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SMALL-SCALE BENTHIC FISHERIES IN CHILE: ON CO-MANAGEMENT AND SUSTAINABLE USE OF BENTHIC INVERTEBRATES

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Abstract. We discuss the issues of sustainable use and management in the Chilean inshore benthic small-scale (artisanal) fisheries. The fishery benefits from two features that make it possible to overcome some of the problems of conventional management. These are: (1) major advances have been made in understanding relevant ecological processes, and (2) this knowledge has been institutionalized in the 1991 Chilean Fishing and Aquaculture Law (FAL). FAL legalizes the use of community-owned shellfish grounds, so-called ''Management and Exploitation Areas'' (MEA); this practice is considered to confer quasi-property rights to fishers' unions. Management plans for these areas have to be approved by the government. This co-management approach solves one of the major problem in many fisheries: overexploitation. In addition, the study of the MEAs could provide useful information, if they are considered as ''replicates,'' in evaluating the effect of human perturbation and different management regimes. We think that by using the different tools provided by the FAL on the spatial arrangement of the small-scale fishery and answering certain key ecological questions, the sustainable use of inshore benthic resources in Chile (e.g., gastropods, sea urchins, and algae) via an ecosystem approach can be achieved in the near future.

Key words: Chile; co-management; community ownership; ecosystem approach; small-scale fishery; sustainable use; invertebrates.

INTRODUCTION

The problem of variation in catches and overexploitation in marine fisheries began to receive scientific attention in the late 1800s (Huxley 1884, Lankester 1884), primarily due to the development of more efficient fishing methods (Smith 1988). On the other hand, natural fluctuation in population abundance appears to be the rule rather than the exception in marine fisheries. Hjort (1914) recognized this factor and identified some of the causes of larval survival and dispersal. Ever since, this topic has been an important focus of study in fishery science (e.g., Ricker 1954, Beverton and Holt 1957). Major difficulties in understanding recruitment fluctuation arise because interactions among species are unknown, and besides, most marine fish populations are open (Sinclair 1988) and under variable exploitation rate. These arguments can be found in almost all major fisheries (e.g., halibut (*Hippolossus stenolepis*): Thompson 1950, Burkenroad 1953; Peruvian anchovy (*Engraulis ringens*): Pauly and Tsukayama 1987; California sardine (*Sardina* sp.): Saville and Bailey 1980). In many cases, the underlying problems still remain unresolved, primarily because of the uncertainty associated with recruitment dynamics (Hilborn and Walters 1992). However, little attention has been given to Lankester's view on species interaction and ecological processes governing ecosystem functioning (but see Hjort 1914, Burkenroad 1953, Paine 1984). The lack of knowledge about these processes is a major constraint in understanding the effect of fishing on population dynamics and ecosystem functioning (Lubchenco et al. 1991, Hilborn and Walters 1992). Furthermore, there are other issues related to fisheries management that need to be considered: (1) exploited populations are subjected to different histories of intentional human ''perturbations'' that interfere with long-term ecological processes and (2) those perturbations are the result of a combination of political, social, and economic factors. Besides, (3) management usually focuses on a single stock with no explicit interaction between its predators, competitors, or other environmental variables.

In this paper we discuss some of these issues in the context of the small-scale (artisanal) Chilean fishery of invertebrates and the new co-management tool (joint management involving resource users and government; Hanna 1994) known as Management and Exploitation Areas (MEA) recently established in Chile (Castilla 1994). We use the example of an artisanal fisher Union

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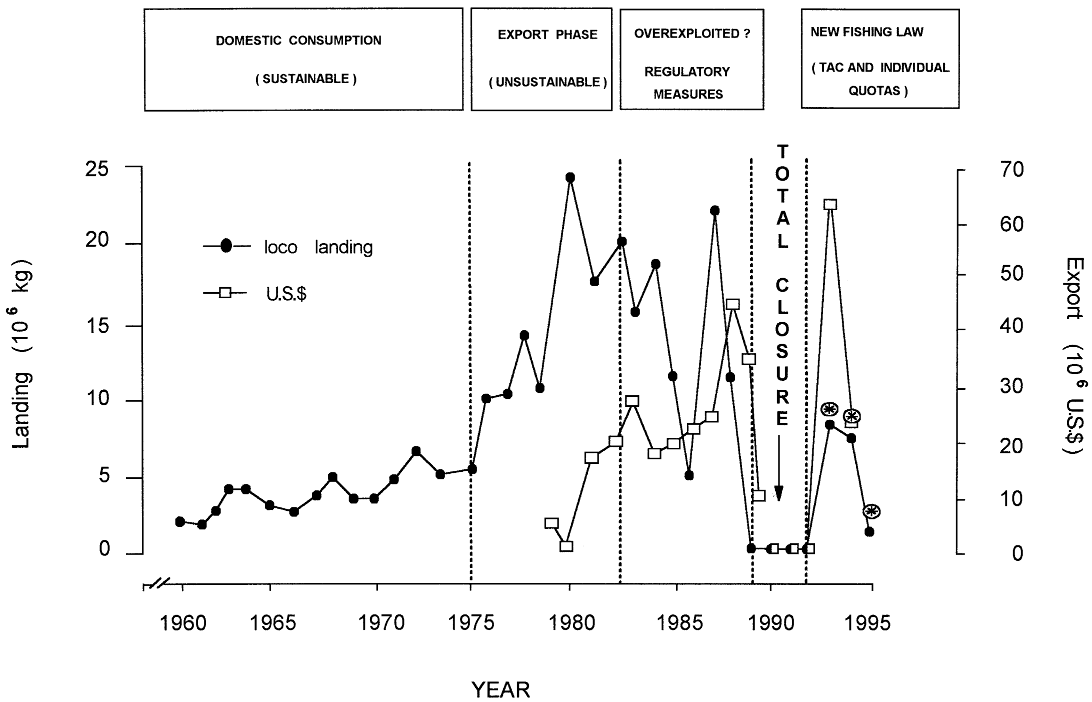

FIG. 1. Chilean small-scale fishery landing (1960–1995) of the muricid gastropod ''loco'' *Concholepas concholepas* and export revenues in U.S. dollars. Different phases of the fishery are shown. Circled asterisks indicate Total Allowable Catch. Partially taken from Castilla 1996*a*.

in central Chile, Caleta el Quisco (33°23′ S; 71°42′ W), where we have worked for ~8 yr.

SMALL-SCALE FISHERIES: THE CHILEAN EXPERIENCE

Although large-scale fisheries have generated most of the attention in fishery biology, small-scale fisheries are also very important. Particularly in developing countries, a large group of finfish and shellfisheries are operated at a small scale as defined by Bermudez and Aguero (1989): (1) fisheries operating with ''open-boats'' of <50 g $\times$ 10^3 kg such as engine-powered (inboard, outboard) boats, or rowboats; and (2) fisheries based on diving operations or even on hand-picking procedures at the shores (food gathering subsistence activities). Aguero (1992) estimated that in Latin America there were $\sim 10^6$ people directly engaged in fishing activities, and ~90% of them belonged to small-scale fisheries. The majority of the resources available to this sector are pelagic or benthic species restricted to inshore coastal areas, and in many cases endemic species with restricted geographical distributions or unique to the area (e.g., Bustamante and Castilla 1987). These authors pointed out that the artisanal fishery in Chile plays crucial economic and social roles because many of the benthic resources (e.g., shellfishes and algae) show elevated export revenues when compared to those from the large-scale fishery sector (Castilla 1996*a*).

Resources targeted by the small-scale fisheries are not immune to overexploitation and, moreover, there are rights conflicts over portions of the ocean ''used'' by the industrial and artisanal fleets. The landings of the industrial fleet in Chile, $>6 \times 10^9$ kg/yr largely overpasses artisanal landings, of $\sim 1.5 \times 10^8$ kg/yr. Nevertheless, in many coastal areas of developing countries, the small-scale artisanal sector provides the bulk of the domestic day-to-day food, and moreover, the fished species (e.g., shellfishes and algae) have elevated market values as compared to products extracted by the industrial fleet. In Chile, >60 species of shellfish and algae (e.g., muricid gastropods, keyhole limpets, bivalves, sea urchins, barnacles, ascidians, bull-kelp, and *Gracilaria* spp.) are regularly exploited exclusively by the small-scale fishery sector and external markets are exerting increasing pressures on these resources (Bustamante and Castilla 1987, Castilla 1995).

The pattern of exploitation of these resources and the socioeconomic and legal ripple effects produced by these external pressures is apparent in the fishery of the Chilean muricid gastropod loco, *Concholepas concholepas* Bruguière. The loco is the single most economically important shellfish in Chile (Castilla 1996*a*) and the most studied invertebrate species in the country (Castilla 1988). During the past 35 yr the commercial exploitation of locos (the commercial fishery is done exclusively by divers) has shown five contrasting phases (Fig. 1). The first phase (1960–1975) was characterized by landings ranging between 2×10^6 and $6 \times$

10^6 kg that were used for domestic consumption (the domestic consumption—sustainable phase in Fig. 1). Between 1976 and 1980–1981, landings abruptly increased due to high demand from the Asian market, reaching a peak of 2.48×10^6 kg in 1980 (export phase—unsustainable in Fig. 1). Thereafter, from 1982 through 1988, landings decreased, probably due to overexploitation (overexploitation phase in Fig. 1) resulting in the implementation of a complex series of management steps. Although illegal extractions occurred, between 1989 and 1992 the fishery was officially closed (total closure phase). Since in Chile the loco can represent up to 50% of the small-scale shellfish export revenues (e.g., $64 000 000/yr in U.S. currency; Castilla 1996*a*), the Chilean shellfish exportation rate deteriorated. The 1991 Chilean Fishery and Aquaculture Law (FAL) was enforced in 1993 and, since then, loco yearly or seasonal Total Allowable Catch (TAC), divided into individual (per diver) quotas, have been used as the main management tool (Castilla 1996*a*). When the fishery was reopened in 1993, for 5 d during the summer and for 9 d during the winter, 8.574×10^6 kg were landed and the per diver quota was 1500 locos in each period. The fishery was opened again in winter 1994 for 72 d and 8.111×10^6 kg tons were landed, and again in winter through spring in 1995 for 77 d, when 2.404×10^6 kg were landed. The per diver quota was 100 locos each year (Payne and Castilla 1994, Castilla 1995, Castilla et al., *in press*; Fig. 1).

The social and economic problems affecting the loco fishery, such as unemployment and poaching, played a key role in the management tools implemented by the FAL. The main objectives were to enhance recovery of the damaged shellfish stocks and to initiate a new management scheme.

Innovative Management of Locos

Through the FAL, two management steps were implemented to resolve fishing ground rights conflicts between the artisanal and industrial fleets. First, exclusive fishing rights within a five-mile (~9-km) limit from shoreline was assigned to small-scale vessels of $<50 \times 10^3$ kg. In Chile, ~85% of this fleet is composed of small wooden, 7–10 m long, boats operated by a crew of three or four members (Bustamante and Castilla 1987, Aranda et al. 1989). Second, the FAL assigned exclusive fishing rights, defined areas of inshore ocean bottom, to registered organizations or communities of artisanal fishers. These areas are called Management and Exploitation Areas (MEA) for benthic resources (also known as Marine Destinations or Concessions). Under the FAL, based on area-specific management plans, members of local organizations of artisanal fishers are allowed to harvest benthic resources within these areas, excluding resources declared ''fully exploited.'' In these cases, the authority can set a Total Allowable Quota (TAC). The idea of management decentralization and protected areas is one of the future goals of marine fisheries management. The main differences between the Chilean MEA–TAC co-management scheme and the Individual Transferable Quotas (ITQ) system were discussed by Castilla 1996*a*. In summary, ITQs, when used as the only tool to solve small-scale management problems within traditional fishery societies, can create ''virtual communities.'' ITQs are quasi-property rights which, if not used properly by the recipients, can destroy traditional fishery societies (Pauly, *in press*). On the other hand, the MEA–TAC scheme is deeply rooted into the small-scale fishery communities and cannot be transferred.

The two main elements considered by the Chilean Government in establishing exclusive fishing rights on benthic resources and allocation of MEAs were: (1) the knowledge about natural restocking of benthic resources obtained from experimental removal of humans from coastal preserves (Castilla and Durán 1985, Durán et al. 1987, Durán and Castilla 1989, Castilla 1990, Oliva and Castilla 1990, 1991); and (2) the pilot loco restocking experiment carried out jointly by scientists and fishers at Caleta Quintay in Central Chile (Castilla and Jeréz 1986, Geaghan and Castilla 1986). These studies resulted in the legal implementation of the first 57-ha MEA (Castilla et al., *in press*).

In Chile the traditionally well-established small-scale fisher Unions (''sindicatos'') have played a key role in the implementation of the MEA (Payne and Castilla 1994). These Unions operate in small coastal villages known as ''Caletas,'' located around coastal coves. There are ~190 recognized (active) caletas, most of them organized in sindicatos (Castilla et al., *in press*). According to the FAL, exclusive fishing rights over benthic resources are granted only to organized communities of small-scale fishers. Between 1991 and 1993 there was active participation from several of these fisher Unions (particularly in central Chile) in order to obtain MEAs (Castilla 1994, Payne and Castilla 1994).

The Management and Exploitation Area of Caleta el Quisco

Caleta El Quisco provides a specific example of the status of MEAs in Chile. Caleta El Quisco is a typical small-scale fishery community of central Chile and currently has 139 members; among them are 42 officially registered divers (Payne and Castilla 1994). The artisanal fleet is composed of 31 wooden boats, 7–8 m long, equipped with outboard engines (25–40 horsepower) and surface hookah air compressors. We started the work at this well-organized Caleta in 1989. We trained the El Quisco divers on principles of sampling and stock assessments of benthic invertebrates and mutual trust and respect developed. In 1991 the Union, following a jointly developed loco management plan, totally banned diving activities on a coastal area of 54

TABLE 1. Comparison of size and catch per unit of effort (CPUE) between Management and Exploitation Areas (MEA) and open-access diving areas for four benthic species of invertebrates exploited in Central Chile. Mean values, with 1 SD in parentheses, or ranges of mean values are provided.

	Management and Exploitation Area (MEA)		Open-access diving areas	
Species	Size (cm)	CPUE (no. individuals)	Size (cm)	CPUE (no. individuals)
Loco	110–117	280–540[s]	103–108	15–143
(*Concholepas concholepas*)	107–118	91–186[w]		
Sea urchin	102 (7.0)	380 (132)	78.8 (5.5)	65.33 (30.4)
(*Loxechinus albus*)	97.1 (8.1)		87.6 (8.1)	
Stone crab	111.7 (10.3)	36.0 (26.1)†	108 (10.9)	17–29†
(*Homalaspis plana*)		21.2 (12.2)‡		17.4–22.7‡
Keyhole limpets	···	729 (44.4)	···	391.8 (129.6)
Fissurella maxima	110.3 (12.7)	···	83.2 (17.1)	···
Fissurella latimarginata	103.1 (9.4)	···	69.5 (11.3)	···
Fissurella cumingi	97.3 (8.9)	···	73.8 (11.4)	···

Note: For locos, the values for size and CPUE are daily means, and the range represents the variation over time during the ban lifting; s indicates summer ban lifting and w winter ban lifting. For keyhole limpet size, the values are shown by species, but only a combined CPUE for the three species is available because divers do not distinguish among these species. Sea urchin mean size is reported for the two ban liftings in the MEA and for two open-access diving areas. CPUE for locos was reported as catch per unit of diving time. However, information on diving time is not available for sea urchins and crabs; only sailing time was recorded. Thus, the CPUE for sea urchins in open-access diving areas is a combination of lower catches and longer time (sailing/handling). Loco data (1993) are from Castilla et al. (*in press*), sea urchin data (1994–1995) from Castilla and Pino (1996), crab data (1994–1995) from Fernández and Castilla (*in press*), and key-hole limpet data (1994–1995) from Pino and Castilla (1995).
† CPUE for crabs reported when crabs were the only targeted species.
‡ CPUE reported when another invertebrate species was targeted.

ha of sea bottom around the cove. The area was considered by the fishers as their best diving ground. On 9 July, 1993 the Union obtained legal rights over this diving ground as a Management and Exploitation Area. Loco stock assessments have been conducted annually at this MEA between 1992 and 1996. Further, we closely monitored the El Quisco small-scale fleet activity at the MEA and open fishing grounds outside the MEA during the three national loco ban liftings: January and July 1993, August through December 1994, and August through October 1995.

Comparison of mean size and catch per unit of effort (CPUE) between the El Quisco MEA and open-access fishing grounds clearly showed the effect of fishing on some benthic resources. Locos, sea urchin (*Loxechinus albus*), and three species of keyhole limpet (*Fissurella* spp.) were larger in El Quisco MEA than in open-access fishing grounds (outside the MEA (Table 1; see also Castilla and Pino 1996, Castilla et al., *in press*). Mean CPUE was higher at El Quisco MEA for those resources, although in some cases the estimates are not directly comparable (e.g., sea urchin and crabs) since effort data were different for both areas (see Table 1). The results are not as clear for mobile species such as the stone crab *Homalaspis plana,* which revealed no differences in mean size and CPUE between the MEA and open-access fishing grounds. Our results clearly show the effect of human perturbation (fishing) on population of sessile benthic species, and, furthermore, that a single management tool may not be feasible for all the harvested species, even in small coastal areas.

THE LESSON: SOLVED AND UNSOLVED PROBLEMS

The artisanal benthic fisheries of Central Chile and the MEAs may offer one of the best approaches to achieve sustainable fishing via an ecosystem approach. We believe, however, that although ecosystem approaches may be an appropriate goal for marine fisheries, they will not be easily attained because much of the fundamental knowledge is lacking. Although small-scale inshore invertebrate fisheries provide one of the best venues to address the classic problems of marine fisheries and to approach sustainable use of the resource using an ecosystem approach, we recognize major problems that need to be addressed. We think that El Quisco MEA can be used as an example to show both the major advances and, also, the difficulties that have arisen.

The main knowledge gaps in our study system, as in many other marine systems (Lubchenco et al. 1991, Hilborn and Walters 1992), are: (1) the complexity and variability of marine open systems, and (2) the slow accumulation of knowledge. For instance, despite a large body of publications on the gastropod loco (see Castilla 1988, 1996*a*), we still know little about its larval dispersal, the population dynamics of its pred-

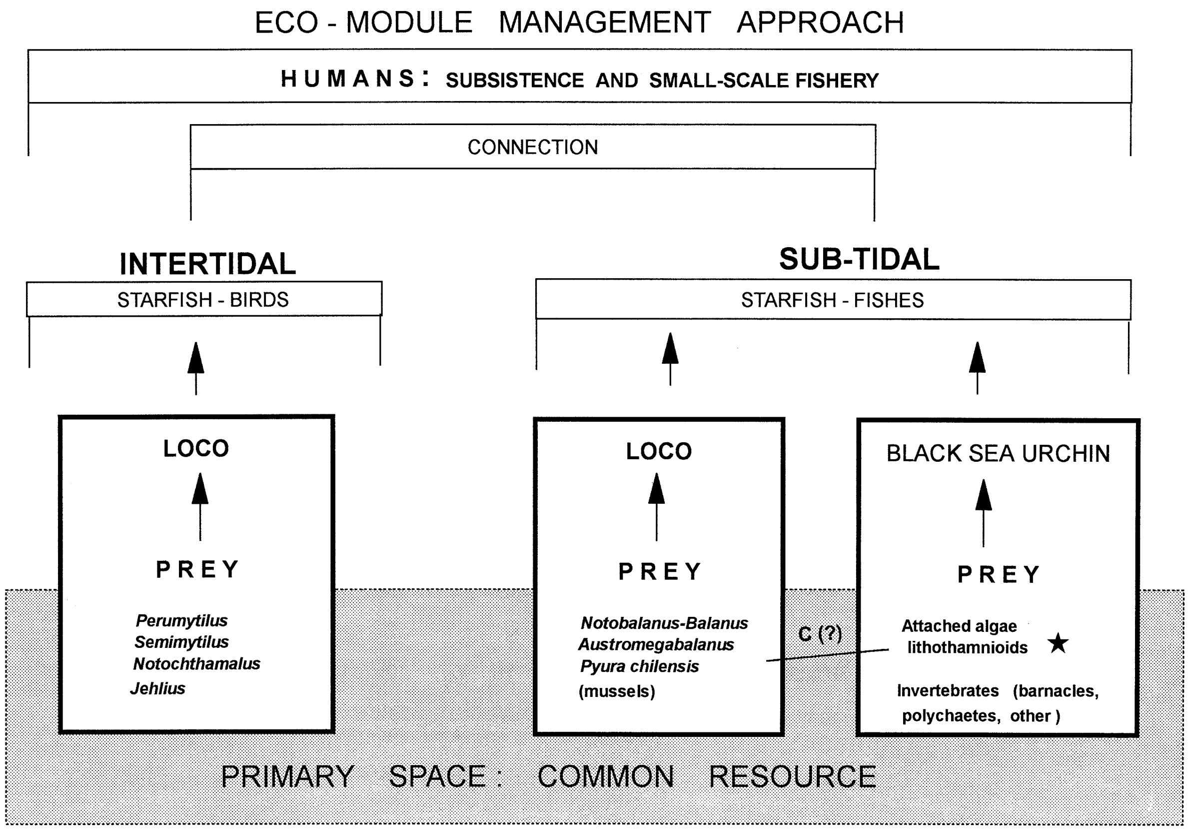

FIG. 2. *Concholepas concholepas* (loco) and *Tetrapygus niger* (black sea urchin) intertidal and subtidal trophic interactive modules. The arrows indicate energy flow. "C" represents competitive interactions. Starfish species are *Heliaster helianthus* (inter- and subtidal) and *Meyenaster gelatinosus* (subtidal); birds are *Larus dominicanus* and *Haematopus ater;* fish are *Syciases sanguineus* and *Semicossyphus maculatus.* The star indicates W. Stotz's suggestion (AMIGO Meeting 1992, Victoria, Canada) that barren grounds created by *T. niger* in subtidal ecosystems at Central Chile have led to the crustose lithothamnioid algae dominating primary space, and negatively affecting the loco prey availability and settlement habitat. References: Schmiede and Castilla 1979, Viviani 1979, Castilla and Paine 1987, Contreras and Castilla 1987, Castilla 1988, Stotz and Pérez 1990, Sommer and Stotz 1991, Stotz et al. 1994.

ators, and species interactions. Although we recognized the importance of founding management plans on sound scientific information, we have not yet fully reached that level of knowledge in the case of the loco. However, the limited ecological knowledge available can be used to initiate experimental or adaptive management (Walters and Hilbotn 1976, Walters 1986), which can be improved as more knowledge about the system and its response to exploitation of the loco or other invertebrates is gained.

The current management plans recently implemented are based on scientific evidence obtained during the past 15 yr in Central Chile. The increased abundance of locos in small, experimental areas ($N = 5$) are being extrapolated to fishing grounds where fishers, the other key actors in the fishery, can understand the advantages of using this management strategy. Furthermore, based on this experience, we have also gained information concerning fishers' behavior and ecosystem functioning (Fig. 2), as well as identified the major issues to be addressed.

According to preliminary information, most of the benthic species we are working on show a planktonic larval stage. Little is known about the oceanographic circulation pattern in central Chile coastal areas, information necessary to understanding larval dispersal and the consequence of dispersal on the long-term ecological sustainable use of the MEAs. On the other side, we are also addressing the issue of variability at the system level by studying the carrying capacity of inshore ecosystems for locos. We believe that solving these two major problems will allow us to suggest more informative management decisions as well as open new ecological research avenues.

Although we have better information on interaction for benthic than for the larval stages, in the short term we also will need to study the factors regulating adult dispersal behavior, mainly on highly mobile species. Most studies on management of closed zones in Chile and elsewhere have focused on sessile species (e.g., the kelp *Durvillaea antarctica*; Castilla and Bustamante 1989, Bustamante and Castilla 1990) and relatively sedentary or territorial species (e.g., reef fish, Bohnsak 1993; key-hole limpets, Pino and Castilla 1995; locos, Castilla et al., *in press*; sea urchins, Castilla and Pino 1996). However, the goals for ecosystem approach go further than sessile/sedentary species, and our results set not only new goals for research on mobile species but also new challenges (e.g., multispecies management approaches, adaptive management; Walters 1986) for the fisheries administration.

The underlying problem is that our pace of learning about the ecology of the system is slow. In this respect, we agree with Ludwig et al.'s (1993) contention that we cannot rely on (''a complete'') scientific knowledge to start making management decisions. Our experience with the Chilean small-scale fishery shows that only after overexploitation was evident were management actions taken and that even then they were taken before enough scientific knowledge was available. According to Hilborn and Ludwig (1993), the rate of learning about ecological systems is too slow, mostly because of the lack of replication. In many cases there is only a single study case and, thus, no possibilities for replication and controls. In this paper we have discussed the increased density of locos, keyhole limpets, and sea urchins by self-regulated resource harvesting activities at El Quisco fishing ground (see also Pino and Castilla 1995, Castilla and Pino 1996; Castilla et al., *in press*). Similar observations have been done in other MEAs in Chile (e.g., Caleta Quintay in central Chile and several caletas in the Los Vilos–Coquimbo area in northern Chile; Instituto de Fomento Pesquero and W. Stotz, *personal communication* to J. C. Castilla). We believe that on the key issue of replication, the Chilean artisanal fisheries may have an extraordinary potential for these reasons: (1) there are several MEAs in central and northern Chile that could be used as replicates, forming a string along the coastline as a meta-population model linked by dispersal; (2) there are control areas (open-access fishing grounds); and (3) MEAs suffer a common perturbation history (at least for locos, since the exploitation is regulated by law). Furthermore, from the commercial point of view, the divers exploiting the MEAs use nondestructive and target-oriented fishing gear, which produce minor (if any) impact on the substrate and other nontarget species.

MEAs: Social, Economic, and Political Factors

The existence of a ''reasonable understanding'' of the fishery target species and the ecosystem was not the most significant factor involved in the short-term success of the MEA in Central Chile. Two key factors need to be considered if sustainable management is to be achieved: (1) the incorporation of the fishers as real actors, and (2) the institutionalization of the fishery and ecological knowledge (Castilla 1994). The current fishery management tools implemented in Chile may also offer a unique opportunity to tackle these problems.

The examples of unsustainable use of resources cited by Ludwig et al. (1993) fall into the same category: open-access resources, which do not belong to any owner until harvested. Such resources are often subject to the ''tragedy of the commons'' (Hardin 1968). However, some ancient societies practiced sustainable harvest of marine resources (Meyer and Helfman 1993). According to these authors, many Pacific island cultures have sustained their harvest of fish from reefs for >1000 yr. A similar case is present in southern Chile regarding Araucanian (mapuche) family-oriented management of the bull kelp *Durvillaea antarctica* along the coast. They divide the rocky shore into family-owned segments and exploit the kelp on a sustainable bases (J. C. Castilla, *personal information*). In these societies each community group has rights to sections of the environment, and outsiders are not allowed to fish these areas. Rather than treating marine resources as ''commons'' (as is done in most of the Western world), resources are owned and managed by community groups.

Castilla (1994, 1995) discussed the tragedy of the commons, paraphrased as ''the tragedy of the locos,'' and singled out one way to solve it using the example of the small-scale fishery of the high trophic level predator gastropod *Concholepas concholepas.* There are fisheries management lessons to be learned from this example. In Chile after the implementation of the MEA, fishers dramatically changed their behavior (e.g., Payne and Castilla 1994). Studies on behavior of fishers in Caleta El Quisco showed that, while fishers are not concerned about overexploitation in common fishing grounds, they are not willing to overexploit their private ground (M. Fernández, *personal information*). So, besides having replicated ecological systems and controls along a portion of the Chilean coast, we could also have uniform behavior of fishers and a common legal rule.

Of course, the main motivation to avoid overexploitation is to obtain the maximum revenue from the MEA, even if it implies perturbations of the system. One of the major problems we may face in the Chilean small-scale fishery is that although fishers have some idea of ecosystem functioning (through experience), their objectives are completely different from those of scientists. Fishers, if allowed, will try to modify the system in order to obtain the maximum revenue: for instance, the removal of predators of the targeted resource. In 1994, the El Quisco fishers removed sea stars from their MEA to increase the survival of locos (Castilla et al. 1993). At the time the removal of starfish took place, environmental conservation was not contemplated in the FAL. Nevertheless, the actual Regulatory Decree (Reglamento sobre Areas de Manejo, Subsecretaría de Pesca, Ministerio de Economía, Fomento y Reconstrucción República de Chile August 1995) includes a sentence stating that ''the Management Plan for the MEAs should take into account the conservation of the resources and the environment; measures should be taken in order not to inflict negative impacts to the environment.'' Legislation cannot be more specific in facing a problem that is little understood and difficult to approach. Finally, we discuss the case of fishers' behavior in El Quisco to emphasize that the single-stock paradigm is not only used in fisheries because of modeling facilitation (Hilborn and Walters 1992), but also because economy drives fishers' behavior into that direction.

A Step Forward: Incorporating Ecosystem Approaches

Besides making advances toward the goal of sustainable use of resources via ecosystem approaches using the different tools provided by the Chilean FAL, we think that a better understanding of the system can be reached through experimental ecology. The path linking, at one extreme single species and at the other ecosystem approach, is long and intricate. Instead of arguing in favor of one or another, we prefer to contribute by pinpointing some of the future challenges we foresee to improve the rational exploitation of *C. concholepas* within the MEAs. Since it is impossible to tackle the whole intertidal and subtidal ecosystems to derive practical recommendations on the management of the species, we have followed the intermediate trophic modular approach offered by Paine (1980, 1984). Hence, the question is: what would we like to know next about the system to improve the present management schemes on *C. concholepas* within the MEAs?

Some of the answers are presented in Fig. 2. We know that humans (intertidal foodgatherers and skin divers) affect both the rocky intertidal and subtidal systems where the locos are ecologically important (key) predators (Castilla and Durán 1985, Durán and Castilla 1989, Power et al. 1996). These two systems are connected. We have much better knowledge about the intertidal loco population and ecosystem than about their subtidal counterpart. Regarding the intertidal module, there are several papers addressing the loco life history, population biology, and ecological interactions. On the contrary, little has been published in connection with the subtidal. Fig. 2 highlights two of these modules for which we have collected preliminary evidence. For instance, resolving the black sea urchin module (see legend to Fig. 2) and its connections with the loco trophic module can be extremely important from the management point of view. It has been argued that abundant subtidal barren grounds in central Chile (''fondos blanqueados'' or lithothamnioid-like-dominated bottoms; Schmiede and Castilla 1979) were caused by the population explosion of the black sea urchin *Tetrapygus niger* following the 1982–1983 El Niño. The implication is that permanent sea urchin overgrazing on the rocks would facilitate the invasion of crustose lithothamnioid algae, which would outcompete barnacles and ascidians, the preferred food and near-shore subtidal settlement habitats of locos. The questions posed by these trophic interactive modules are directly linked to future management strategies and should be scientifically addressed. This can represent a step toward an ecosystem approach.

The Future

In Chile, large Coastal Management Areas provide a future strategy for a sustainable use of benthic inshore resources. However, this may pose a difficulty for patrolling them, and thus poaching may take place. We are confident that in the country there is the potential (and certainly legislation) to overcome these problems through the implementation of a wise national policy linking the small-scale MEAs in existence with a National network of Marine Parks and Preserves (Castilla 1996*b*).

In any case, for the small-scale artisanal fishery it is unavoidable that quick management steps, as those initiated in Chile with the establishing of experimental MEAs and co-management, should be continued and perfected. Simultaneously, we should aim for a better ecological understanding of inshore systems and the linkages between inter- and subtidal ecosystems.

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