006. Fishery and Aquaculture Department. 34 p. Available from: http://www.fao.org/docrep/009/a0699e/A0699E05.htm

Gelcich, S., G. Edwards-Jones, M. J. Kaiser, and J. C. Castilla. 2006. Co-management policy can reduce resilience in traditionally managed marine ecosystems. Ecosystems 9: 951–966.

________, N. Godoy, L. Prado, and J. C. Castilla. 2008a. Add-on conservation benefits of marine territorial user rights fishery policies in central Chile. Ecol. Appl. 18: 273–281.

________, M. Kaiser, J. C. Castilla, and G. Edwards-Jones. 2008b. Engagement in co-management of marine benthic resources influences environmental perceptions of artisanal fishers. Environ. Conserv. 35: 36–45.

________, O. Defeo, O. Iribarne, G. Del Carpio , R. DuBois, S. Horta, J. Isacch, N. Godoy, P. Penaloza, and J. C. Castilla. 2009. Marine ecosystem-based management in the southern cone of South America: stakeholder perceptions and lessons for implementation. Mar. Policy 33: 801–806.

Gómez-Lobo, A., J. Peña, and P. Barría. 2007. ITQs in Chile: measuring the economic benefits of the reform. ILADES-Georgetown Univ. Working Paper inv179. 42 p.

Geoffrey, H. and W. Schlenker. 2008. Sustainable fisheries. Nature 455: 1044–1045.

Grafton, R. Q., R. Hilborn, L. Ridgeway, D. Squires, M. Williams, S. Garcia, T. Groves, J. Joseph, K. Kelleher, T. Kompas, et al. 2008. Positioning fisheries in a changing world. Mar. Policy 32: 630–634.

Hannenson, R. 2005. Rights based fishing: use rights versus property rights to fish. Rev. Fish Biol. Fish. 15: 231–241.

Hilborn, R., J. M. Orensanz, and A. M. Parma. 2005. Institutions, incentives and the future of fisheries. Phil. Trans. R. Soc. B Biol. Sci. 360: 47–57.

_________, T. A. Branch, B. Ernst, A. Magnusson, C. V Minte-Vera, M. D. Scheuerell, and J. Valero. 2003. State of the world's fisheries. Ann. Rev. Environ. Resour. 28: 359–399.

Johannes, R. E. 1978. Traditional marine conservation methods in Oceania and their demise. Ann. Rev. Ecol. Syst. 9: 349–364.

____________. 1998a. Government-supported village-based management of marine resources in Vanuatu. Ocean Coast. Manage. 40: 165–186.

____________. 1998b. The case for data-less marine resource management: examples from tropical nearshore fisheries. Trends Ecol. Evol. 13: 243–246.

_____________. 2002. The renaissance of community-based marine resource management in Oceania. Ann. Rev. Ecol. Syst. 33: 317–340.

____________, M. R. Freeman, and R. J. Hamilton. 2000. Ignore fishers' knowledge and miss the boat. Fish Fish. 1: 257–271.

Mace, P. 2004. In defence of fisheries scientists, single-species models and other scapegoats: confronting the real problems. Mar. Ecol. Prog. Ser. 274: 285–291.

Makino, M. and H. Matsuda. 2005. Co-management in Japanese coastal fisheries: institutional features and transaction costs. Mar. Policy 29: 441–450.

Martínez, C., A. Aranis, C. Estrada, and P. Bernal. 1987. Situación actual de la pesquería de sardina Española (*Sardinops sagax musica*) en la zona norte de Chile. Pages 115–131 *in* P. Arana, ed. Manejo y Desarrollo Pesquero. Univ. Católica de Valparaíso, Valparaíso, Chile.

McClanahan, T. and J. C. Castilla. 2007. Fisheries management: progress toward sustainability. Blackwell Publishing, Oxford. 332 p.

_____________, J. C. Castilla, A. T. White, and O. Defeo. 2009. Healing small-scale fisheries by facilitating complex socio-ecological systems. Rev. Fish Biol. Fish. 19: 33–47.

Meltzoff, S. K., W. Stotz, and Y. G. Lichtensztajn. 2002. Competing visions for marine tenure and co-management: genesis of a marine management area system in Chile. Coast. Manage. 30: 85–99.

Myers, R. A. and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. Nature 423: 280–283.

Orensanz, J. M. and G. S. Jamieson. 1998. The assessment and management of spatially structured stocks: an overview of the North Pacific Symp. Invertebrate Stocks Assessment and Management. Pages 441–459 *in* G. S. Jamieson and A. Campbell, eds. Proc. North Pacific Symp. Invertebrate Stock Assessments and Management. Can. Spec. Publ. Fish. Aquat. Sci. 125.

Parma, A. M., R. Hilborn, and J. M. Orensanz. 2006. The good, the bad, and the ugly: learning from experience to achieve sustainable fisheries. Bull. Mar. Sci. 78: 411–428.

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese, and F. Torres. 1998. Fishing down marine food webs. Science 279: 860–863.

________, J. Alder, E. Bennett, V. Christensen, P. Tyedmers, and R. Watson. 2003. The future for fisheries. Science 302: 1359–1361.

________, V. Christensen, S. Guénette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. Nature 418: 689–695.

Peña-Torre, J. 1997. The political economy of fishing regulation: The case of Chile. Mar. Resour. Econ. 12: 253–280.

SERNAPESCA (Servicio Nacional de Pesca). 1970–2006. Anuarios estadísticos de pesca. Servicio Nacional de Pesca. Ministerio de Economía Fomento y Reconstrucción. Available from: http://www.sernapesca.cl

______________. 2009. Estado de situación de las Áreas de Manejo. Available from: http://www.sernapesca.cl/index.php?option=com_content&task=view&id=188&Itemid=220

Townsend, R. and R. Shotton. 2008. Fisheries self-governance: new directions in fisheries management. Pages 1–19 *in* R. Townsend, R. Shotton, and H. Uchida, eds. Case studies in fisheries self-governance. FAO Fisheries Technical paper 504. Food and Agriculture Organization of the United Nations, Rome.

_____________, R. Shotton, and H. Uchida, eds. 2008. Case studies in fisheries self-governance. FAO Fisheries Technical Paper 504. Food and Agriculture Organization of the United Nations, Rome. 451 p.

Shumann, S. 2007. Co-management and "consciousness": fishers' assimilation of management principles in Chile. Mar. Policy 31: 101–111.

Worm, B., A. Sandow, A. Oschlies, H. K. Lotze, and R. A. Myers. 2005. Global patterns of predator diversity in the open oceans. Science 309: 1365–1369.

Young, O. R., G. Osherenko, J. Ekstrom, L. B. Crowder, J. Ogden, J. A. Wilson, J. C. Day, F. Douvere, C. N. Ehler, K. L. McLeod, et al. 2007. Solving the crisis in ocean governance: place-based management of marine ecosystems. Environment 49: 20–32.

Available Online: 8 March, 2010.

Address: *Departamento de Ecología y Centro de Estudios Avanzados en Ecología y Biodiversidad (CASEB), Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Casilla 114-D, Santiago, Chile. E-mail: <jcastilla@bio.puc.cl>.*