FISHING IN THE GULF OF MEXICO: TOWARDS GREATER BIOMASS IN EXPLOITATION

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INTRODUCTION

The form, magnitude and lack of control over fishing activities worldwide pose an issue for global ecology that requires immediate attention. The ecological value and environmental services at risk must be reviewed. Overinvestment, excessive fishing effort, biological overfishing, inoperative regulation, etc., are added to the destruction of coastal ecosystems, multifocal pollution and recreational shoreline fishing. According to recent data (Myers and Worm 2003), stocks of high trophic level fish species have been reduced by over 90%, representing over 30% of total marine production. The coastal zone lacks effective mechanisms of protection.

The Gulf of Mexico is not immune from this situation. Fishing is carried out in all environments and ecosystems, with little regulation. The value of the populations that inhabit the coastal lagoons is evident, as well as their connectivity with other ecosystems. Focus on integral management of the coastal zone, including the neritic zone as a border to the sea and the hydrological basin toward the coast, constitutes an alternative approach to the problem. The objective should be to break the vicious cycle where constantly increasing global demand reduces biomass and prices increase, resulting in increased fishing effort. In this sense, the objective should be to recover biomass lost to overfishing and habitat destruction, with the benefit of restoring ecosystem services and obtaining better economic results. At present there is sufficient technological development for this to be feasible without a large investment and it is important to formally subordinate regulation and fishing management to integral management of the coastal zone. In the Gulf of Mexico it is important to make fishing a quality not quantity activity.

WORLDWIDE FISHING OVERVIEW

In recent years, scientific publications having the greatest impact on fishing have been dedicated to pointing out the difficult situation that marine ecosystems face due to fishing activities. The technological advances that have transformed and industrialized fish detection and catching is used in all regions of the world where there is significant industrial fishing, generating significant impacts on marine ecosystems. Artisanal or subsistence fishing that uses human ingenuity is uncontrolled and impacts a great variety of species. Mariculture technology advances without recognizing the risk of ecological destruction. Myers and Worm (2003) point out that industrial fishing reduced fish population biomass by 80% in 15 years of extraction, and they estimate current predator fish biomass at only 10% of pre-industrial levels. This reinforces the estimate by Jackson (2001) on collapse of coastal ecosystems from overfishing and the statement by Weiss (2003) that 90% of the population of ocean species in the world, including cod, halibut, tuna, sword fish and marlin, have disappeared in recent decades.

The above is not yet an economic problem for the big industries that have adapted to changing conditions, exhausting species whose populations increased in the absence of top predators; using deeper and more distant banks that were exhausted in the last century. Large industrial fishing operations are compensated through subsidized polices that maintain investment levels in fishing that overcapitalized by more than 50 billion dollars. Surplus fishing effort in the world economy is over 50% and, from a resource point of view, this translates into intensified search for fish, a widening of target species and competition with subsistence fishing. World economic collapse is not predicted, yet a series of ecological collapses can be foreseen.

Marine ecosystems constitute over 50% of the world's productivity (Field *et al.* 1998), and the main stocks are either overexploited or their populations have already collapsed. Worldwide, biomass removed by fishing annually averages over 30% of potential biomass landings in all oceans and seas.

Residual populations oscillate between 5 and 24% of virgin populations. Historical data reveals that in coastal environments losses of both large predatory fishes and mammals has been very pronounced (16% per year), causing changes in the structure and function of ecosystems (Jackson 2001). FAO data indicate a distortion in the information and a tendency to global reduction in landings in the absence of control over fishing efforts. Watson and Pauly (2001), after analyzing FAO catch data, concluded that fishing has gradually been moving down the food chain.

From an exploitation point of view, independent of ecological effects, the situation must be reversed to obtain better economic results and subsequently greater biomass in extraction. The above is of great importance for management decisions and resource exploitation control. There is clear evidence that coastal ecosystems operate with "top-down" controls, in which ecological consequences increase exponentially (Worm and Myers, 2003). This consequence of fishing on ecosystems is of concern because of its worldwide prevalence, the level of reduction in populations and the subsequent difficulty in reversing this situation. Another problem is the extinction of populations, particularly of those that mature at an advanced age. Local extinctions have occurred unnoticed even in ecosystems that have been carefully monitored (Casey and Myers 1998). Fishing is an inescapable world ecological problem. The United Nations Environmental meeting held in 2002 established in its resolutions the need to recover fishing stocks to a more sustainable level.

FISHING IN THE GULF OF MEXICO AND ITS NATIONAL (MEXICO) CONTEXT

The situation of fishing in Mexico is not different from what is happening worldwide. Over-exploitation, overinvestment, excessive fishing effort, lack of regulation and pollution, are the common factors that contribute to degrading coastal ecosystems.

Annual fish landings have stabilized at around 1.3 million metric tons (live weight) in the last 20 years, in spite of the growing fish farm production and inclusion of previously unwanted species. Total production in 2001 was 1,325,785 metric tons, that represented an income of $12.9 billion pesos off the boat (SAGARPA 2001). The contribution of fishing activity to Gross Domestic Product was only 1.7%, well below the petrochemical industry, its derivatives, and tourism, the activities that contribute most foreign currency to the country. In fact, from a strictly economic point of view, suspending fishing activities in the Gulf of Mexico would not affect national economic processes.

Biogeography and climate in the Gulf of Mexico result in the vast majority of fishing resources being multi-specific, in contrast to the main fisheries in the Pacific Ocean, which tend to be mono-specific.

The Carta Nacional Pesquera (SEMARNAP 2000) estimates that 551 species are caught in marine waters, 287 in the Pacific and 264 in the Gulf of Mexico and Caribbean Sea. Despite the fact that the numbers of species are similar, the latter contribute only 23% of national fishing volume, that (~298,818 metric tons) whereas the Pacific contributes 74%.

The main fisheries in the Mexican portions of the Gulf of Mexico and Caribbean Sea are shrimp, shark, tuna, grouper, octopus, lobster, queen conch and other finfish. Official catch data for the Gulf of Mexico from 1966 to 2001 averaged of 300,000 metric tons, and shows a clear increase in the mid-1990s with a subsequent decline that does not reach the lowest values recorded in 1987 (Fig. 25.1). It is unlikely that these records reflect the abundance of the resource and catch efficiency; it is more likely that the statistics reflect the government's intention of inviting private enterprise to invest in fishing during those times. In Mexico, as in the rest of the world oceans, increased fishing efficiency through improved techniques in catch and detection are not reflected with a real increase in landings; instead it is affecting more species in more areas and with greater intensity.

The State of Veracruz is the main fishing producer in the region, contributing 40% of volume in landings. Nationally, the State of Veracruz occupies 5th place in production below Sonora, Sinaloa, Baja California and Baja California Sur with a volume of 119,304 metric tons, of which 98% comes from artisanal fishing, which is of low economic value.

PRESENT FISHING STATUS IN MEXICO

The shrimp fishery, which is one of the most important fisheries in the Gulf and Caribbean Sea region, is found mainly in Tamaulipas and northern Veracruz, where brown shrimp (*Farfantepenaeus aztecus*) are caught. Pink shrimp (*Farfantepenaeus dourarum*), Atlantic white shrimp (*Litopenaeus setiferus*) and Atlantic seabob (*Xiphopenaeus kroyeri*) are found in the Campeche Bay and red shrimp (*Farfantepenaeus brevirostris*) and rock shrimp (Sicyonidae) are found in the Caribbean Sea. Landings have leveled off at about 20,000 metric tons in the past few years. These three zones are maximally exploited and can not support more fishing effort by either artisanal fishers or the industrial sector. The 770 shrimp boats that operate in open sea and the effort applied in coastal lagoons can not be increased. The brown shrimp population is presently in good condition and has sustained the shrimp fishery in recent years. However, white shrimp and especially pink shrimp populations, are extremely deteriorated, with biomass levels far below that of their maximum productivity (Arenas and Díaz de León 1999).

In 1997, production of Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) and other sharks in the Gulf of Mexico was of 5,780 metric tons; 35% of national production came from this region. Artisanal shark fishing represents valuable sources of food and employment for shoreline communities on the Gulf of Mexico. The main shark-producing states are Veracruz and Campeche. The number of commercial shark fishing permits in the region is 400, with which 3,600 boats operate. This fishery catches 33 species of shark, of which 10 provide 90% of artisan catch. The Atlantic sharpnose shark fishery is maximally exploited and is at risk of diminishing drastically if the same exploitation strategy continues, in which the catch of immature organisms predominates (90%) (Arenas and Díaz de León 1999).

The only ocean fishery in the Gulf of Mexico that is carried out in the exclusive economic zone is yellowfin tuna (*Thunnus albacares*), which is caught with 20 long line fishing boats, generating ~1,100 metric tons. This fishery has development potential and could expand to up to 45 boats while still exploiting the resource sustainably (Arenas and Díaz de León 1999).

The grouper population in Campeche Bay is the largest in the world and is exploited mainly by three fleets: a small fleet of 3,440 skiffs and two larger fleets, one Mexican with 539

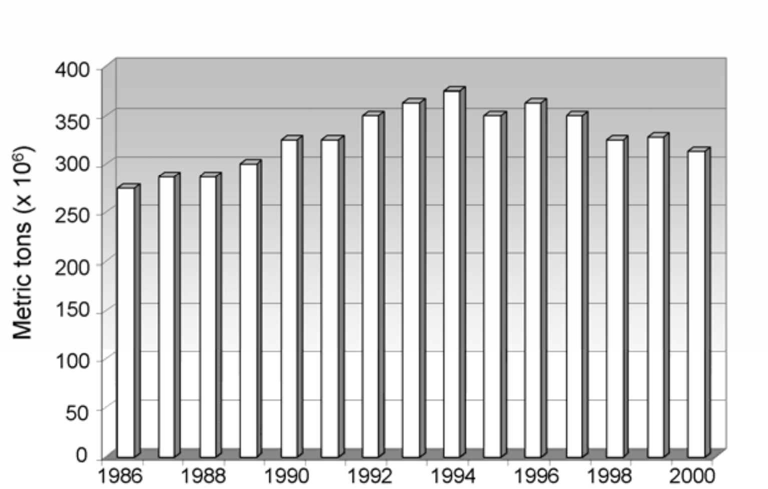

Fig. 25.1. Total annual fishing production in the Gulf of Mexico and Caribbean Sea, 1986-2000.

boats and one Cuban with 16 medium-length boats that receive the catch from numerous small boats. Landings in the last 10 years have fluctuated from 8,000-14,000 metric tons. This fishery is deteriorating and the exploitation rate must be reduced by 40% (Arenas and Díaz de León 1999).

The species of octopus, *Octopus maya* and *O. vulgaris*, are caught in Yucatán by about 1,900 skiffs and 500 medium-length boats that launch and receive the catch from 10 wooden canoes each, recorded a catch of 17,776 metric tons in 1997. This fishery is maximally exploited and in order to maintain sustainable levels, landings need to be maintained at 10,000-12,000 metric tons (Arenas and Díaz de León 1999).

The Caribbean spiny lobster (*Panulirus argus*) fishery is found on the coasts of Yucatán and Quintana Roo by free diving, and despite being artisanal, it is highly profitable because its production has a high beach price (26 USD/kg in 1997). Landings in 1997 were 844 metric tons. About 400 skiffs and 14 boats are dedicated to this fishery in both states, and this fishery is considered maximally exploited in both states. The Campeche Bank has a fraction of stock that has potential for development. (Arenas and Díaz de León 1999).

Queen conch *(Strombus gigas*) is a resource of great tradition in the Mexican Caribbean region, mainly in Quintana Roo, but its deterioration has been such that now it is only fished in Banco Chinchorro and Cozumel. Seventy boats and 140 fishermen make up the effort in this fishery whose catch has declined over the last10 years. Since the early 1990s, about 57 metric tons have been caught annually. The biomass levels of at least 470 metric tons, established as a reference point for stock recovery, requires a two year complete closure of the fishery (Arenas and Díaz de León 1999).

An evaluation carried out by Arenas and Díaz de León (1999) on 18 fisheries covering 109 species that inhabit the Pacific and the Gulf of Mexico, representing 65% of the national production volume and 67% of the national landing value, indicate that, in general, the fisheries in our country have not reached a critical state; however, excess capacity has led to deterioration of some and these require recovery strategies. Such is the case of the Pacific anchovy (*Cetengraulis mysticetus*) on the western coast of Baja California, abalone, sea urchin and the sea cucumber from Baja California, queen conch from Quintana Roo and grouper from the Campeche Bay.

Other fisheries have stable landings with a fishing effort that, if increased, would put at risk the populations and the fishing activity. Examples of fisheries that have been maximally exploited are shrimp and shark in the Pacific and Gulf, octopus in Yucatán and spiny lobster in the Caribbean. On the other hand, fisheries with development potential are tuna in the Pacific and Gulf, Pacific sardine (*Sardinops sagax*) in the Gulf of California and western coast of Baja California, giant squid (*Architeuthis dux*) in the Gulf of California and spiny lobster from Baja California. With the existing information, it can be estimated that in the Gulf of Mexico and the Caribbean Sea, 86% of the fisheries have no potential for expansion, given that they are deteriorated or maximally exploited and with limited renewal capacity (INP 1998).

Since the 1950s, artisanal and industrial fishing have coexisted, evolving in apparent free competition, under unspecified development policies. In the past, when vigorous promotion was given to industrial fishing worldwide, this activity was intended to promote growth in all fisheries; even shoreline fishing came to be considered as a transitional phase towards large scale fishing (Breton 2002). Evidently, investment required by industrial fishing is very high compared to that needed for artisanal fishing. Perhaps this is why the view today is far from that utopia. Unfortunately, in Mexico, industrial fishing did not prosper in relation to the support received, due perhaps to poorly planned decisions and bad management. Currently, shoreline fishing with low economic returns continues to predominate. Furthermore, there are conflicts between artisanal and industrial fleets that exploit the same resource and do not allow greater development, as in the case of the shrimp fishery in the open sea and coastal zone.

Artisanal fishing is characterized by the catch of very diverse, low density resources, carried out by fishermen whose level of income, mechanization, product quantity, fishing radius, political influence, market option, employment, social mobility and financial dependence leave them subordinated to the economic decisions and operations of those who buy their products.

In addition to the great diversity of fish species caught on the coast of the Gulf of Mexico and Caribbean Sea, there is great complexity in the types of boats and fishing techniques used. For finfish fishing in the Gulf of Mexico and Caribbean Sea, 890 large boats and 15,902 small boats are employed. Large boats are those over 10 tons of gross weight, with gillnets, hand lines or sea lines and up to 10 fishermen. Small boats are those with outboard motor and up to four fishermen, using gillnets, cast nets, beach seines, hand lines or sea lines (SEMARNAP 2000). In the state of Veracruz, 15,681 boats are registered for both open sea and shore line fishing, with 99% of the boats corresponding to the latter. A great diversity of fishing techniques are used in artisanal fishing, such as gillnets, hand lines, sea lines, traps and shooting; these vary in their materials, size and operating systems, depending on the fishing resource objective. Fishing techniques and equipment registered for Veracruz total 23,073 nets, 10,915 lines, 215,423 traps and 5,761 sets of diving equipment (INEGI 1999).

CURRENT STATUS OF FISHING IN THE NORTH AMERICAN REGION

Specific studies on some of the resources shared by Mexico and the USA show that common factors of overfishing and over-capacity are also shared. Shipp (1999), based on a hatching potential index that enables evaluation of the capacity of the population to recover that part of the population lost to fishing, points out that fish associated with reefs such as grouper, sea bass, snapper and jacks, have a hatching potential that is on the limit of the threshold that is considered over-fished. The sea bass matures at 70 cm, however the minimum legal catch size is 50 cm, which means that it is not allowed to reproduce before being caught, so there is no guarantee that the population will recover the organisms that are removed via fishing. If this were not enough, there is a tendency for males to predominate over females, apparently due to the aggressive domination of the males, which further limits reproduction potential.

The Atlantic sharpnose shark also sometimes forms part shrimp trawl by-catch. In this case, according to Shipp (1999), the population appears to be stable and needs no regulation whatsoever (NMFS 1997). Amberjacks are one of the species that are often confused with at least one of its congeneric species, so there is uncertainty regarding its life history. Vermilion snapper (*Rhomboplites aurorubens*) catch rates are already high.

Sea trout has suffered a strong impact from being heavily fished in both open and closed waters in the various stages of its life, with the use of different fishing techniques such as hook and line, gillnets and trawls, which make its recovery difficult. Nevertheless, the government has set a target of allowing 30% of recruits that are found in estuarine nursery areas to escape, so that they are able to reach open sea breeding areas.

According to Shipp (1999), in 1997 the cero (*Scomberomorus regalis*) fishery appeared to be in good condition; however, there is no current information on its status. On the contrary, bluefin tuna (*Thunnus thynnus*), whose importance for the Gulf of Mexico is significant, is severely overfished. Yellowfin tuna catch increased in 1984, and up to 1996 had remained at high levels (NMFS 1999).

In 1999, Shipp reported the gag grouper (*Mycteroperca microlepis)* as the most overfished species in the Gulf of Mexico and attributed this to the high mortality of less than one year old fish of the species due to shrimp trawling. This situation is difficult to control given that these small organisms live on the sea floor alongside shrimp. It is not until they reach 15-20 cm in length that they move towards reef habitats.

Almost all grouper stocks in the Gulf of Mexico are at risk of collapse. In 1997 two species of grouper, the warsaw grouper (*Epinephelus nigritus)* and the speckled hind *(E. drummondhayi)*, were added to the list of species in danger by the National Marine Fisheries Service Office of Protected Resources. In 2000, 11 of 15 species of groupers managed in the Gulf were identified as vulnerable or in danger of extinction by the American Fisheries Society. The National Marine Fisheries Service in Miami, Florida identified the red grouper (*E. morio)* and the Nassau grouper *(E. striatus)* as overfished.

CAUSES OF FISHERIES PROBLEMS

The continuous increase in human population and the need to meet demands for food, housing, employment, recreation and education, creates a series of impacts that cause environmental alterations. The negative effects on fishing resources are most notorious in the coastal zone, which are the nursery, reproduction and refuge areas used by these resources. The coastal zone receives sewage discharged from coastline municipalities and from the upper part of the basins through rivers, containing excess organic material, fecal coliforms, detergents, bleach, agrochemical waste, industrial material, etc., that alter the biogeochemical cycles that are crucial for development of aquatic life.

This zone also suffers from the effects of deforestation in both adjacent and upper basin areas. Resulting soil erosion increases water turbidity and modifies transport and sedimentation processes, occasionally blocking the mouth of marshes that are the road to the sea for diverse organisms that need marine conditions to complete their life cycle, such as shrimp. Reduction in rainfall, another consequence of deforestation, alters freshwater flow to the sea, modifying salinity conditions required for the development of various species.

In the coastal zone, mangrove clearing also causes reduction in areas that are favorable to development of the early life stages of various fish. Installation of petroleum and thermoelectric platforms, as well as activities related to tourist development, also constitute sources of alterations or loss of marine habitat. Maritime activity in the ports, dredging, fuel and oil spills, and the introduction of exotic flora and fauna through ballast water, are added to the long list of anthropogenic impacts. With all these impacts, including natural events, such as red tides, hurricanes, tropical storms, northerlies, southerlies, ENSO, upwellings, etc., fishing resources need to continuously replenish their populations, and their inability to do so translates into significant declines in landings.

As technological development of fishing techniques and equipment increases, access to fishing resources increases, but their availability does not. This leads to a notable increase in effort invested to obtain minimum economic gains, with more effort on occasion being directed towards fewer resources.

Furthermore, fishing resource extraction is subject to supply and demand relationships determined by consumers. On many occasions the impacts are oriented towards the eggs, newborn or young organisms of the resources. Examples of these are mullet, silverside offspring, young shrimp, etc. Evidently, it is urgent to assume responsibilities for fishing activity and its impact as a consequence on other components of the ecosystem.

In the Gulf of Mexico, fishing activity reflects the problem of poverty and demography. Pauperized families migrate to coastal areas in search of a higher quality of life. Local fishing immediately suffers the "Tragedy of the Commons" or effect of the "Common Good", because more demanders obtain increasingly less resources until the resources are exhausted. In the last decade, coastal population growth has been more than double that of national population growth. The country seems to repeatedly migrate towards the coast in search of recreational activities and tourism. This exacerbates the problem in the demand for sea products; however, this demand should be seen as a development alternative through the promotion of mariculture.

THEORETICAL FRAMEWORK FOR FISHERY MANAGEMENT

The great diversity of exploitable species in the Gulf of Mexico and the diversity of habitat in which these develop force us to abandon the vision of isolated fishing resources. We must obtain a deeper knowledge of the processes that occur within the ecosystem of which the fishery resources are a part, and consider the environmental, economic and political cycles to which fishing is subjected. All of these factors are related to the analysis of environmental, ecological, technological, socioeconomic and political variables (Fig. 25.2).

This type of information, indispensable to support fisheries management, can be generated at the core of a multidisciplinary research group, with the capacity for analysis and risk assessment in decision making. This clearly requires research planning, good will, commitment and collaboration, as well as the generation of criteria and reference indexes that are comprehensible to those who make decisions, those who use the resources and the general public.

In addition, aquatic resource management requires participation of both users and regulatory authorities in the subjects of fisheries, ecological regulation, conservation,

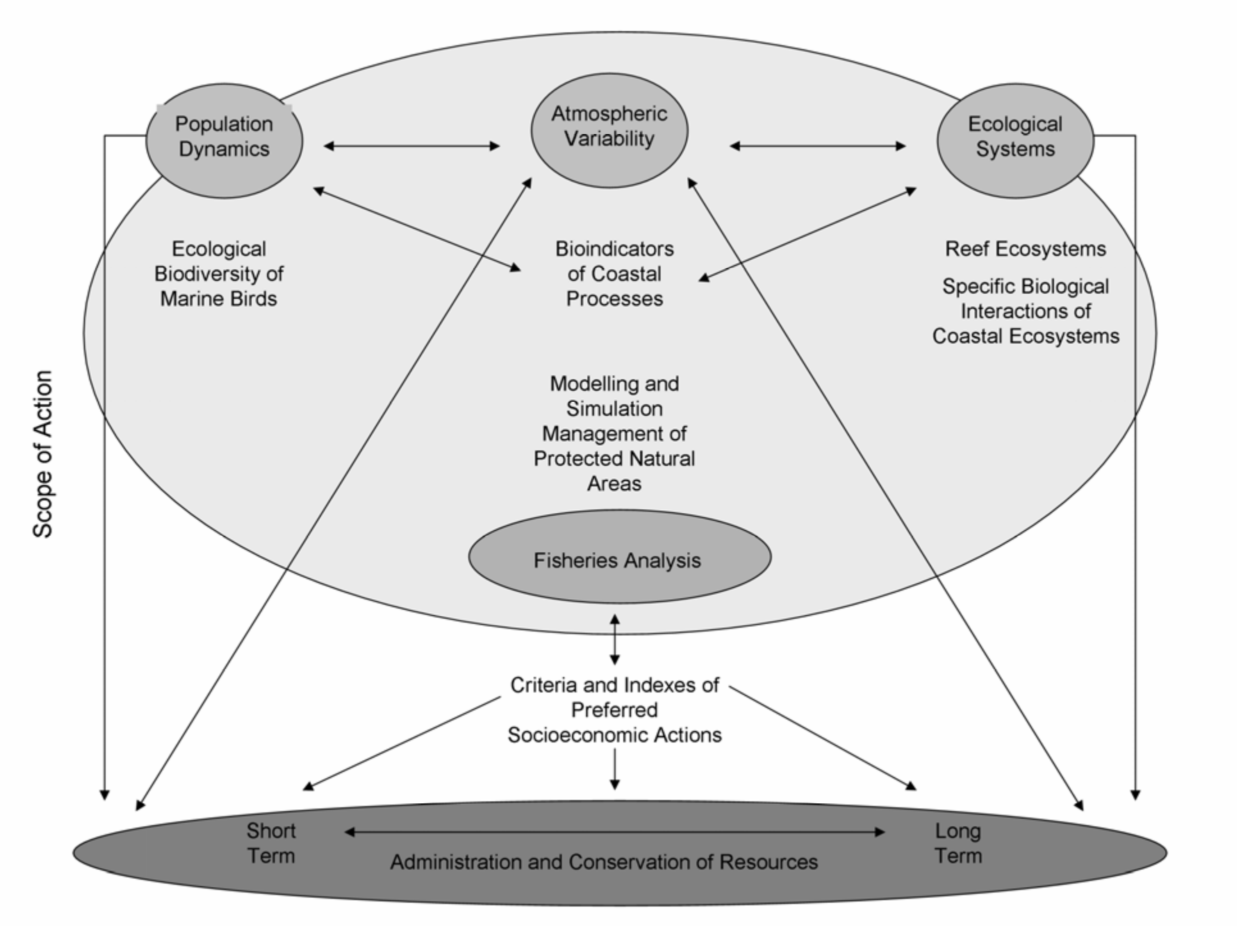

Fig. 25.2. Conceptual model showing the need to link decision-making in the long- and short-term with biological, social and economic information. Decision-making must include the concept of both resource exploitation and conservation. While short-term decisions are determined by exploitation needs and population response to fishing, the latter is due to evolutionary and coevolutionary processes of environmental variability and the ecosystems in which they are integrated

environmental legislation, economics, etc., each field contributing to a joint response. In the same manner, the decision to implement any measure to manage fishing resources must be sustained by scientific research and be agreed upon by both resource users and local, regional, state, federal and even international authorities. Furthermore, it is important that a measure does not imply the restriction of any activity without having an alternative, because there must be guarantees that the exchange will be beneficial and lead to improving quality of life for the user community if the laws/regulations are to be successful.

Fishing administration can not regulate resources in isolation without provoking alterations to other resources associated to the same or other ecosystem. Examples of this are the by-catch that on occasion reach the level of 10:1 of the objective species; incidental catch, which sometimes becomes the objective species; the impact of trawls on benthic communities; or alterations to native species, derived from the introduction and translocation of species for aquaculture (SEMARNAP 2000). All this makes it difficult to have sufficient regulations for the different resources. Measures from similar resources are sometimes adopted and, on many occasions, are not the most convenient. Thus, the need for regulations that have been agreed on by the governments of different countries is essential.

It is not possible to continue the management schemes of the past because today reality is different. Currently, a vision of integral management must predominate, and work must be done to achieve socially just, economically sustainable and environmentally feasible development.

Due to the exhaustion of resources that have traditionally been exploited, it is time to turn to those that, like marine algae, have potential in biotechnology. Also, it is important to continue exploring and researching cultivation and exploitation of resources that are more profitable economically than tilapia, trout and oyster. By-catch fauna that has little or no market value has nutritional value comparable to the value of objective species. Research is recommended on industrialization processes of these and other marine products that can provide added value. There is still much to be developed in terms of conservation and presentation of fishing products that can also provide added value and are key elements in market competition. If improvement in the state of fishing is desired, then it is time to switch from subsistence fishing to micro-business fishing. This can only be achieved through creating productive projects, sustained by scientific research that must be associated with a change in the vision of fishing communities, who should integrate themselves as small entrepreneurs.

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