THE SUSTAINABILITY OF THE GULF OF MEXICO'S FISHING GROUNDS

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INTRODUCTION

Ludwig *et al.* (1993) establish that when natural resources are uses they are inevitably overexploited, often to the point of collapse or extinction. Overfishing is a widespread threat (Dayton *et al.* 1995; Schiermeier 2002; Rosenberg 2003a); the removal of top predators (Christiansen *et al.* 2003; Myers and Worm 2003; Sala *et al.* 2004) is deemed to be the main cause of impacts on marine ecosytems and the primary indicator of the latter's deterioration (Goñi 1998; Pauly *et al.* 1998; Jackson *et al.* 2001; Sala *et al.* 2004). Likewise, ecosystems have also been altered by pollution and by deterioration of habitats and breeding grounds (Rosenberg 2003b). Moreover, the short-term needs of society (e.g., food, work income), and institutional structures play a decisive role in the administration of resources.

Traditional fishery management applies entrance (effort) and exit (catch) controls (Hilborn and Walters 1992; Haddon 2002). Recently, alternatives have been proposed. Pauly *et al.* (2002), Sainsbury and Sumaila (2003), and Gell and Roberts (2003) suggest that, given the high degree of uncertainty faced by fisheries administrators, it is necessary to close parts of fishing zones (protected natural marine areas), set higher mortality limits for threatened stocks (effort restriction) and measure function in fishery-ecosystem and sustainability terms. In addition, application of the precautionary principle (Rosenberg 2003a) and holistic approaches to the management of large marine ecosystems (Duda and Sherman 2002) are needed.

If fishery management is to be effective and deterioration reversed, it is necessary to consider: 1) the optimal sustainable use of resources and the maintenance of natural values (e.g., genetic diversity) in the long term; 2) the preservation of ecosystem structure and integrity; 3) management structures that acknowledge ecosystem complexity; and 4) indicators of resource health, economic viability, social acceptance and governability.

With regard to sustainability indices, Arenas and Díaz (1998) made an initial proposal as to how to move towards fishery sustainability in countries such as Mexico. Two years later, a simple index pertaining to Mexican fishery sustainability (INE-INEGI 2000) was presented. The FAO (2000) produced guidelines for setting up a "Reference System for Sustainable Fishery Development". The OECD has started revising fishery indices and determining levels necessary for responsible fishing (Le Gallic 2002). Chuengpagdee and Alder (2002) have ranked North Atlantic nations in terms of sustainability indices.

Catch is declining in the Gulf of Mexico, stemming from over-capacity of the fishing fleet and inadequate management (Díaz 2001). In this chapter, the antecedents for the construction of the first fishing-environment analysis and the results of deterioration in the main fishing grounds are set forth. In addition, we propose a way to move towards building a framework that will make it possible to achieve regional fishery sustainability, by showing the lack of sustainability in the main fishing activity in the region, shrimp fishing.

DEVELOPMENT OF CATCHES AND FISHERY CAPACITY IN THE GULF OF MEXICO

The majority of fishery development in Mexico occurred in the late 1970s, with the creation of the Departmento de Pesca (Fisheries Department) and substantial investment in state-owned fishing fleets and industrial plants. Catch peaked at over 1.5 million metric tons in 1981 and, after dropping to around 1 million metric tons in 1983, have since fluctuated around 1.5 million metric tons (Fig. 24.1a). In the Gulf of Mexico, catch peaked at nearly 400,000 metric tons towards the end of 1980s, since dropping by 20% (Fig. 24.1b).

The main species caught in the Gulf of Mexico are shrimp, octopus, grouper, crabs, sea bass, red snapper, sardines, tuna, lobster, shark, mullet and mackerel. Except for octopus and tuna, for which catch-level increases have remained moderate, rising from 15,000 to 20,000 metric tons of octopus and from 1,000 to 3,500 metric tons of tuna in the last 10 years, catch levels for the rest of the species in the Gulf of Mexico have tended to drop (Fig. 24.2).

The industrial fleet has tended to decrease in size but not in fishing capacity. The most important fleet in the Gulf of Mexico is the shrimp-fishing fleet (742 ships), which is concentrated in the states of Campeche (316 ships) and Tamaulipas (290 ships). Second is the finfishing fleet with 795 ships concentrated mainly in Yucatán (636 vessels), although there are small finfish fleets in all the Mexican Gulf states.

The artisanal fleet has grown by 700% over the last three decades (SAGARPA 2002). Just over 46% (43,392 vessels) of the national artisan-fishing fleet operates in the Gulf of Mexico. Veracruz has the biggest artisan fleet (15,898 vessels), followed by Tabasco (9,601 vessels), Tamaulipas (6,662 vessels), Campeche (5,362 vessels) and Yucatán (4,981 vessels).

On the other hand, income from fishing is unevenly distributed. Fishermen in the Gulf of Mexico receive, for their work, a fifth of the average income obtained by those fishing the Gulf of California (INE-INEGI 2000).

Our analyses indicate that there is excess capacity in the artisanal and industrial fleets. The industrial shrimp-fishing fleet has sufficient capacity to catch 8-16 times the 2001 catch. The artisanal and industrial finfishing fleets are capable of catching 9-18 times the 2001 catch.

Deterioration of resources, along with the excess capacity in both fleets, low income levels, and poor management and regulation of fishery activities, has caused conflicts in Tamaulipas (shrimp), in Tabasco and Campeche (fishing vs. petroleum), in Campeche (shrimp), in Campeche and Yucatán (octopus, Celestún vs. Isla Arena), and in Yucatán (grouper and octopus, trawler fishing, Cuban fishing). It is probable that these problems will get worse if they are not faced and solved, and that new problems will arise (See Nadal-Egea 1996; Cabadas-Nápoles 2002).

INSTRUMENTS FOR ANALYSIS AND REGULATION OF THE FISHERY-ENVIRONMENT (SUSTAINABILITY AND RESPONSIBLE FISHING AND THE 2000 NATIONAL FISHERIES CHARTER)

In the 1994-2000 administration, faced with the proposition that the organization charged with managing and regulating fishing at the national level (Subsecretaría de Pesca, currently CONAPESCA) did not have the scientific resources to enforce national fishing regulations in the manner set out in the 1995-2000 “Plan Sectorial de Pesca y Acuacultura” (Sectorial Fishing and Aquaculture Plan), the Instituto Nacional de Pesca (INP; National Fishery Instititute) focused its efforts on developing fishery management research. In 1998, INP published the first systematic

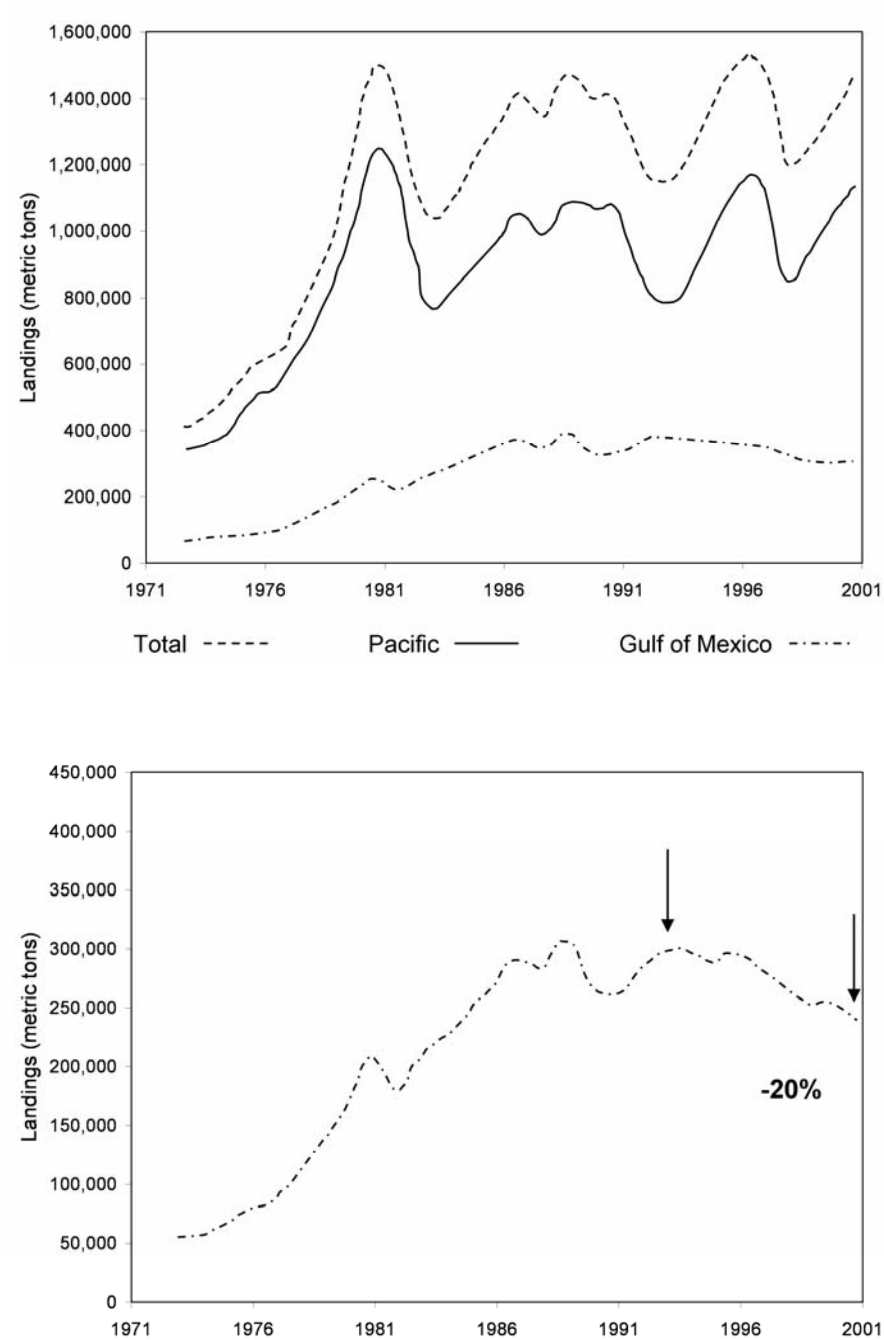

Fig. 24.1. Total fishery landings in Mexico: a) a comparison of total and by sea; b) detail of landings in the Gulf of Mexico.

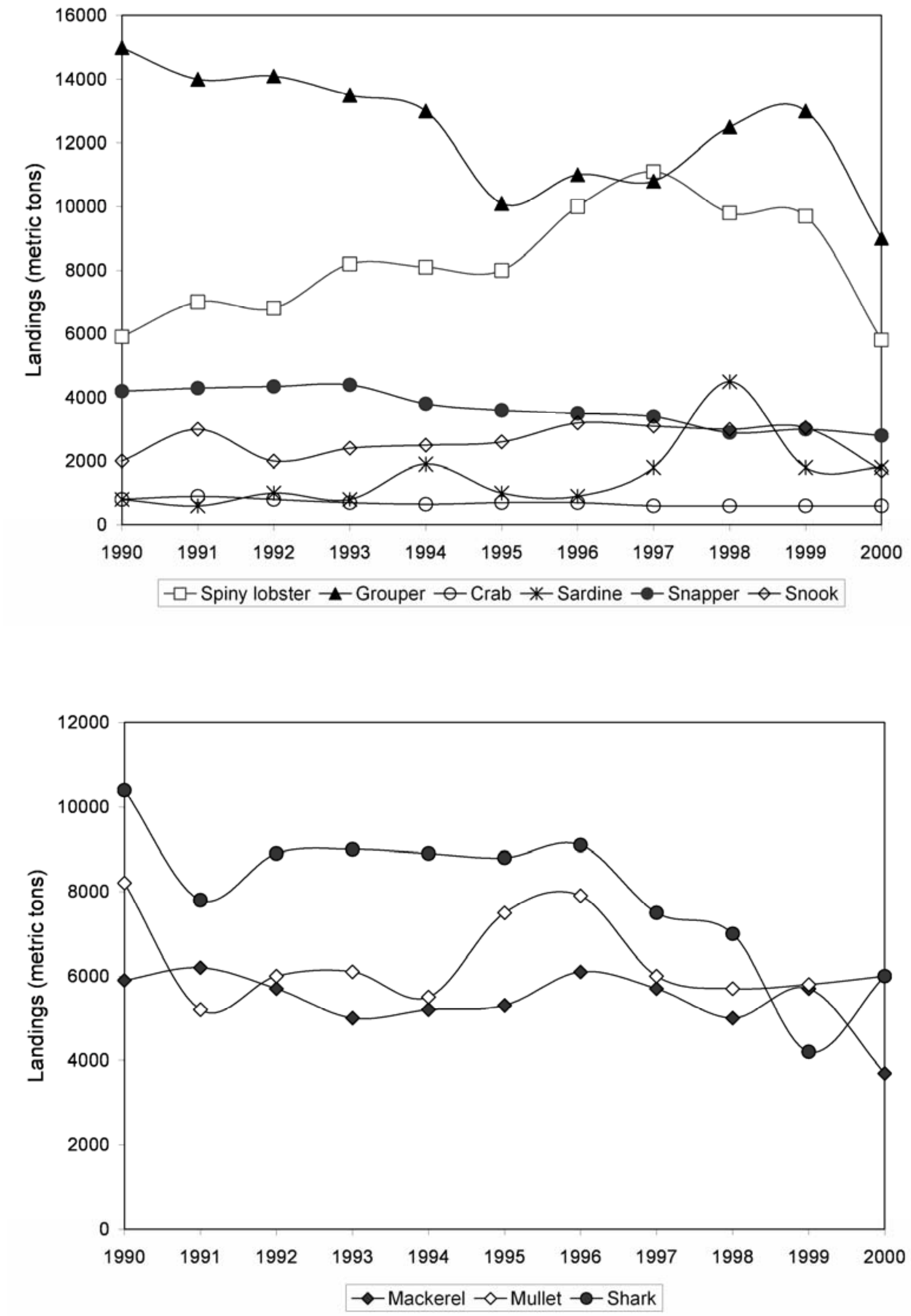

Fig. 24.2. Trends in catch over the past decade for the main fishing stocks in the Gulf of Mexico.

results (INP 1998) that, using the latest appropriate analytical procedures described the health of the 18 main commercial fishing grounds (109 species), which constituted 65% of national catch and 69% of value. This document was updated 1999-2000 (INP 2001) and the projects entitled Catálogo de Artes de Pesca en México" (Catalogue of Fishing Arts in Mexico), "Estado de Salud de la Acuacultura" (The Health of Aquaculture) and "Estado de Salud de los Ecosistemas Costeros y de las Especies Marinas en Estatus de Protección" (The Health of the Coastal Ecosystems and Protected Marine Species) were carried out. These led to scientific and technical support and the adoption of an integral ecosystem approach in the management of the fishing grounds. These analyses showed that species such as grouper and queen conch were being grossly overfished. They also showed that there was limited room for growth in traditional fisheries and that the bulk of stocks had reached their maximum exploitation levels.

Once the first fishery-environment analyses had been carried out, the organization charged with fishery management and regulation reported that it did not have the resources to implement the Ordenamiento Pesquero Nacional (National Fishery Regulations) which had been listed as a priority in the "Programa Priortario del Plan Nacional de Acuacultura y Pesca" (1995-2000 and 2001-2006), and that existing resources had already been assigned to other activities.

During the 1999 public review of the Ley de Pesca 1992 (Fishery Law) regulations, INP proposed that the "Carta Nacional Pesquera" (National Fisheries Charter) should clearly and transparently define the state of resources, along with a resource inventory, and should include details of the maximum applicable amount of fishing effort and plans for managing, regulating, exploiting and conserving resources and their habitat. The National Fisheries Charter became a regulatory instrument rather than just informative, a cartographic vision of fishing that had last been published in 1994.

During the first three months of 2000, the public was invited to take part in drawing up the first edition of the 2000 National Fisheries Charter. Academics, users, other government bodies and non-governmental organizations expressed opinions, put forward scientific arguments and, for the first time, found the doors open to participation and dialogue.

In July of 2000, the 12th Congreso Nacional de Oceanografía (National Oceanography Conference) was organized by INP, ASOCEAN (Mexican Association of Oceanographers) and Red Oceanográfica Pesquera Mexicana (Mexican Oceanographic Fishing Network) seeking, among other things, to present the results to the scientific community, and creating an atmosphere conducive to the exchange of information associated with the drawing up of the 2000 National Fisheries Charter (SEMARNAP 2000).

The National Fisheries Charter was presented to the nation by the President of Mexico, in a speech expressing concern about fishing in Mexico, on the 18th of August. It was published on the same day, and the appendix to it was published on the 28th of August. Thus were built the first governmental fishing-environment analytic instruments for the purpose of fishery regulation, which set out the scientific bases for identifying biological yardsticks to measure the level of deterioration of fishing resources and of fisheries habitat in Mexico. Other analyses pertaining to fishery in the Gulf of Mexico have existed (Shipp 1999, Arreguin *et al.* 2000), but none were of a regulatory nature. Today, the National Fisheries Charter is the only fishery-environment regulatory instrument of a general nature that indicates the health of fishing resources in Mexico and proposes restrictions and limits on fishing. Versions of this process are found in Alvarez *et al.* (2002) and Hernández and Kempton (2003).

INDICATORS OF FISHERY HEALTH (DEGREE OF DETERIORATION)

The 2000 National Fisheries Charter analyzes the state of around 551 species on both coasts (264 in the Gulf and 287 in the Pacific), which share 36 common species belonging to five categories in the Gulf of Mexico and to six in the Pacific, and gauges the importance of each of the groups (Table 24.1, Fig. 24.3). Likewise, it identifies 65 fishery-management units (FMUs) whose definition is more advanced and is related to the fact that resources must be managed and administered, rather than simply used and exploited, with the aforementioned category of fishing grounds being more precisely delimited. Of these, 28 are located in the Gulf of Mexico and 37 in the Mexican Pacific Ocean (Fig. 24.4). These FMUs constitute 90% of all catch and value of extractive fishing in Mexico. Analyses show that 82% of these FMUs are fully exploited, with little chance of growth, and that 25% (16) are in urgent need of intervention for rebuilding and recovery. It also shows that 18.5% (12) of the FMUs are under-exploited (Fig. 24.4).

In our analysis of the health of the 28 FMUs in the Gulf of Mexico, 79% (22) are completely exploited: brown shrimp, crab and crayfish in Tamaulipas and Veracruz; red shrimp and rock shrimp in Contoy, Quintana Roo; lobster in Yucatán; sea catfish in Veracruz and Campeche; and throughout, sea trout, red snapper, porgy, striped mullet, sea bass, snook and “chucumite” (fat snook), sardine, mackerel, wahoo, red octopus and shark, among others. Of these, 25% are seriously deteriorated and in urgent need of intervention for restoration (e.g., white and pink shrimp in Campeche Bay, conch, crab, sea robin and pinfish in Campeche, , lobster in Quintana Roo and throughout, grouper, rock bass and cod). In 21% of the remaining FMUs, the fisheries are underexploited (e.g., tuna, seabob in Campeche; crab in Yucatán and Quintana Roo; sea robin and pinfish in Yucatán; sea catfish in Tabasco and octopus throughout; Table 24.2, Fig. 24.5).

García and de Leiva Moreno (2001) analyzed the FAO database which contains 441 world stocks with available information, and conclude that 4% appear to be underexploited, 21% moderately exploited, 47% completely exploited, 18% overfished, 9% wiped out and 1% in recovery. Table 24.3 shows the degree of exploitation of fishing resources both at the world level and in Mexico, base don data produced by García and de Leiva Moreno (2001) and from the 2000 National Fisheries Charter. Compared to the rest of the world, a high proportion of Mexico’s fishery resources are totally exploited and there are few options for fishery growth, although deterioration levels are marginally lower. However, given that 57% of FMUs are totally exploited, it is expected that these levels will quickly begin to deteriorate.

In the Gulf of Mexico, the trend is holding steady. Potential areas for growth and deterioration are diminishing, but the amount of saturated or maximally exploited stocks is increasing, and these stocks will soon begin to deteriorate. If immediate remedial steps are not taken, this will produce conditions that are increasingly conducive to political conflict regarding effective management in the zone, as has already occurred in other regions (Rosenberg 2003a; Fig. 24.6). In these cases, catch has declined and warnings by scientists about the state of the resources have been increasing. However, responses by fishery managers have been backward, uncoordinated and anachronistic, making it impossible to reverse deterioration and fueling arguments about the problem. These managers are now seeking apparent fishing alternatives, or job or activity subsidies, which, rather than facing up to the problem, only serve to postpone the problem and make it worse.

Table 24.1. Marine species included in the "Carta Nacional Pesquera" 2000. Overall, there were 24 species of bony fishes and 14 elasmobranchs that were found on both coasts with a net total of 551 species including in the marine and coastal fisheries records.

Groups	Gulf of Mexico and Caribbean Sea	Pacific Ocean	Total
Crustaceans	18	21	39
Echinoderms		2	2
Molluscs	13	23	36
Bony fishes	197	198	395
Elasmobranchs	36	40	76
Plants		3	3
Total	264	287	551

Rosenberg (2003a) summarized the problem: 1) overfishing is a persistent and pressing problem that will only be solved by fishing less; 2) a typical cause of overfishing is that apparent fishery population increases immediately lead to the relaxation of fishing restrictions or regulations, while responses to population decreases are generally slow and minimal; 3) it is very difficult to intensify corrective measures, especially when faced with the political pressure from the fishing industry; and 4) foresight and prevention-focused management can counteract this commercially destructive environmental trend. What cannot be ignored is that the health of resources is directly linked to resource management, and management of habitats and ecosystems, with the consensus, responsibility and support of the fishermen.

TOWARDS BUILDING FISHERY-SUSTAINABILITY INDICES

In the current climate, it is imperative that the partial vision afforded by biological studies of the exploited fishery resources be broadened so that all the factors that play a part in the activity are considered in both building fishery-sustainability indices and in managing marine resources and ecosystems in where fisheries are located. Table 24.4 shows the fishery-sustainability indices which are analyzed below. We insist that it is essential to pass from a *political* vision of infinite resources (I, 1), that although it remains hidden in the discourse does exist, to a vision that evaluates the integrity and effectiveness of public policies aimed at reversing deterioration and giving resources and society their desired places in the scheme of things.

This will require defining and evaluating measurable indicators and natural states that will tell us whether, and to what extent, we are progressing towards fishery sustainability. We need to have *biological* elements (II, 2) associated with the captured resources and their fishing grounds, *techological* elements (III, 3) associated with physical means and the effort put into capturing the said resources, and *environmental* elements (IV, 4) associated with the relationships that arise between the resources and the ecosystem, with the activity's impacts on resources, on the habitat and on the ecosystem, and with the role played by protected natural areas in the conservation of biodiversity, resources and vulnerable zones, and in the exportation of fishing resources. We also need to have the *social* (5) elements pertaining to the existence of or lack of ownership rights, to employment, to income, to the degree of nutritional security

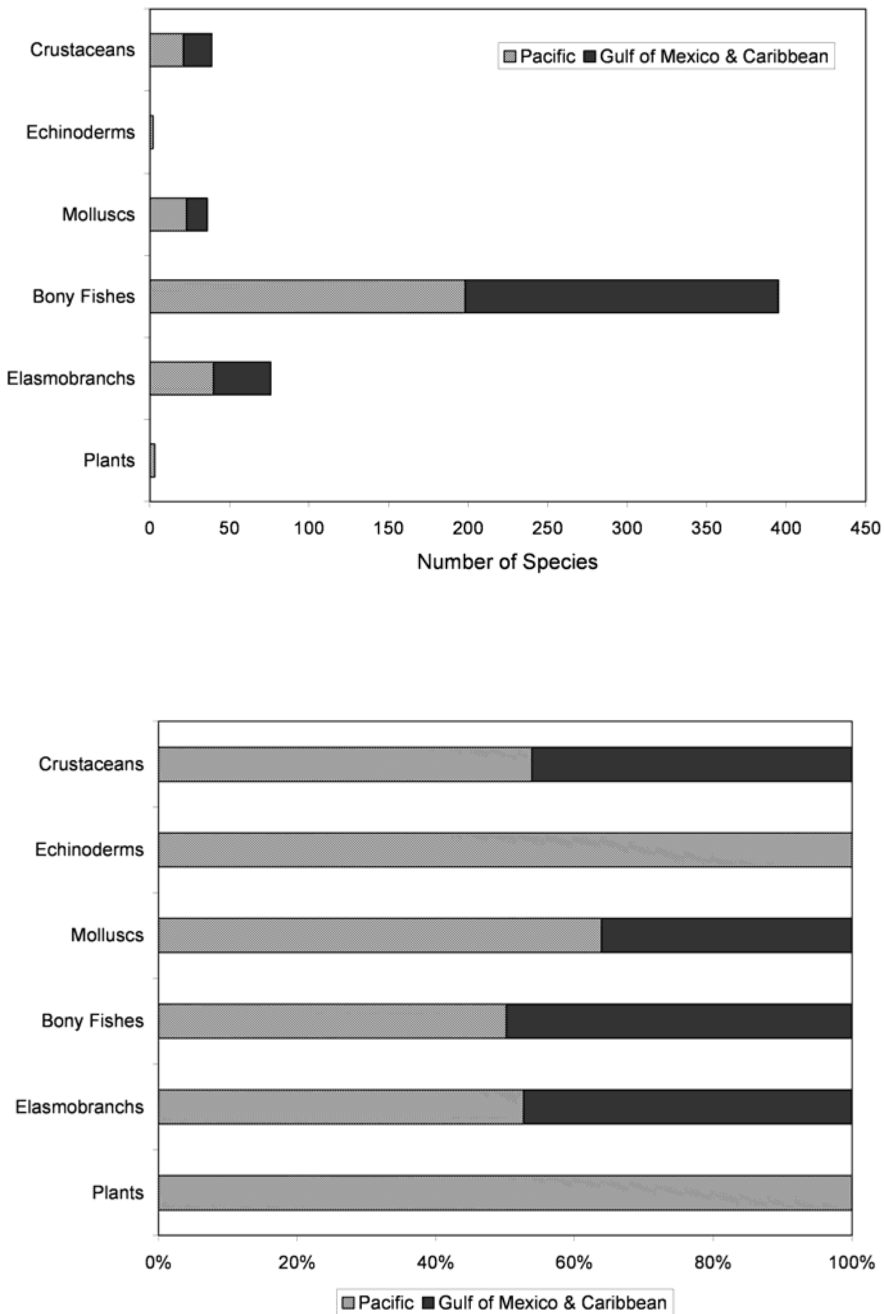

Fig. 24.3. Regional distribution of species numbers (top) and percentages (bottom) of species included in the "Carta Nacional Pesquera" 2000.

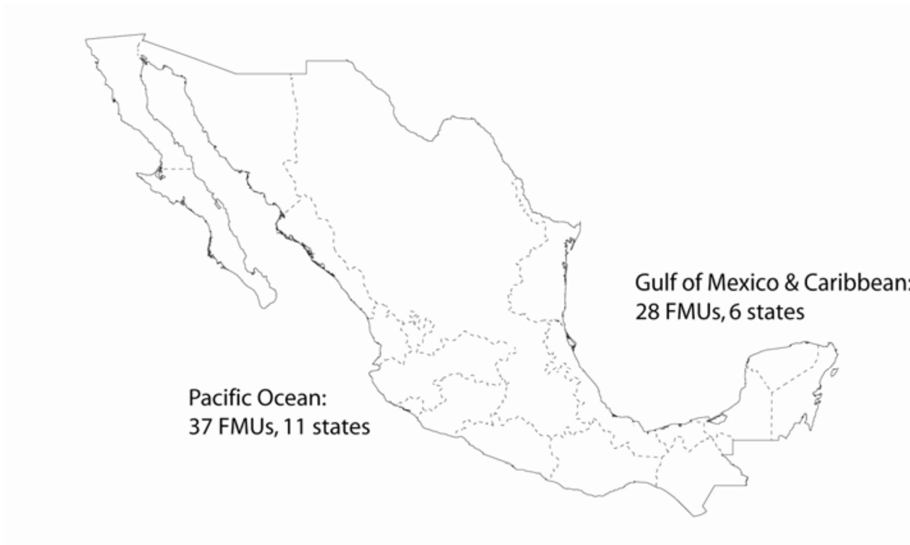

Fig. 24.4. Fishery management units (FMUs) in Mexico. There are 65 fishery management units that represent 90% of the volume and value of coastal and nearshore fishery production.

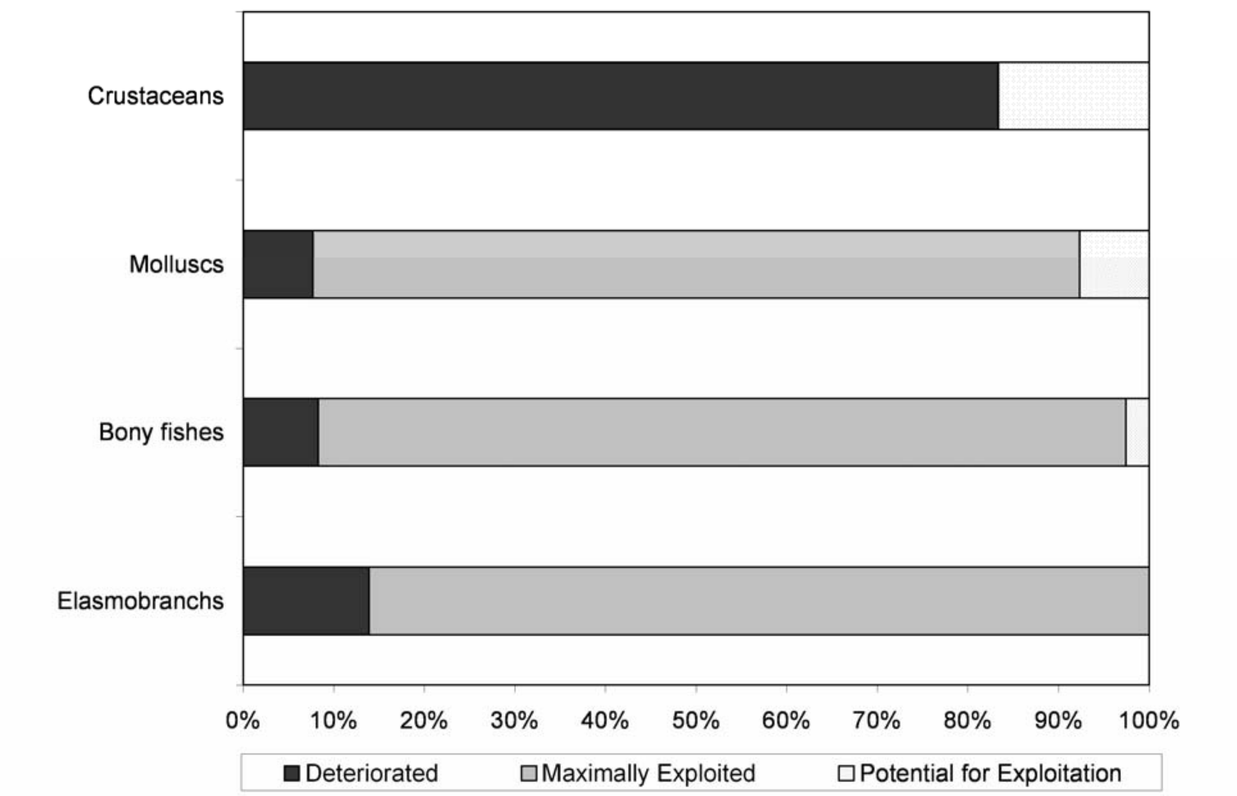

Fig. 24.5. Overall status of various fisheries organism groups in the 28 the fishery-management units in the Gulf of Mexico.

Table 24.2. Status of fishery species in management units on the Gulf of Mexico and Caribbean Sea. If no geographic area is listed, then status is for entire region. P = potential for development; M = maximal exploitation; D = deteriorated.

Fishery Species	Status
Tuna	P
Shrimp	
Brown, Tamaulipas and Veracruz	M
Pink, Campeche Bay	D
White, Campeche Bay	D
Rock, Contoy	M
7-Barbed, Tabasco and Campeche	P
Crayfish	M
Conch	D
Crab	
Tamaulipas and Veracruz	M
Campeche	D
Yucatán and Quintana Roo	P
Spiny Lobster	
Yucatán	M
Quintana Roo	D
Sea Robin and Pinfish	
Campeche	D
Yucatán	P
Sea Catfish	
Veracruz and Campeche	M
Tabasco	P
Sea trout	M
Snapper and porgy	M
Mullet and sea bass	M
Grouper, rock bass, cod	D
Snook and “fat” snook	M
Sardine	M
Mackerel and wahoo	M
Octopus	
Red	M
Common	P
Shark	M

Table 24.3. Comparison of the exploitation of fishery resources in the world and in Mexico (overall, Pacific and Gulf of Mexico).

	World (FAO)	Mexico		
		Pacific	Gulf of Mexico	Overall
Potential	25	16	21	18
Fully exploited	47	59	54	57
Deteriorated	28	24	25	25

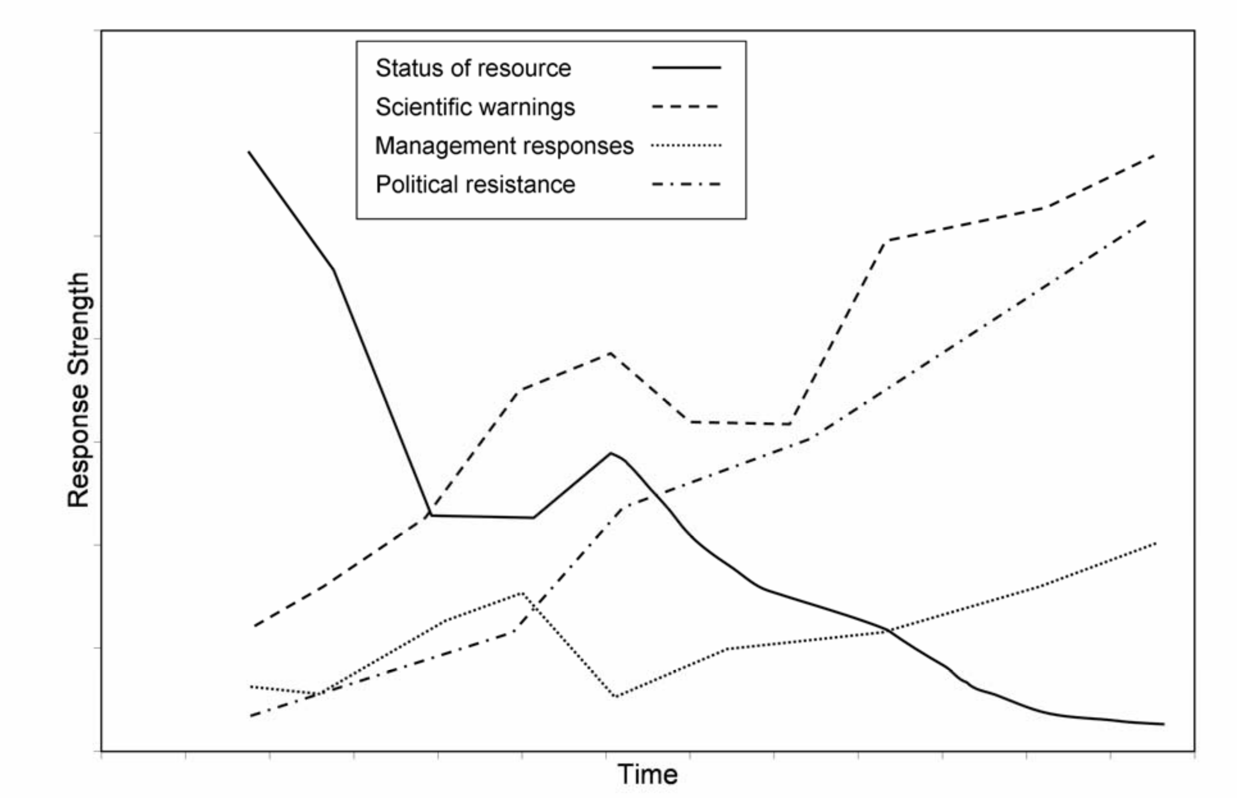

Fig. 24.6. Characterization of the typical scenarios of fishery management (redrawn from Rosenberg 2003a).

that the arrangement produces, and to the end use and final destination of the fishing products, the *economic* (6) elements pertaining to the degree of industrial integration, the monetary outlay and income from the primary activity, management costs, the availability and use of economic instruments to underwrite sustainability, and the *legal* (7) elements pertaining to the existence of legislation, to inspection, vigilance and the observance of sanctions and penalties, and to the legal guarantees afforded both to the participants and to society. *Governance* (8) includes the degree of conflictiveness, political and administrative consensus, social organization of the protagonists, and the existence of channels for social participation. *Institutional strength* (9) can

Table 24.4. Fishery sustainability indices.

Index	Little or no sustainability I (Political)	II (Biological)	Towards sustainability III (Technological)	Greater sustainability IV (Environmental)
1. Vision	Infinite resources	Finite resources	% deterioration	Effectiveness of policies against deterioration
2. Fishery resources	Maximization of captures	Biomass (B) Health (by management unit)	Total C/B Potential Fully exploited Over-exploited Deteriorated	Reproductive C/B Points of difference Points of management Points of recuperation
3. Technological Effort	Maximum number of boats/ships Defined markets	Mortality x fish (F) Minimal regulation	F/Z total mortality Regulation and control	F/Z reproduction Appropriate resources, environment and ecosystems
4. Management				
Fishery	Unspecified	Groups of resources		Ecosystems and adaptive management
Environmental Impact	Not recognized	Yes, environmental indices	Evaluation of environmental impact	Restoration and mitigation of environmental impact
PNA (with regards to fishing)	Non-binding	Some coordination	Coordination	NPAs with controls
5. Rights				
Property	Non-existent	Vague	Some rights	Precise
Employment	Maximization		Sufficient to maintain	Only as much as the resource can tolerate
Food security	No security			Security
Resource use	Status quo or market forces	% of use	As desired	Controlled
6. Integration				
Industrial	Market-defined	% of integration	As desired	
Costs/returns	Market	Profits of RMS	<RMS>MRE	% sustaining the activity
Management costs	Minimal			MRE or amount needed for sustainability
Costs to the user	Minimal			Adequate for the value of the resource
Economic instruments	No	In select units	In all units	Adequate and adjustable for sustainability

Table 24.4. Continued.

Index	Little or no sustainability I (Political)	 II (Biological)	Towards sustainability III (Technological)	Greater sustainability IV (Environmental)
7. Legislation and legal agreement	Generic	Legal framework exists	Reinforced legal framework	Effective, efficient
Inspection, monitoring and fulfillment	Minimal			Acceptable, effective, efficient
Sanctions and penalties	Administrative	Penal		According to the offense
Legal certainty	Non-existent	Weak		Effective and efficient
8. Conflictivity	Increasing	At odds	Decreasing	Minimal
Socio-political adjustment	Vertical	Changing	Horizontal	Mixed
Social organization	Non-existent	Dispersed	Consolidated	Participatory, consensus building
Participation	Limited	Committees	Functioning	Informed, applied
9. Institutional Strength				
Internal strength				
Financial capacity	Low	Medium	Episodic	Sufficient
Competency definitions	Diffuse	Medium	Episodic	Precise
Intra-institutional coordination	Low	Medium	Episodic	Sufficient
External strength				
Access to information	Limited	Aggregated	Released	Accessible
Transparency	Minimal	Administrative	Technical and administrative	Technical, administrative and political
Payment of costs	Minimal	Regular	Permanent	Effective
Inter-institutional coordination	Low	Medium	Episodic	Sufficient
Scheme	Centralized	Changing	Decentralized	Mixed
10. Conscience	None	Limited	Growing	Informed

be split into *internal strength* gauged by the capacity of institutions, in terms of both human and financial resources, the specification of competencies, and of internal coordination and *external strength* consisting of the existence of operational indices that help society to verify whether the existing institutional framework is succeeding in moving towards sustainability. Finally, the *public-awareness* (10) indicator, relates to society's perception regarding sustainability and, consequently, to the likely overall ability of society to move from the status quo towards desirable or sustainable scenarios.

For a start, this proposal helps us to understand that the problem of fishery sustainability goes beyond simply maintaining the health of the resource. This is a necessary, but not sufficient, condition for progressing in towards sustainability, because only overexploitation and deterioration of resources threaten to bring about a state of unsustainability. This initial proposal seeks to integrate previous elements and is presented as a basis for discussion and improvement (Table 24.4). Although the indices can be improved, balanced or reduced, they make the concept of sustainability viable and, above all, identify the areas where improvement is needed and in which public policy must play a more energetic role, and to suggest how progress can be made in that direction.

Progress towards fishery sustainability would be achieved by passing from State I (political) to State IV (sustainable), from 25% to 100%. With the exception of some methodological problems of a biological order, the above transition can be measured ordinally and, in this way, a yardstick for measuring progress towards sustainability, both by indicator and overall, could be found. Subsequently, appraisers could be found and non-parametric inferences made regarding the results of a series of surveys on this issue. This proposal seeks to balance the particular indices associated with the abovementioned 10 meta-indices. The proposal also makes it easier to find both partial and global indices that show the way towards sustainability. We carried out a pilot exercise that showed the indices' median level is around 1.5, suggesting a pathway towards sustainability in the region. Finally, the indices can be used at multiple organizational levels and comparisons can made, i.e. from a fishery, a management unit, a region, a state, a coast or a country to a large marine ecosystem that involves various countries.

THE CASE OF SHRIMP FISHING IN THE GULF OF MEXICO

As case in point in terms of the abovementioned indices, we will focus on shrimp fishing. On the coast of the Gulf of Mexico, shrimp is the third largest fishery by volume (~11,000 metric tons in 2001). However, its production value (~853.48 million pesos in 2001) makes this fishery the most important on the coasts of the Gulf of Mexico and the Mexican Caribbean.

The main shrimp landed in the Gulf of Mexico and the Caribbean are brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), red shrimp (*F. basiliensis*), white shrimp (*Litopenaeus setiferus*) and rock shrimp (*Sicyonia brevirostris*). Exploitation occurs mainly in three zones: 1) Campeche Bay in the states of Campeche and Tabasco (white, pink and brown shrimp, 22% of all production); 2) northern Gulf of Mexico, in the states of Tamaulipas and Veracruz (for the most part, brown shrimp, which is at least 70% of the coastal catch); and 3) the Mexican Caribbean in the state of Quintana Roo (red and rock shrimp, at least 1%, part of that catch is recorded in other zones).

The juveniles are found in lagoons or shallow sea water (where they are susceptible to artisanal fishing, with small sizes and relatively low market value), and then migrate out to sea to breed as adults (caught by industrial fishing boats, with larger sizes and higher market value).

This fishery is a typical example of a sequential fishery where negative consequences are produced, since the catches made by the artisanal sector affect those achieved by the industrial sector and vice versa. Although this is one of the most intensively researched fisheries, and one of the first to be regulated, there are various factors that are unfavorable to sustainablity. The most obvious is overfishing due to excess effort.

The catch in the Campeche Bay (primarily pink and to a lesser degree, white shrimp) decreased by ~20,000 metric tons since1970. Catch has declined to ~500 tons for both species in the last few seasons (Figs. 24.7 and 24.8; Fernández *et al.* 2000, SEMARNAP 2000). Although catch per unit of effort has decreased in Contoy, it is not clear how much of this trend can be attributed to reductions due to the catches made by the Campeche fleets along other parts of the coast. In Tamaulipas, following a sustained increase in artisanal and industrial fishing that started in the 1970s, and an increase in deep-sea catches since the imposing of the closed season in 1993; the catch has dropped significantly since 1997 (Fig. 24.9).

In this respect, the logical remedy would be to apply regulatory measures. Although, on the administrative front, measures such as zonal fishing restrictions and the definition of which fishing methods are allowed do exist, administration of this resource has revolved around reducing mortality per catch via the imposition of closed seasons. However, problems have increased regarding the imposition of closed seasons for various reasons. One reason is the fact that the closed seasons were imposed from 1993 on, while this measure has been applied for decades.

By the time the closed season was imposed in Campeche Bay, the populations of white and pink shrimp were already much diminished. Although the closed season offers protection in the important growth and reproduction phases of white and red shrimp development, illegal fishing in lagoons and shallow waters is still intensive and mortality resulting from industrial fishing at the start of the season reaches levels that are comparable to those observed before imposing the closed season.

In Tamaulipas and Veracruz, there was artisanal fishing in coastal zones with high production levels before the closed season was imposed (Fig. 24.9). So far, in this zone, emphasis has been placed on the avoidance of growth overfishing resulting from the capture of small specimens, mainly in lakes, but also in shallow marine areas, which leads to decreases in both the size and the value of the catch (a short-term loss in production capacity). The emphasis has been the same in the closed seasons for brown shrimp in Texas (Klima *et. al.* 1982; Nichols 1982), which served as a model for the measures implemented in Tamaulipas and Veracruz. As applied, the closed season protects the species while it is juvenile in the lagoons, without affording protection to any of the reproductive phases that occur out at sea, although it is based on the hypothesis that the more breeders that are allowed to exist out at sea, the greater the probability of ensuring successful reproduction and hence achieving larger final numbers.

For its part, the closed season imposed in Tamaulipas in October of 2002 only provides protection for breeding activities occurring in autumn, a period which, despite having more individual breeders, is not the most important in terms of population increases. Despite recommendations made in this respect, the most important breeding period (in terms of subsequent population growth), occurs towards the end of the first quarter, and has not been protected.

In addition to protection of breeding periods, consideration should be given to the number of breeders available, due to mortalities stemming from overfishing during the open season, which leads to a long-term drop in the stock’s production capacity due to the decrease in the

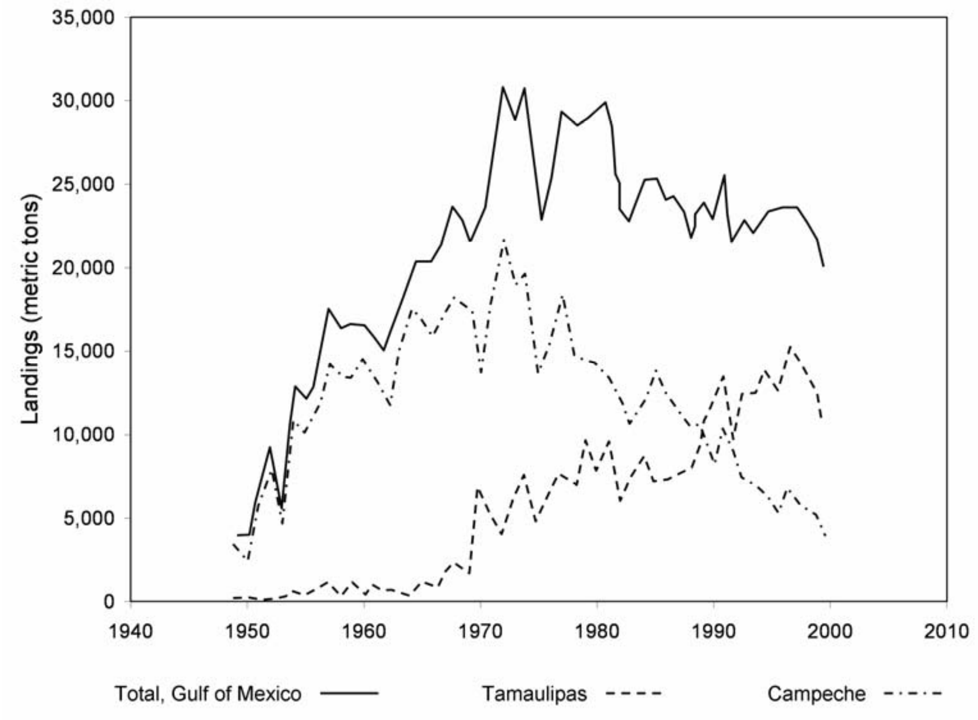

Fig. 24.7. Trends in shrimp catches in Tamaulipas and Campeche, compared with Gulf of Mexico totals.

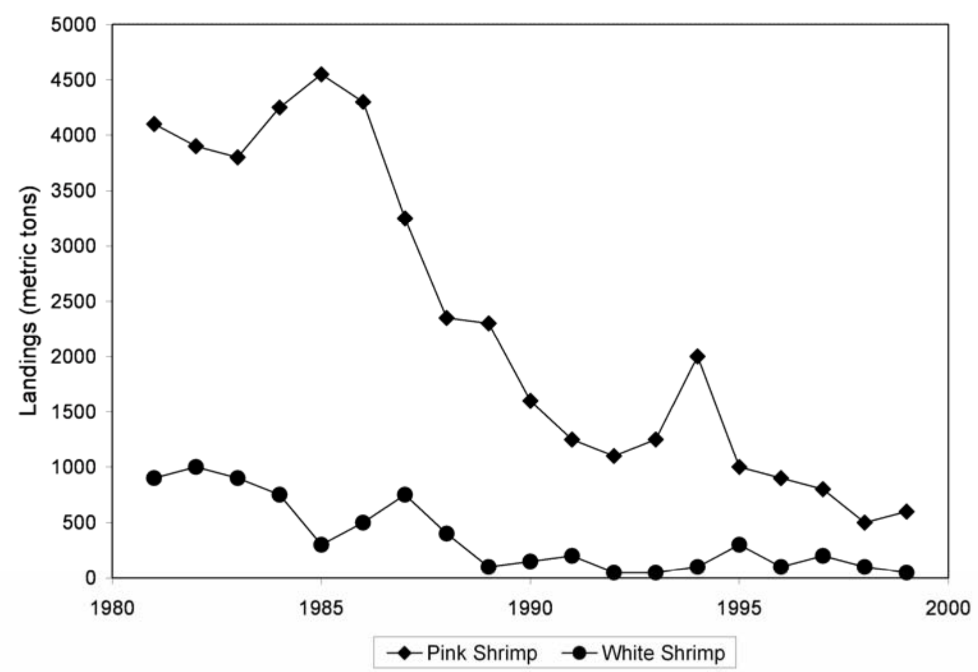

Fig 24.8. Trends in catches of the two main shrimp species exploited in Campeche Sound (from Carta Nacional Pesquera 2000).

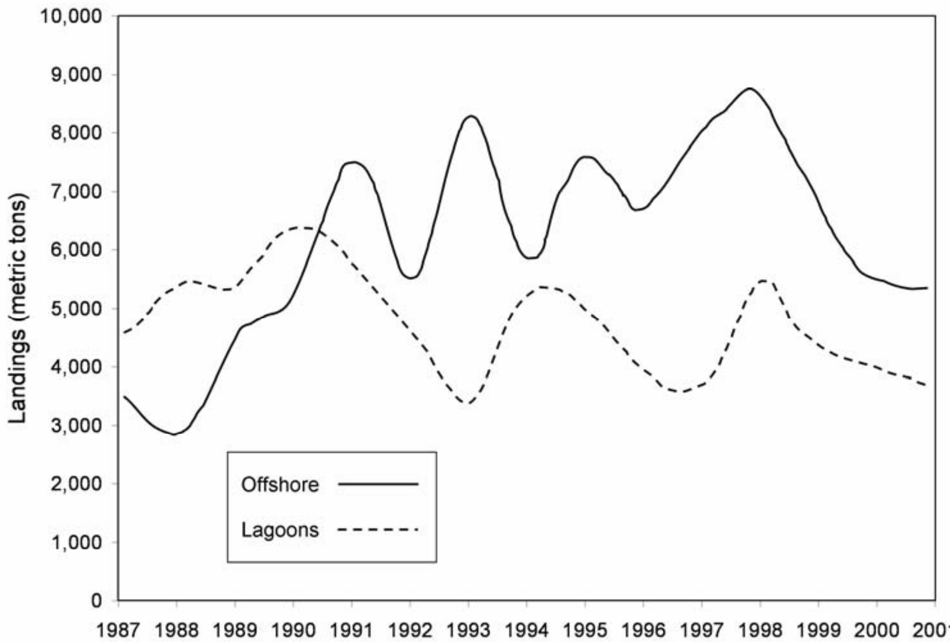

Fig. 24.9. Trends in shrimp landings in Tamaulipas.

number of breeders. This possibility has long been pointed out in the case of shrimp fishing in the United States (Viosca 1958), and has long been thought to be the causes of population delines in the Campeche fishing grounds (Gracia 1996; Ramírez *et al.* 2001).

There are indications that this might also be the case in the Tamaulipas fishing grounds. Levels of fishing-induced mortality in deep-sea fishing in Tamaulipas are comparable to those that have been detected since the1970s, the period when declines in catches began in the Campeche fishing grounds (Fernández 2001).

This is a consequence of the overall administrative structure. Fishing effort has not been regulated in fishery administration (other than laying down guidelines pertaining to increases). The varying duration of the closed seasons in the states causes movement of the fleets, which has an important effect on the increased levels of fishing-induced mortality in different areas. For example, since the Campeche closed season lasts from May to October and the one in Tamaulipas ends in mid-June, the Campeche fleet concentrates along the Tamaulipas coast, doubling the number of ships operating in the zone (INP 2000). This tendency has been occurring since 1993, the year when the closed season was imposed (Fig. 24.10). The same can be said of the closed season in Contoy. Although the closed season was established in order to stop the fleet from moving to that zone, it has left the breeding and replenishment season unprotected in the zones where red shrimp, the most economically significant species is fished (INP 2000).

Another factor that has had a significant influence on the management of the shrimp fishery (given its sequential nature) is the increasingly intensive competition between the artisanal and industrial sectors for access to the shrimp. For example, as implemented in the lagoons of Tamaulipas and Veracruz (45-60 days, from May to July), the closed seasons restrict artisanal fishing in the months when stocks are most plentiful.

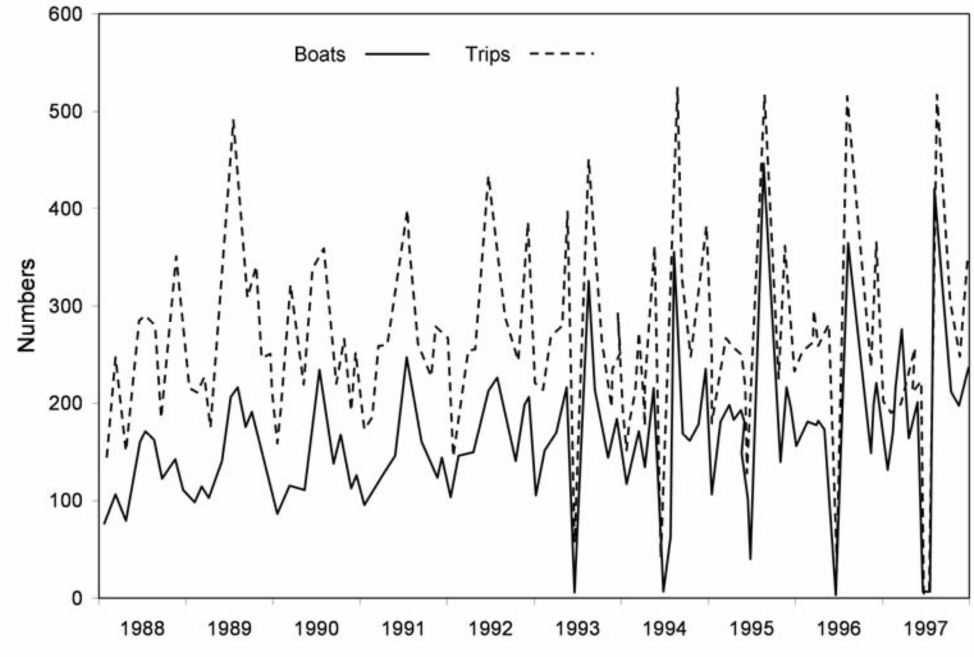

Fig 24.10. Trends in the number of shrimp fishing boats and trips in Tamaulipas from 1989 to 1997.

However, since the closed season for deep-water fishing is implemented at roughly the same time (lasting up to 90 days, from May to June), when the main stocks of the year are located in the lagoons and deep-sea catches are low, the closed season has no negative effect on the industrial fleet's catch. The main positive effect of the deep-sea closed season is to protect the shrimp that migrate out to sea in June during their growth stage, until the start of the season, which has fluctuated between mid-June and early August. Since the shrimp that were not caught during the lagoon fishing closed season between May and June will be caught at the beginning of the July-August deep-sea season, the closed season has become an instrument devoted to the sharing of stocks (Fernández *et al.* 2000), rather than protecting the resources.

As things stand, the artisanal fishermen from the areas of Tamaulipas and Veracruz have little incentive to respect the closed season and the administrative set-up. Since 1977, the average age of the individuals caught at the start of the season shows that the exit of individuals from the main stocks, which were initially protected by the closed season imposed on the lagoons, has gradually been reduced (Ramírez and Fernández 2001), showing that the closed season has very clearly stopped being effective in fulfilling its original aims (Fig. 24.11).

The decrease in total catch since 1997 has led to a decrease in deep-water catches per boat (Fig. 24.12), and to an increase in the already high level of competition for, and conflict over, the resource between the artisanal and the industrial sectors, given that the only instrument that has produced any measurable result to date has been the closed season in lagoon areas.

In this case, the policies that were initially implemented (Level I of meta-index 1), revolving around the sharing out of the resource, did not take the latter's finite nature into account. Management has been based on the reduction of growth overfishing, focusing on the optimization of catches (Level I of meta index 2). No definition exists of ownership rights, nor

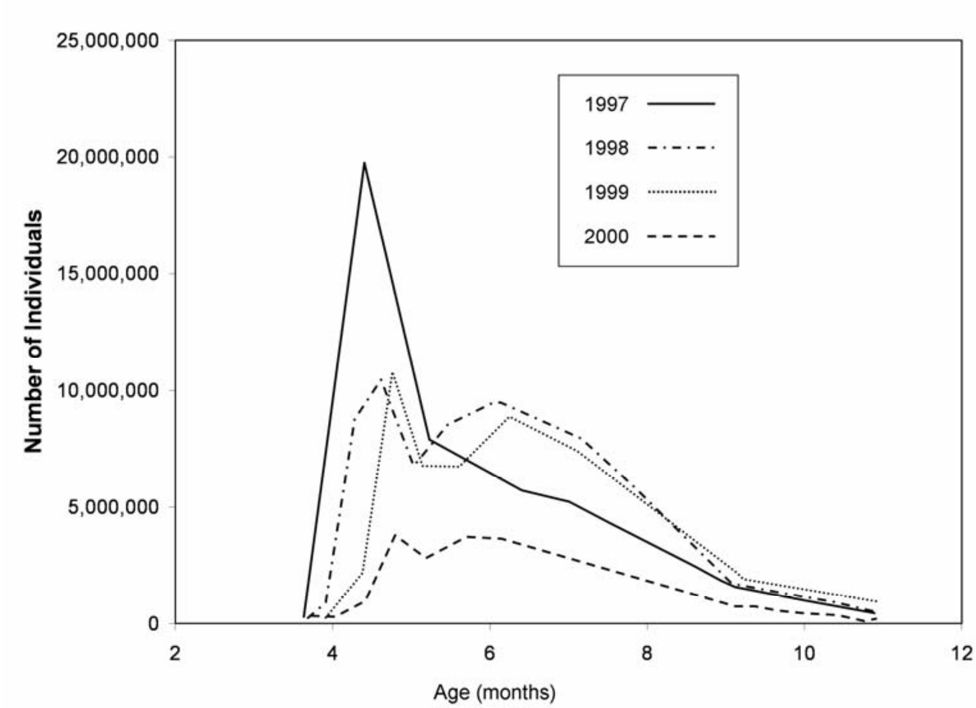

Fig 24.11. Variation in age-frequency in deep-water catches of brown shrimp in Tamaulipas.

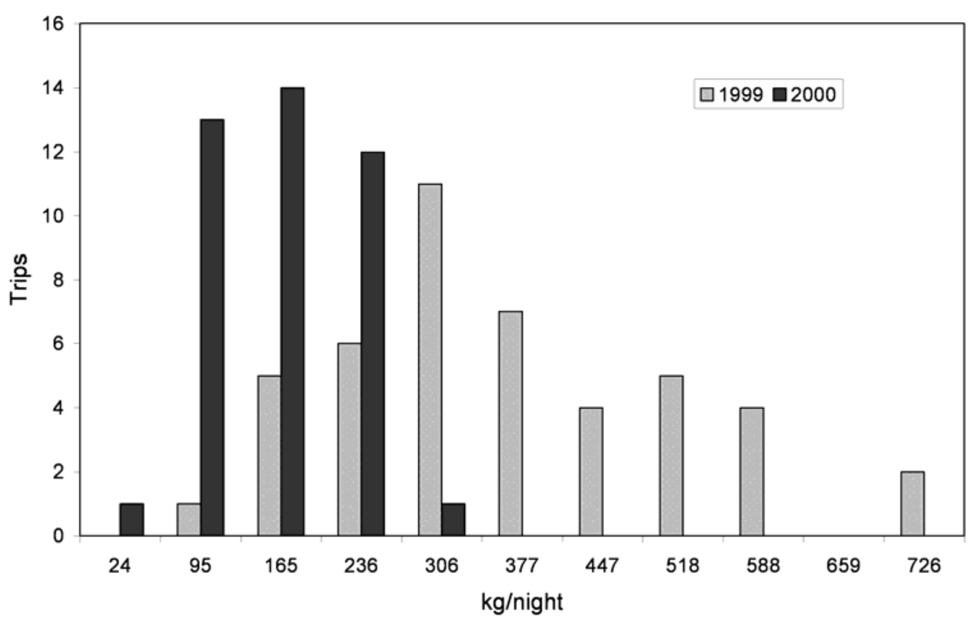

Fig. 24.12. Variation in deep-water night catches of brown shrimp in Tamaulipas.

any income outlay rules (Level I of meta-index 5). Profitability is tending to decrease (Level I of meta-index 6). Legislation exists, but, in addition to the fact that it suffers from supervision failures (Level II of meta-index 7), it is necessary to impose effort regulations, among other instruments, in the artisanal and industrial sectors, along with bigger restrictions on the latter's technology (Level I of meta-index 3). Conflictiveness in fisheries is high and there are few incentives encouraging users to comply with institutional provisions (Level I of meta-index 8).

Internal institutional capacity has dropped as a result of budget and staff cuts, while external institutional capacity has not changed (Level I-II of meta-index 9). Finally, little attention has been paid to environmental factors, apart from the adoption of turtle-excluding devices (Level II of meta-index 4), and it can be asserted that there is limited, but growing, social awareness of the fishing situation (Level II-III of meta-index 10). It can be affirmed that, despite the initial benefits, failures in the application of the overall institutional framework have negatively affected biological sustainability, lowered levels of social acceptance and reduced profitability.

DISCUSSION AND PERSPECTIVES

The Gulf of Mexico is the least productive, and indubitably the most fragile, of Mexico's seas, being definitely more fragile than the Mexican Pacific. It supplies around 21% of all catches on both coasts. Consequently, in fishing-effort-saturation conditions, it is to be expected that catches will be in direct proportion to existing biomasses and that changes will be in proportion to changes in resources.

Overall catch, and that of the main fishing resources, have decreased by roughly 20% in the last seven years, and, consequently, so have their biomasses, since it is not possible to optimize catches without affecting natural stocks. Much of the above can be attributed to overfishing, given that, alongside this, the amount of artisanal effort has increased significantly and industrial effort, although it has decreased in numerical terms, has increased its technological efficiency and, hence, its catching power.

There is a problem of overcapacity of the fleet and economic inefficiency in Gulf fishing grounds, due to short-sighted communalist policies focusing on job promotion and catch optimization, as a result of which, in average industrial-production conditions, the artisanal and industrial finfishing fleets are capable of catching 9.5-19 times their present levels, while the industrial shrimp fleet is capable of catching 8-16 times its present catch.

Indices of wellbeing, regulatory instruments and the first fishery-environment análisis have been implemented and prove that fishing resources in the Gulf of Mexico are suffering from overexploitation, with 79% of them unable to continue growing because they are being exploited to the maximum, and 25% of them deteriorating. All of this shows that current fishing in the Gulf of Mexico is unsustainable. Despite this, no urgent steps have been taken to acknowledge the deterioration, try to reverse it, and strengthen state institutions and regulatory capacity, which have been weakened due to economic liberalization and structural adjustments. In addition, there have not been any efforts at creating public awareness so as to face and mitigate the effects of the deterioration. On the contrary, a policy based on subsidies and on reacting to conflicts has been opted for, which, far from facing the problem and solving it, will tend to aggravate the problem over time (Senado de la República 2003). This runs contrary to generally accepted principles such as the precautionary principle, the XXI Agenda, the "Código de Conducta para la Pesca Responsible (Responsible-fishing Code), the recent Declaration, and the Johannesburg Sustainable-Development-Summit Implementation Program, as well as contravening the guidelines issued by economic organizations such as the OECD, of which Mexico is a member.

The present trenes in the loss of marine resources in the Gulf of Mexico, whose coasts are inhabited by more than 12 million people, undoubtedly constitutes a very significant risk factor with regard to food security. The most acute effects of this situation are observable in the short term in the Campeche Bay region, due to petroleum-extraction activities and growth of the number artisanal fishers in that region. Unfortunately, despite the existence of indices and regulations based on the 2000 National Fisheries Charter, in fisheries management there has been a marked tendency to relax presently-existing indices and to operate in accordance with laxer policies, which will negatively affect marine and fishing resources.

Given the lack of measures to curb and reverse deterioration caused by fishing, it is necessary to strengthen present sustainability indices and add new ones, to introduce proactive preventive policies and to prevent the fisheries sector from straying further away from this paradigm. Given these conditions, it is also worth reflecting on the role that should be played by the national environmental institutions in order to face the situation and curb the loss of such a valuable natural resource in the Gulf of Mexico.

In this paper, we presented a proposal regarding indices, the process for moving towards fishery sustainability, and means of quantifying the progress achieved in the attempt to bring about the desired state in the Gulf of Mexico. This proposal, the merits of which will have to be put to the test, acknowledges that sustainability is a complex, multi-factorial, multi-level, multi-sectorial aim, and is presented in support of efforts to design and implement public policies aimed both at reversing deterioration and at identifying areas that are in need of improvement, so as to put fishing activities on the road towards sustainability.

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