FISHERIES TRAINING PROGRAMME

P.O. Box 1390, Skulagata 4

120 Reykjavik, Iceland

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CUBAN FISHERIES MANAGEMENT REGIME: CURRENT STATE AND FUTURE PROSPECTS

Julio Abraham Baisre Hernández
Dirección de Regulaciones Pesqueras, Ministerio de la Industria Pesquera
5ª Ave. y 246, Barlovento. Playa
Ciudad de La Habana
Cuba
jbaisre@gmail.com

Supervisor
Daði Már Kristófersson
Institute of Economic Studies
University of Iceland
dmk@hi.is

ABSTRACT

This paper is an attempt to study the level of resource exploitation and the present fisheries management regime in Cuba. The paper comprises an overview of the Cuban fisheries, some theoretical background on management regimes, a critical review of the fisheries regulations through time and an account of the legal and institutional framework of the fisheries sector. An evaluation of the current status of the most important fisheries is also presented, based on catch and effort data using the Gordon-Schaefer model.

Four fisheries were analysed: lobster, shrimp, tuna and other fishes, and the results show that at the current effort levels the catches are sustainable both in ecological and economic terms, not surpassing reference points like Maximum Sustainable Yield and Maximum Economic Yield. Even though there seem to be other factors influencing the outcome, they prove that the management regime has been successful. A further hypothesis test was conducted in order to prove if the regulations issued from 1996 have had an impact on the analysed fisheries. The results showed a relation for the lobster, shrimp and other fishes, thus statistically confirming a change after 1996 in these fisheries. Nevertheless, this change could also be influenced by external factors like economic constraints. Some recommendations for future sustainable management of fisheries in Cuba, like further and more detailed studies, are also given.

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ABBREVIATIONS

MIP: Ministerio de la Industria Pesquera (Ministry of Fishing Industry)
CIP: Centro de Investigaciones Pesqueras (Fisheries Research Centre)
ONIP: Oficina Nacional de Inspección Pesquera (National Office for Fisheries Inspection)

1 INTRODUCTION

The Cuban archipelago is located in the Caribbean Sea, nearly south of the Tropic of Cancer. It includes the main island (Cuba), the Isle of Youth and thousands of smaller cays amounting to 109,886 km^2 in total. The subtropical climate is moderated by the Trade Winds and two seasons, rainy and dry, can easily distinguish. The insular shelf is 61,525 km^2 and the Exclusive Economic Zone (EEZ) is 350,751 km^2. According to the last demographic census (ONE 2005), the current population is 11.2 million inhabitants, with more than 75% living in urban areas. The most important natural resources are nickel, agricultural products, forests, fishes and shellfishes in the territorial waters.

Fishing has therefore been an important source of revenue in Cuba. Sustainable and efficient fishing is consequently of significant importance for the Cuban economy. The Cuban fisheries management regime has undergone some important changes in the last decades in response to stock size development that indicated non-sustainable utilisation in the 1970s-80s. The most important changes to the fisheries management were with respect to increased emphasis on sustainability as well as a greater focus on the value of the catch rather than the quantity. As pointed out by FAO (1997) and Seijo *et al.* (1998), it is advisable to revise management strategies periodically to adapt to the dynamic conditions of the stock and resource users, as well as to changes in the inter-temporal preferences of the fishing sector.

A resource management regime must allow for several different and often conflicting interests. Fishermen and the fish processing industry have an interest in how much can be caught, as well as when and how. However, their short run interests may conflict with society's best interests, the interests of future generations and even their own long run interests. A study that attempts to evaluate a management regime in a constructive way must therefore include a description of the current management regime and its historical background to lay the foundations for evaluation and future policy recommendations. There is currently no well-documented study on the existing Cuban fisheries management regimes on which such an evaluation could be based. The closest thing approximating such a description is chapter 5 in "The Marine Fisheries in Cuba" (Baisre 2004), called "Exploitation and Management". There the general fisheries management topics are discussed as well as a description of some Cuban experiences in the field. However the discussion is general, in line with the nature of the book, which is aimed at the general public. Another relevant publication is the paper "The fisheries regulations in Cuba" (Sánchez 1997). This document presents the fishing regulations in Cuba at that time and also describes the way they are grouped. Both previously quoted works lack an analysis of the current management regime in terms of effectiveness. This paper will attempt to provide a more detailed description of Cuban fisheries management that can be used as a basis for evaluation of the management regime.

Considerable expectations have been associated with the recent changes to the Cuban fisheries management regime. This can clearly be seen from the following quotation.

> *"In the case of Cuba, a redesigning of the monitoring system has occurred recently, giving coverage in a systematic and extensive way all fishing areas; they have information on the fishery both dependent and independent data. (...) a systematic assessment of the resource status is carried out and*

> *bio-economic models are applied, which are components used in resource management"* (Carcamo *et al.* 2003:213)

However, available data shows that almost 40% of the Cuban fisheries were in the senesce phase and about 50% in the mature phase[1] in 1995 (Baisre 2000a). The latest milestone in Cuban fisheries management, the Decree-Law 164, was issued 10 years ago, in 1996. This new law constituted a significant shift in emphasis for fisheries management, focusing on sustainability and profitability. Now, a decade has passed and it is timely to assess whether it has achieved the goals that were set out initially of sustainable utilisation and improved catch value. It implies a critical review of the management system for further considerations.

This research project will produce a case study on Cuban fisheries management, its historical background, current status and future prospects. The main objective of such a case study will be to provide an overview and evaluation of the Cuban fisheries management regime (FMR). The evaluation of current policy will be based on one main aspect: sustainability of a given fishery, measured both in ecological and economic dimensions.

2 CUBAN FISHERIES

2.1 A brief introduction

During the 19th century and the first half of the 20th, the commercial fishing industry in Cuba was characterised by a fleet composed of small boats and vessels plying the coastal waters. These crafts, which were typically low capacity and technically unsophisticated, primarily targeted a combination of reef fish: spiny lobster, sponge and a few pelagic finfish species such as mackerels, tunas, and billfish. The landings were handled by small-scale processing facilities and the products were then mostly directed into the local domestic markets and the tourism industry (Adams *et al.* 2000, Claro *et al.* 2001). Catches were around 5,000 – 10,000 MT/year in the early 1900s and around 20,000 MT/year during the 1950s.

After the Cuban Revolution of 1959, growth of the fisheries industry was an important objective of the government. Figure 1 shows trends in the Cuban fisheries in the past 50 years (source FAOSTAT).

[1] According to the classification by Grainger and García (1996)

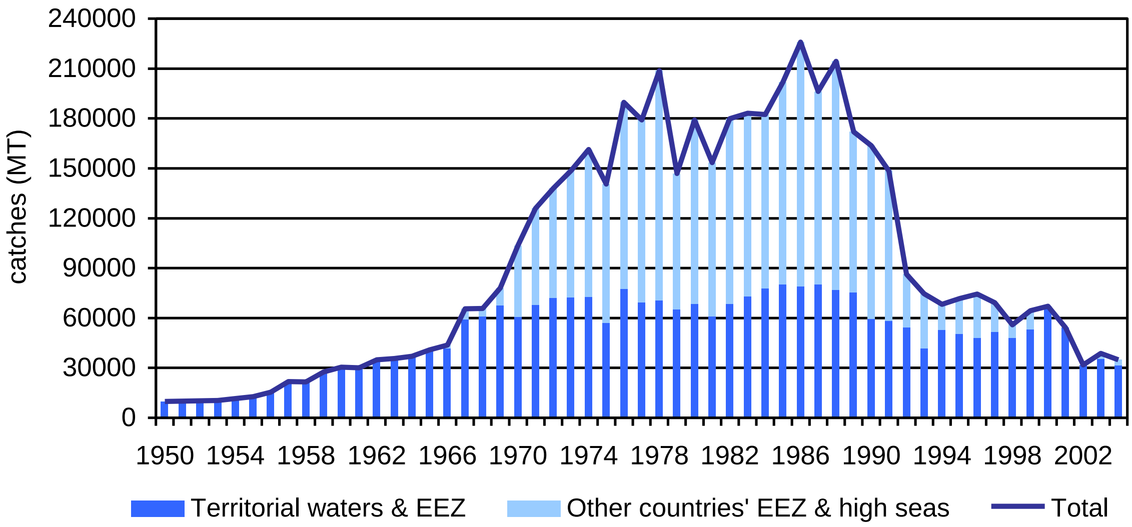


Figure 1: Evolution of the catches in Cuban fisheries, 1950-2004.

The figure clearly shows two separate aspects of Cuban fisheries. The domestic catches dominated until the late 1960s; from that moment on to the early 1970s they saw a substantial increase in catches in international waters. During the 1970s and 1980s these catches dominated, accounting for about two thirds of the total catch. It is to be noted that the clear decline in the early 1990s was forced by the break-up of the Soviet Union, which stopped supplies and hence ended the Cuban fisheries in international waters. From the 1990s onwards, domestic catches have again been dominant, however the domestic catches have also been clearly declining in recent years.

Given the cited changes in the early 1990s, Cuba's commercial fishing industry changed dramatically. As a result, production emphasis has shifted from high-volume, low-valued, pelagic stocks toward high-valued, near shore fisheries. Cuba has more recently played an increasingly important role in the world market for these high-valued finfish and shellfish seafood products harvested primarily within Cuba's near shore waters (Adams *et al*. 2000).

2.2 Current fisheries

The Cuban fisheries combine elements from both artisanal and industrial fisheries and their most outstanding features are:

- A complete production system that includes a wide network of facilities for landing, storing, processing, transporting and marketing fish products. It comprises docks, cold storages, ice plants, specialised boats and construction/repair workshops for both boats and fishing gear.

- The use of small boats (rarely exceeding 20 m in length), typical of short-range fisheries.

- An exploitation of all the marine resources in the territorial waters, except some demersal species and some highly migratory oceanic species.

- The wide range of fishing gears and methods used, mainly due to the diversity of species and the bottom topography.

- The seasonality of catches, determined by behaviour patterns of some species. These animals group together only in specific seasons, either for spawning or in response to weather conditions.

The fishing industry products in 2005 amounted 72.4 millions Cuban Pesos (66.6 millions USD), i.e. 3.6% of the total Cuban exports (ONE 2005). This sector employs around 34,000 people including fishery, industrial process, shipyards, marketing and research workers.

2.2.1 Fishing resources and gear

The marine fisheries in Cuba account for almost 60% of the total fish production (more than 30,000 MT), while the remaining 41% (21,000 MT) are going to aquaculture (ONE 2005). The main resources are lobster, shrimp, small pelagics, demersal reef fishes, mullets, crabs, some molluscs and sponges.

In terms of importance, measured as value of catches, these resources can be listed as (in descending order):

- Lobster (Caribbean spiny lobster)
- Shrimps (southern white shrimp and southern pink shrimp)
- Tunas (skipjack tuna, black fin tuna and occasionally bigeye and yellowfin tuna)
- Demersal reef fishes (yellowtail snapper, lane snapper, mutton snapper, Nassau grouper, red grouper, Goliath grouper)
- Other pelagics (king mackerel, Spanish mackerel, crevalle jack, bar jack, blue runner, amberjack, permit, thread herring, false herring)
- Other fin fishes (lebranche mullet, fantail mullet, common snook, tarpon)
- Other crustaceans and molluscs (blue crab, stone crab, land crab and mangrove oyster, turkey wing clam, queen conch)
- Sponges
- Other species (sea cucumber, turtles)
- Bycatch (several species of fishes caught by shrimp trawling)

The average composition of Cuban marine fisheries in the last decade is presented in Figure 2. The graph depicts the proportion of major species/groups in the total catches, which averaged 45,000 MT from 1993-2003 (Baisre 2004). The group labelled “Others” also includes crustaceans other than lobster and shrimp.

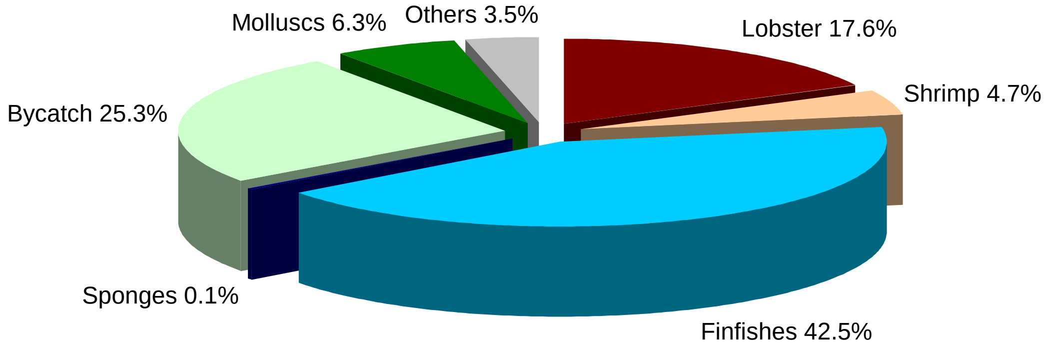


Figure 2: Composition of Cuban marine fisheries by species/groups, average 1993-2003.

As seen, there is a variety of different species harvested in Cuba. Not surprisingly there is a number of different fishing gears used to harvest the different species. The most common gear used for demersal reef fishes are traps, seines and haul nets. On the other hand pole and line with live bait is used in the tuna fishery. Small pelagic species are most commonly caught on longlines. Trawl nets are employed in the shrimp fishery while lobster is caught using different types of traps, seines and scuba divers (Claro *et al.* 2001, Baisre 2004).

The fishing fleet is mainly composed of fibreglass hulled motorboats equipped with two or even more gear. However there are still a number of other types, mainly wood, cement and steel hulled boats. According to MIP (2006), the fishing fleet can be divided into:

- Industrial fisheries
    - Shrimp (58 boats, 23 m long)

- Commercial fisheries
    - Lobster (245 boats, 10-18 m long)
    - Skipjack tuna/albacore (32 boats, 21-24 m long)
    - Reef fishes and small pelagics (465 boats, 10-22 m long)
    - Small scale coastal fisheries (587 boats, 10-14 m long)

There is a regional division for statistical purposes that began to be used in a natural way by the fishermen themselves, i.e., the fishermen from different ports established their own fishing zones without government intervention and such *de facto* division later became official. The four regions therefore coincide with the four insular shelves: Southeast, Southwest, Northwest and Northeast. The four regions and fishing companies' area limits are represented in Figure 3 as well as the main fishing ports and processing plants.

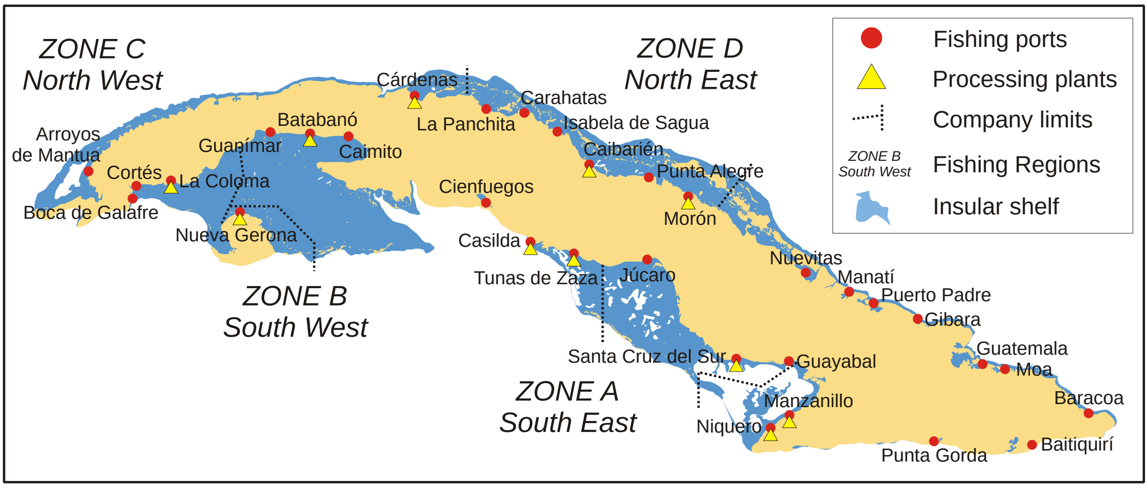


Figure 3: Fishing zones, main ports and processing industries.

The most important species in Southeast (Zone A) is shrimp, only harvested there and -at lesser extent- in Zone B. Lobster catches in Zone B account for more than 50% of the total lobster catch, though this species is caught in all zones. The Northeast (Zone D) is the main area for tuna fishing and sponge collection. The smallest shelf area is Zone C which therefore has the lowest contribution to the total catches.

2.3 National fisheries strategy

The present Cuban strategy for the development of the fishing industry until 2010 (MIP 2005) is based on the acknowledgement of some important elements, as the following:

The large diversity of the fisheries resources and its low abundance (common to tropical waters) provide highly valued products. It makes the marine fisheries sector a source of capital for the rest of the fishing/aquaculture sector and for the country's economy.

Almost every fishing resource in Cuban waters has been fully exploited and therefore a rise in the catches is not expected (Baisre 2000a).

The Marine Protected Areas are a useful and effective tool for fisheries management and recovery of some resources.

The above mentioned points imply that there is no projected rise in catches and fishing effort but a reduction in operational costs and an increase in value added products.

Then, the strategic objective is to use the Cuban fisheries resources in a sustainable way and to ensure an efficient, high quality production by reduced costs and added value (MIP 2005).

3 FISHERIES MANAGEMENT

3.1 Theoretical background

The existing status of the world's living aquatic resources is largely a result of the difference between the private incentives for each fisherman to maximise his catch and the common best interest to conserve a resource for future sustained use. This justifies government intervention into fisheries management to address the problem and prevent the resource from become a victim of the so-called tragedy of the commons. Still many governments fail at this mission of fisheries governance and to achieve responsible and effective management of fisheries in most countries (FAO 1997). Fisheries management is defined by Panayotou (1982) as the pursuit of certain objectives through the direct or indirect control of effective fishing effort or some of its components. The previous definition seems to be too general and a more accurate one, described as a "working definition", can be found in FAO (1997:7) and reads:

> "The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives."

Most of the existing management measures can be grouped into two broad classes: biological and economic. The latter may be further divided into direct restrictions and indirect measures (Arnason 1994), as seen in Figure 4 (adapted from Arnason 2001)

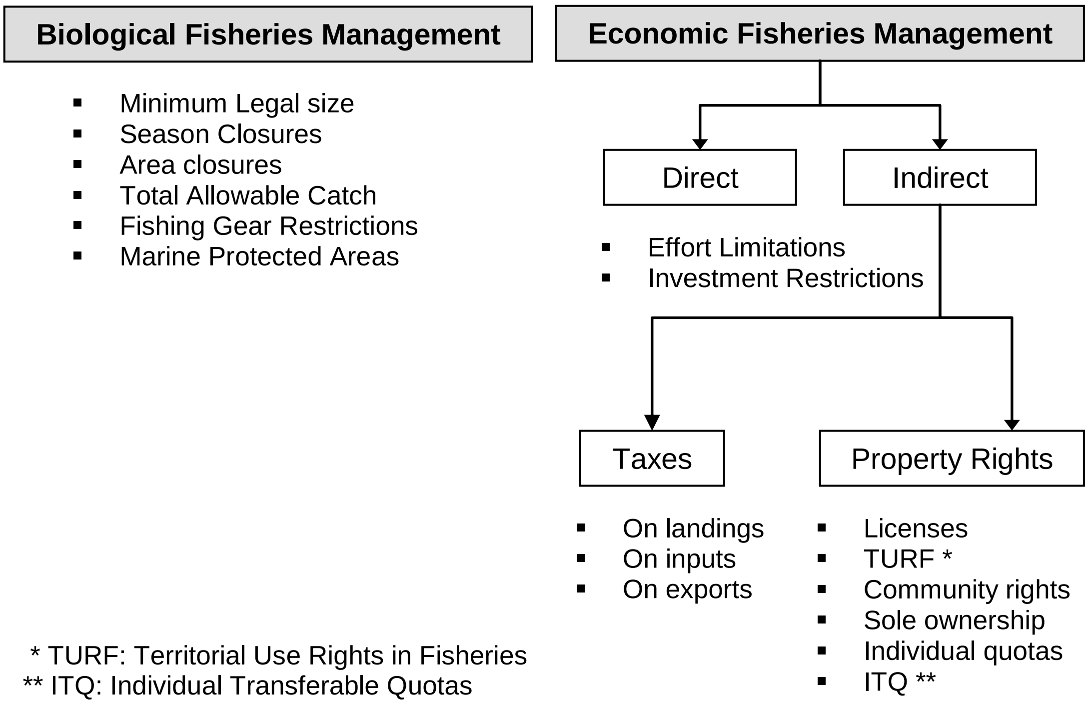


Figure 4: Classification of fisheries management systems.

Hannesson (1993) addresses this classification in a similar way, distinguishing between: indirect controls (through taxes on effort or landings), control of fishing capacity and fishing effort and control of the catch (which includes the quota system).

The Technical Guidelines for Responsible Fisheries no.4 shows a comparable division into "technical measures" for the biological management mentioned above, "input (effort) control" for most of the economic management and "output (catch) control" for individual quotas and ITQs (FAO 1997).

Another equivalent classification is pointed out by Seijo *et al.* (1998) who group most biological management as "regulation of catch composition" and the rest plus the economic restrictions as "regulation of catch size", except the property rights which are grouped alone.

3.1.1 Sustainability indicators and reference points

Any sustainable development system comprises four main dimensions by which it can be described: ecological, social, economic and governance or institutional (FAO 1999b).

The Organisation for Economic Co-operation and Development also uses the same terms, called components, in assessing the performance of fisheries (OECD 2000). In this case they are named: biological, economic, social and administrative components.

A similar approach is taken by the European Common Fisheries Policy, a policy aimed at sustainable development in environmental, economic and social terms (EC 2002). According to this source, the first element regards responsible and sustainable fisheries, thus contributing to healthy stocks and/or its recovery. The second one is about maximising the rent by creating profitable and competitive fisheries. Both objectives could clash depending on the approach used, being the first (environmental) a constraint in economic terms. The social objective deals with the standard of living of fishermen and other people involved in fisheries.

For the purposes of this study, only two dimensions or components will be taken into consideration: environmental or ecological and economic. This is in line with the stated purpose of the Cuban fisheries management regime and the Ministry of Fishing Industry, as described in the strategic objectives for the Cuban fishing industry (see subchapter 2.3 above). Regarding the social dimension, the salaries and other social benefits received by fishermen and processing industry workers make this issue not a priority in the present work. As for the institutional dimension, the well-built institutional framework, with highly competent staff, accurate data collection system and the parties' involvement in the decision-making process via the Fisheries Consulting Commission (see subchapter 3.3) as well as the strength of the property rights for the two main fisheries, endorse the decision of focusing only on the two above mentioned components.

In considering sustainability, this concept applied to fisheries needs to be defined. According to the World Conference on Environment and Development, 1987 (quoted in FAO 1999b), sustainable development is simply defined as *"development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"*. Therefore the sustainability concept in fisheries deals with the trade-offs between present and future relating to depletion of fish stocks as well as the disruptive impact of fishing activity, coastal settlements and waste disposal on the wider marine ecosystems (FAO 1999b). This can be translated in the following objectives:

- Sustaining fisheries harvesting and processing activities
- Ensuring the long term viability of the resource which supports these activities
- Catering for the well being of a fishery workforce
- Maintaining the health and integrity of marine ecosystems for the benefit of others uses and users

A set of sustainability indicators is needed to assist in assessing the performance of a fisheries policy and management (FAO 1999b, Le Gallic 2002). They will describe the state of a given fishery in terms of resource and fishing activities, and will also show the trends followed. For example, the achievements of the aforementioned objectives will be determined by the indicators used. Changes in indicators over time, however, cannot be interpreted without considering them in relation to a reference value (FAO 1999b). These values are known as reference points and can be of two types: target reference points (TRP) and limit reference points (LRP). Target reference points indicate a desirable level of the fisheries and Limit reference points specify a risky and therefore avoidable status (Caddy and Mahon 1995, Sainsbury and Sumaila 2003). Well-known examples of TRP are Maximum Economic Yield (MEY) and Maximum Sustainable Yield (MSY). Some LRPs are Maximum Spawning Potential (MSP), Minimum Stock Size Threshold (MSST or $B_{threshold}$) and Bioeconomic Equilibrium (E). Two reference points will be used in this work: MSY and MEY.

The indicators presented in Table 1 were compiled from several sources: FAO 1999a, FAO 1999b, OECD 2000 and Le Gallic 2002. As can be seen, some criteria and their indicators may be used in both ecological and economic dimensions.

Table 1: Dimensions, criteria and indicators of sustainable development.

DIMENSIONS	***CRITERIA***	***INDICATORS***
	Stock biomass	Catch per unit effort (CPUE)
	Harvest	Catch
ECOLOGICAL	Fishing pressure	Effort / No. of gear per fishing area
	Stock structure	Catch composition (size / species)
	Fishing capacity	No. of boats, gross tonnage, total effort
	Effort	No. of boats, fishing time
	Harvest	Catch, by-catch
	Harvest capacity	No. of boats, gross tonnage, total effort
ECONOMIC	Harvest value	Total value (prices)
	Exports	Export / catches value
	Net returns	Resource rent (revenues - costs)
	Effort	No. of boats, fishing time

3.1.2 Modelling approach

The evaluation of the current Cuban fisheries policy will be based on a surplus production model, in this case the Schaefer model, also known as Gordon-Schaefer model. The choice is based in the fact that such models are holistic, that is, deal with the entire effort and total yield obtained from the stock, without entering into details like growth and mortality or the age size (Hannesson 1993, Sparre and Venema 1998, Seijo *et al.* 1998). This is consistent with the data available for this study: time series of catches and effort.

The Schaefer model is represented by the following equation:

$$y_{(t)}/f_{(t)} = a+b*f_{(t)}$$

Where **y** is yield (harvest) and **f** is effort, both measured in time **t** (year), hence $y_{(t)}/f_{(t)}$ is catch per unit effort. The constants **a** (intercept) and **b** (slope) will be obtained by linear regression. Working out the **y** (yield) in the previous equation, the next formula is obtained:

$$y_{(t)} = a*f_{(t)}+b*f_{(t)}^2$$

Afterwards a curve is created that plots revenues and costs against effort in order to determine the reference points: Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY). Overall figures for revenue and costs will be obtained using the unitary price per MT and the cost per effort unit.

The implementation of Decree-Law 164 "Rules of Fisheries"[2] in 1996 constituted a substantial shift in Cuban fisheries management. It is therefore appropriate to test the hypothesis that the Schaefer model for each fishery has shifted from the period before 1996 to the period after 1996. This can be expected if the regulatory measures, such as minimum size and gear restrictions have indeed been applied to restrict the fishery. This hypothesis can be tested directly on the model by generalising it as:

$$y_{(t)}/f_{(t)} = a_1+a_2*D_{(t)}+b_1*f_{(t)}+ b_2*f_{(t)}* D_{(t)}$$

Where $D_{(t)}$ is a classification variable taking the value 0 before 1996 and 1 after 1996. Then the model for the period before 1996, where $D_{(t)}$=0, becomes:

$$y_{(t)}/f_{(t)} = a_1+b_1*f_{(t)}$$

On the other hand the model for the period after 1996, where $D_{(t)}$=1, becomes:

$$y_{(t)}/f_{(t)} = (a_1+a_2) +(b_1+ b_2)*f_{(t)}$$

The test of the hypothesis that no change occurred is a simple linear restriction that $a_2=0$ and $b_2=0$, which can be tested with an F-test. The test statistic has 2 and *n* degrees of freedom, where *n* is the sample size.

This analysis will be carried out on the four most important fisheries: lobster, shrimp, tuna and other fin fishes (collectively known in Cuba as *escama*) and the data source for all fisheries is the statistical database from MIP.

[2] See next subchapters, 3.2 and 3.3

3.2 History of fisheries management in Cuba

The commercial fisheries in Cuba became a part of the economy only after the early 19th century, during the colonial era. Nevertheless, it was still an artisanal, small-scale economic sector. The number of fishing communities grew and consequently the exploitation of the fishing resources at that time.

The first fishing regulations recorded in Cuban history were issued by the Temporary Commission of Fisheries *(Comisión Temporal de Pesca)*. This commission was created in 1880 and included several prominent scientists (Baisre 1987a). Unfortunately there is no much information on those regulations.

Between the end of the Spanish-American War and the proclamation of the Republic of Cuba, the country went under the U.S. military intervention. During this period (1898-1902) the U.S. occupation army issued several rules for fisheries in the form of Military Orders. These regulations included general rules for fisheries and fishing gear, a closed season and minimum legal sizes for the sponge fisheries, closed season and fishing gear restrictions for turtle fisheries, fishing restrictions and spawning zones for lane snapper and the appointment of the Coast Guard Service to control the fulfilment of the issued rules. Even though those rules were not issued by concern of the fishing resources but aimed to favour the businessmen, they must be considered as positive because they created a legal and control system for the fisheries in Cuba (González 2004).

The Republic of Cuba was proclaimed on 20 May 1902 and in its early years the National Board of Fisheries *(Junta Nacional de Pesca)* was created. This body, created in 1911 and attached to the Ministry of Agriculture, issued the fishing regulations thus continuing the work of the previous Temporary Commission of Fisheries. This period's regulations didn't differ much from the previous one, focusing on minimum legal size and season closures for the few commercial species (reef fishes, crustaceans, molluscs, sponges and turtles).

The next milestone in the Cuban Fisheries Management Regime is the issuing of the Decree-Law 704 "General Law of Fisheries" in 1936. It compiled and updated the previous fisheries legislation that was either scattered as agreements, enactments and military orders or outdated. This law contained several regulatory measures that were empirical, supported by fishermen and fishery officers' knowledge and not by research works. Some other rules were copied from similar ones existing in the U.S. and were generally aimed to protect species by season and zone closures (Baisre 1987b). Besides the season closures for all commercial species; the authorised fishing gear, pollution prevention and the ban on use specific gear in breeding zones were also contained in that Decree-Law.

The National Institute of Fisheries *(Instituto Nacional de la Pesca)* was created in 1955 with the objective of studying and researching the fisheries. The new Decree 2724 "Rules for the General Law of Fisheries" was created by this institution and issued a year later (1956). But the scarce budget and the government's lack of interest in the fishing industry were damaging to this institution and its efforts.

The Cuban Revolution of 1959 also "revolutionised" the fishing industry. The two main objectives of the new government for this sector of the Cuban economy were:

- Increasing the catches, as well as expanding the fishing zones.
- Developing the processing industry.

In order to accomplish such objectives, some previously issued regulations were inconsistently eliminated by the end of the 1960s. There also began the use of set gillnets and even pair trawling for some fishes. Moreover, the use of trawl nets for shrimp and drift nets for lane snapper was generalised in this period, consequently increasing the catches (Baisre 1987c, Claro *et al.* 2001).

The overfishing generated by the misuse of fishing gear, the increased effort as well as the lack of proper regulations caused an alert on the perils of overexploitation of fishing resources. All this, and the fact that regulations for the lobster fishery were significantly improved in 1978 with optimistic results, showed the effectiveness of an appropriate management system. Such improvements included an extended season closure to 90 days (previously reduced to 45 days) and more control on minimum legal size (Baisre 2004). Thus the management rules were changed and season closures for several species were implemented again. Also the restriction and/or ban of certain types of fishing gear was applied as well as the limit on effort (Baisre 1987c).

All in all, these changes were fully put into practice in 1981, so that year set the beginning of a new period in the Cuban fisheries, one of properly managed fisheries.

A timeline of the management policy can be observed in Figure 5. The historical series of Cuban catches is presented as well as the milestones in fisheries management (Baisre 2000a and MIP, unpublished data).

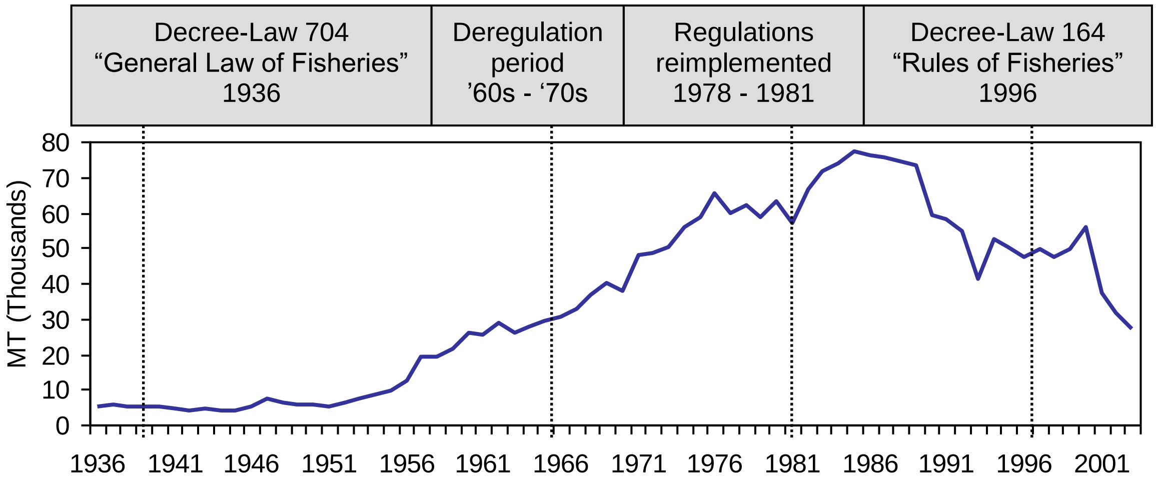


Figure 5: Historical catches in territorial waters and timeline of the management policy.

The effects of the increased emphasis on catch quantity from the mid 1960s onward are clearly seen in Figure 5. The signs of over harvesting are clearly seen as well in the stagnation and decline in catches. There was obviously need for a revision of the fisheries policy. This revision came with the Decree-Law 164 “Rules of Fisheries” which was approved in 1996 and represents the latest milestone in the Cuban fisheries management history (see Figure 4 above). Its main features will be presented in the next subchapter.

3.3 Legal and institutional framework

Today's main rules for fisheries management can be found in the Decree-Law 164 "Rules of Fisheries". This was approved by the Council of State of the Republic of Cuba on 26 May 1996 (GOO 1996).

The most relevant aspects of this legislation are:

- The creation of a system of fishing licenses, by which any fisherman or fishing boat must have a proper license or permit. This is issued and/or cancelled on an annual basis.

- The system of fines and penalties to be applied to the lawbreakers

- A monitoring, control and surveillance system, by means of an enforcement agency (National Office for Fishery Inspection). This agency has offices in every province.

- The establishment of an advisory and consulting body (Fisheries Consulting Commission). In the Commission all parties involved in the use and exploitation of fishery resources and the coastal zone are represented[3].

- Watching over conservation of the marine environment, including penalties for spills and other forms of pollution.

The regulatory measures either approved by the Consulting Commission or directly released by the Fisheries Regulations Division, become legal through resolutions. Then these resolutions are signed by the Minister of Fishing Industry.

According to Sánchez (1997), the resolutions can be grouped according to their purpose in:

a) Areas under special regime of use and protection (Marine Reserves or Marine Protected Areas)
b) Permanent or temporary closures for some species
c) Regulatory measures to marine species
    - Minimum legal size
    - Prohibition on catching and marketing potentially toxic species (ciguatera)
    - Quotas for sport fisheries
d) Regulations on construction and use of fishing gear
e) Methodology for the concession of fishing licenses and authorisations

[3] These parties include: scientific institutions not pertaining to the Ministry of Fishing Industry like *Institute of Oceanology* and *Centre of Marine Research*; ONGs like *Cuban Federation of Sport Fisheries* and *Cuban Federation of Underwater Activities*; ministries like *Ministry of Tourism, Ministry of Science, Technology and Environment* and *Ministry of Agriculture* as well as *Border Guard*. Their participation is not only limited to consultation but they also suggest any remarkable issue to be discussed.

In addition to the above groups of regulations, there is also Article 51 of Law-Decree no. 164. This article establishes the penalties for the ones who catch, land, transport, process, market or consume any of the endangered species reported by CITES without the proper authorisation by the Ministry of Fishing Industry.

There are also other pieces of legislation that are related to fisheries and marine resources, like the following:

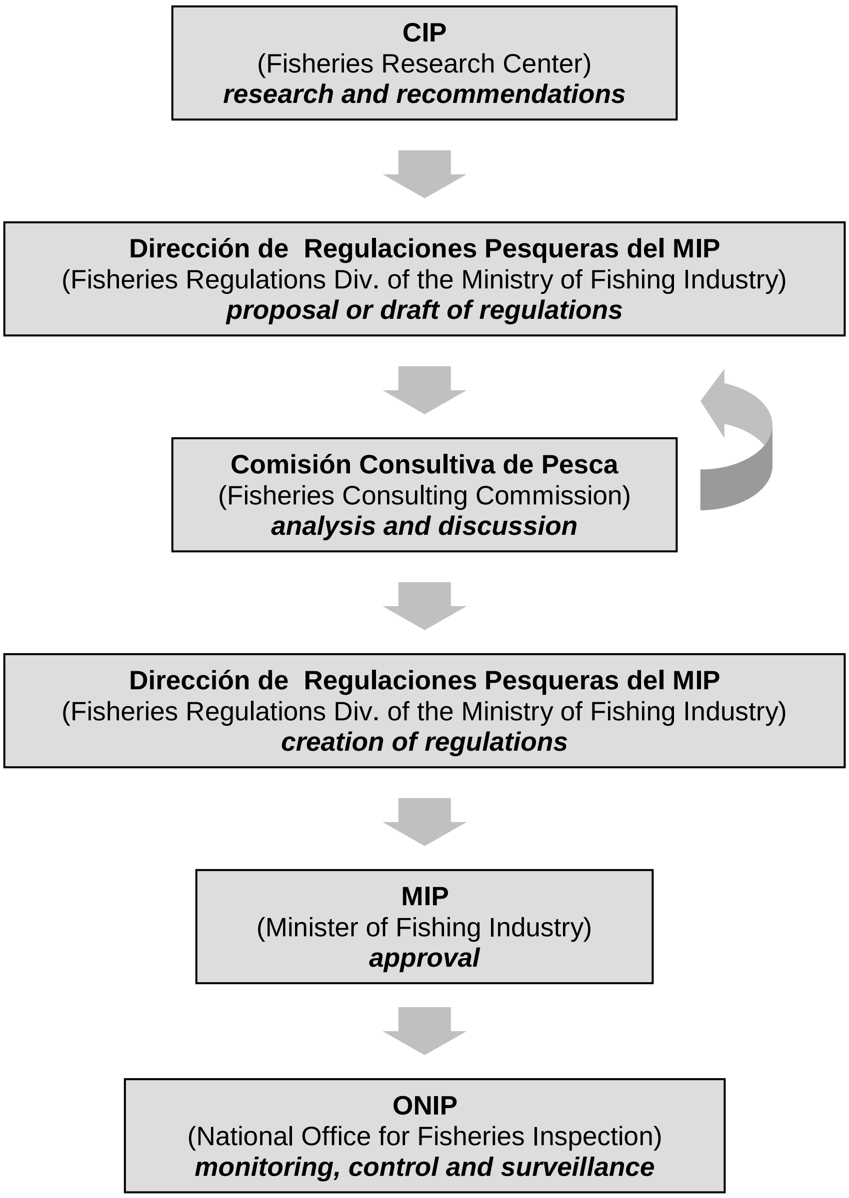
- Joint Resolution 1 of Ministry of Fishing Industry (MIP) and Ministry of Science, Technology and Environment (CITMA) on protection of coral reefs *(1997)*
- Law 81 of Environment *(1997)*
- Decree-Law 200 on Environmental Infringements *(1999)*
- Decree-Law 201 on the creation of the National System of Protected Areas *(1999)*
- Decree-Law 212 on Coastal Zone Management (2000)

Even though these documents don't regulate the fisheries directly, they are useful tools for the fisheries policy, e.g. Law 81 of Environment considers the endangered species, the environmental impact of fisheries projects and the marine pollution. The same applies to the Decree-Law on Protected Areas, some of which are Marine Protected Areas and the Joint Resolution 1 because of the importance of coral reefs as the main habitat of demersal fishes.

Cuban legislation on fisheries is also supported by international law to which Cuba is a signatory, such as:

- FAO Code of Conduct for Responsible Fisheries (CCRF)
- United Nations Convention on the Law of the Sea (UNCLOS)
- Convention on Biological Diversity (CBD)
- Convention on International Trade in Endangered Species (CITES)
- Convention on Wetlands (RAMSAR)

The following diagram (Figure 6) explains the workflow of the fisheries management regulations, showing the institutions involved at every stage (adapted from Puga and de León 2003).



Legend:
BOLD (original Spanish name)
Normal (English translation)
bold italics (mission or assignment)

Figure 6: Workflow of the management regulations and the institutions involved.

3.4 Current regulations

The main regulatory measures in current Cuban fisheries are presented in Table 2 as well as their purpose (adapted from Baisre 2004).

Table 2: Main fisheries management measures in Cuba, their purpose and examples.

PURPOSE	***REGULATORY MEASURE***	***EXAMPLE***
Reduce mortality of juveniles by letting free the smaller individuals	**Fishing gear restriction**	Mesh size in shrimp trawl nets Excluding device in trawl nets
Protect the stock from overfishing by avoiding capture of immature animals	**Minimum legal size**	Minimum legal size for lobster, shrimp and demersal fishes
Protect the stock during the reproduction period, or during recruitment	**Season closure**	Closure for lane snapper and mutton snapper Closure during recruitment period for shrimp
Protect the individuals in the breeding zones	**Area closure**	Closure of breeding zones for lobster and shrimp
Resource conservation	**Total allowable catch**	Catch quota for queen conch and sea cucumber
Avoid effort excess and make the fishery more profitable	**Fishing license**	Licenses for commercial boats and recreational vessels
Protect the rights of the fishing companies and make the operations more efficient	**Territorial limit**	Zones in lobster and shrimp fisheries
Recovery of a fishery or a zone (emergency measure)	**Moratorium (temporary)**	Temporary closure to shrimp fishery in La Broa inlet
Protect the consumer of being poisoned	**Ban on certain species**	Ban on capture species prone to ciguatera poisoning
Preserve a particular area, an specific habitat to serve as a compensatory element to the exploited areas surrounding	**Marine protected area**	Zones under special regime of use and protection, only open to lobster fishery

4 EVALUATION AND FUTURE PROSPECTS

4.1 Lobster fishery

Figure 7 shows the trend for the lobster fishery in terms of catches and effort from 1990 to 2004. The catches have been stable in spite of a raise in effort from the mid to the late 1990s due to the reduction of the closed season to less than 90 days in that period. The instability and decrease of catches in the last five years may be a result of poor recruitment because of the combined effect of fishery and adverse environmental factors like tropical storms, according to Puga and de León (2003)

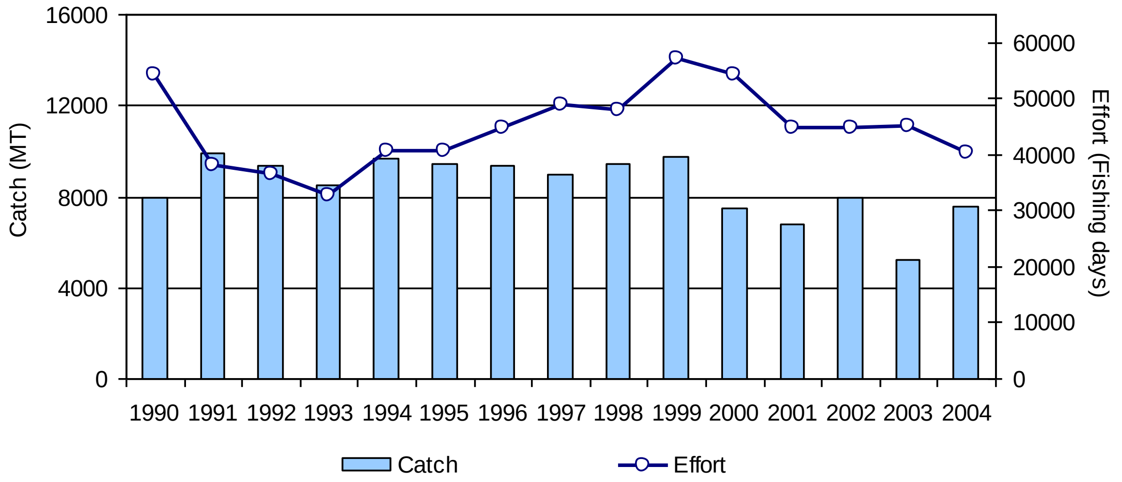


Figure 7: Lobster catches and effort, 1990-2004.

The Schaefer model was applied to the data and the parameters estimation results appear in Table 3. Catch and effort data from 1980 to 2004 were used in the estimation of constants a and b plus Maximum Sustainable Yield (MSY) and effort at MSY (f_{MSY}).

Table 3: Results for the Schaefer model in the lobster fishery, 1980-2004.

Schaefer model	a	B	MSY	f_{MSY}	r^2
$y_{(t)} = a*f_{(t)}+b*f_{(t)}^2$	0.288	-0.00000177	11’679	81’231	0.16

According to the model applied, the Maximum Sustainable Yield (MSY) is 11,679 MT obtained at an effort level of 81,231 fishing days. The Maximum Economic Yield (MEY) is 11,456 MT with an effort of 70,000 fishing days, as appears in Figure 8.

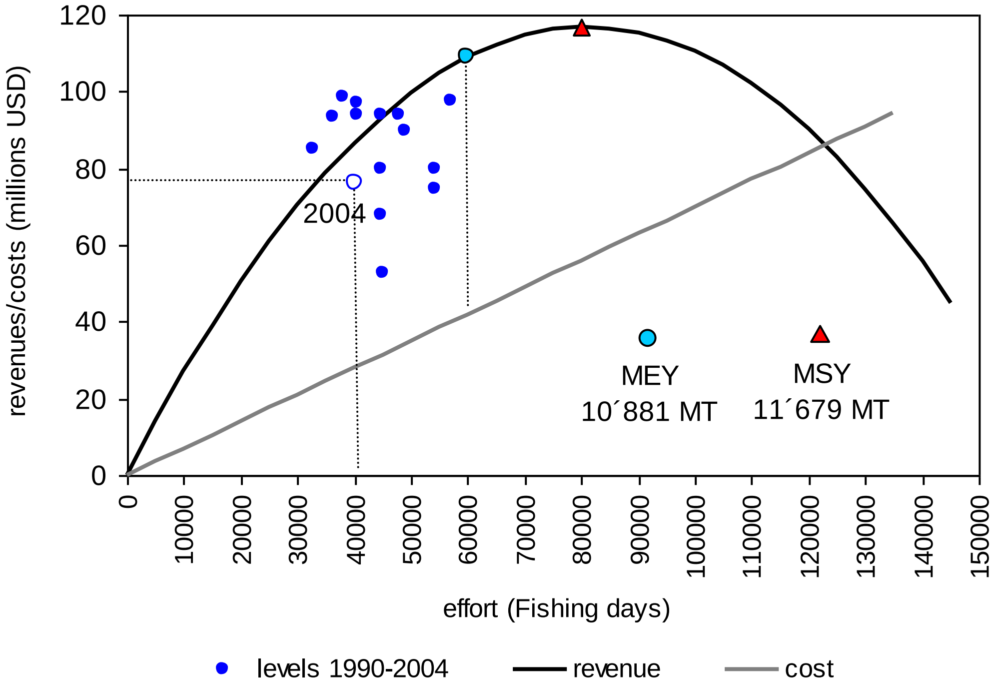


Figure 8: Surplus production model (Schaefer) for the Cuban lobster fishery.

The exploitation level for the past 15 years has been below the MEY and the current effort level is 40,156 fishing days for a yield of 7,601 MT (appears as a hollow circle). This point is still sustainable both in ecological and economic terms and has been similar during the period studied except for the last five years. The limited access to this fishery by issuing fishing licenses prevents any risk of overexploitation (Baisre 2000b)

The results for the hypothesis test are shown in Table 4 which shows the estimated parameters. The sum **(a_1+a_2)** and **(b_1+b_2)** are the results for the second equation (after 1996).

Table 4: Results for the hypothesis test in the lobster fishery, 1980-2004.

a_1	b_1	a_2	b_2	r^2	a_1+a_2	b_1+b_2	F	P
0.348	-0.0000026	-0.120	0.00000139	0.60	0.228	-0.0000012	11.88	0.00

The hypothesis that the regulations after 1996 have had no effect is rejected for the lobster fishery. These results support the hypothesis that a change has occurred after 1996. Although the regulatory changes in 1996 were quite substantial, the results should be interpreted with caution since other factors such as generally difficult economic conditions in Cuba could have contributed to reduced effort.

4.2 Shrimp fishery

The tendency of catches and effort for the shrimp fishery from 1990 to 2004 is presented in Figure 9. The catches declined in the mid nineties but have been steady since the end of that decade. The degradation of coastal habitat might have had a negative effect on catches (Claro *et al.* 2001) which on average is lower than in the early 1990s. The effort level plunged in the late 1990s due to a closure in one of the two fishing regions.

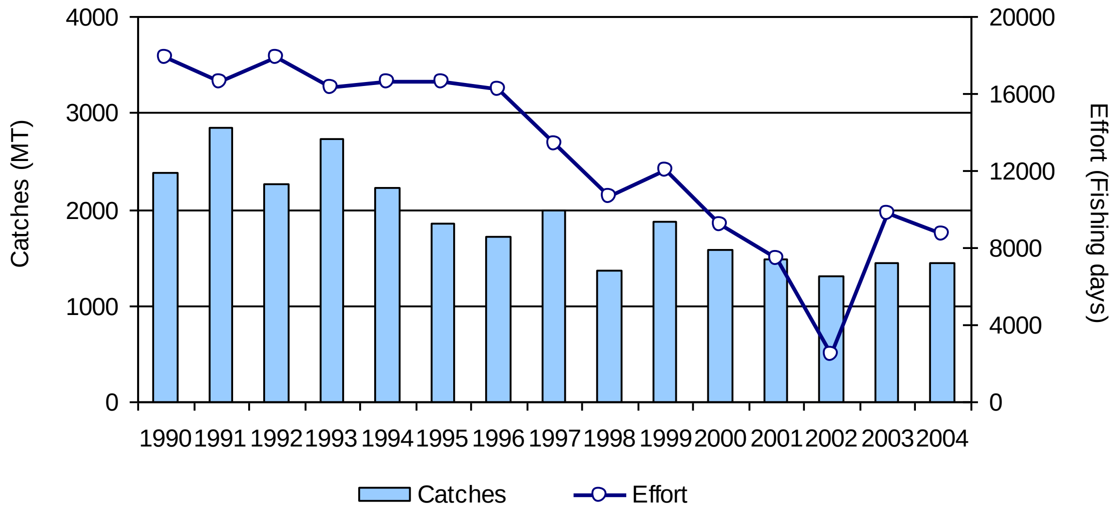


Figure 9: Shrimp catches and effort, 1990-2004.

The parameters estimation results for the Schaefer model appear in Table 5.

Table 5: Results for the Schaefer model in the shrimp fishery, 1980-2004.

Schaefer model	**a**	**b**	**MSY**	**f_{MSY}**	**r^2**
y(t) = a*f(t)+b*f(t)2	0.230	-0.0000032	4’131	35’931	0.14

The MSY is 4,131 MT obtained at an effort level of 35,931 fishing days. The MEY is 3,749 MT with an effort of 25,000 fishing days (Figure 10).

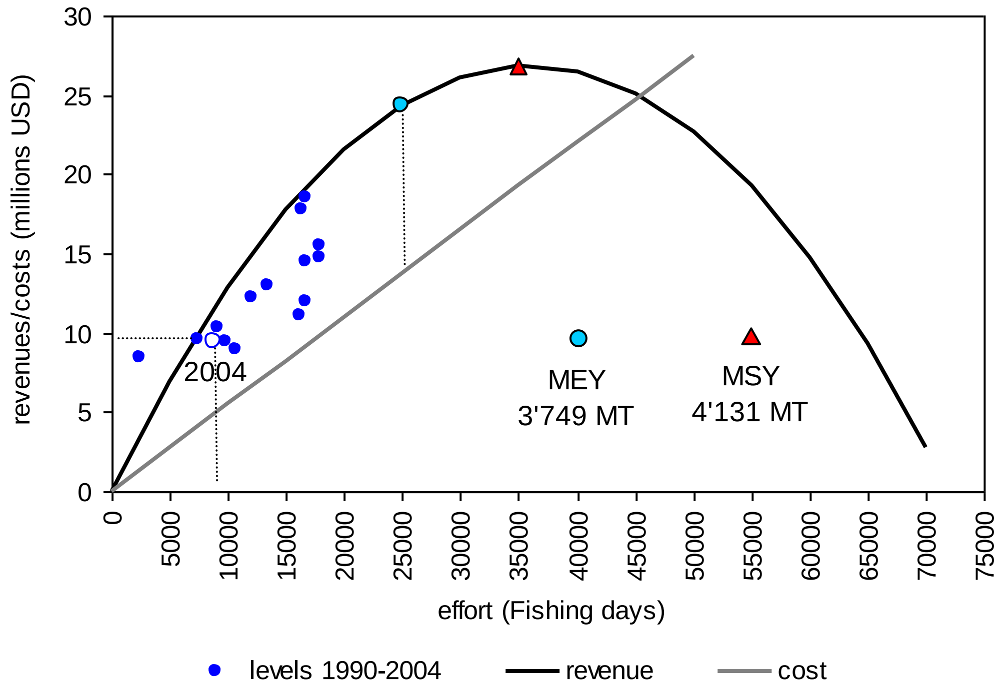


Figure 10: Surplus production model (Schaefer) for the Cuban shrimp fishery.

The exploitation level for the past 15 years has been below the MEY and the present effort level is 8,717 fishing days for a yield of 1,451 MT (hollow circle). This point is still sustainable both in ecological and economic terms, but an increase in effort would increase profits, which are maximised at the MEY.

Table 6 shows the results for the hypothesis test regarding the regime change in 1996. There the estimated parameters can be seen.

Table 6: Results for the hypothesis test in the shrimp fishery, 1980-2004.

a_1	b_1	a_2	b_2	r^2	a_1+a_2	b_1+b_2	F	P
0.141	0.0000005	0.330	-0.000028	0.67	0.47	-0.0000028	17.32	0.00

The hypothesis that the regulations after 1996 have had no effect is rejected for the shrimp fishery, as for lobster. Rather, the results support the hypothesis that conditions have changed after 1996. However, the same reservations with respect to interpretation apply as stated above with respect to the lobster fishery.

4.3 Tuna fishery

The catch and effort trend for the tuna fishery from 1990 to 2003 are shown in Figure 11. One reason for the fluctuating catch levels could be the accessibility of the fleet to the schools since this is a highly migratory species (Claro *et al.* 2001).

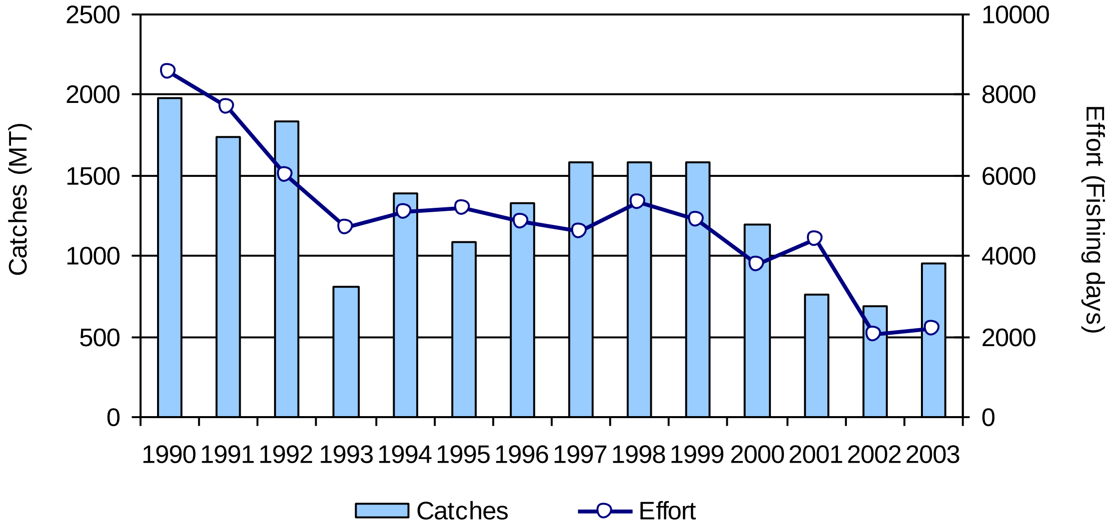


Figure 11: Tuna catches and effort, 1990-2003.

The Schaefer model was applied to catch and effort data and the estimated parameters are presented in Table 7.

Table 7: Results for the Schaefer model in the tuna fishery, 1980-2003.

Schaefer model	a	B	MSY	f_{MSY}	R2
y(t) = a*f(t)+b*f(t)2	0.369	-0.000017	2’001	10’849	0.54

According to the model applied, the MSY is at 2,001 MT obtained at an effort level of 10,849 fishing days. The MEY is 1,749 MT with an effort of 7,000 fishing days, as appears in Figure 12.

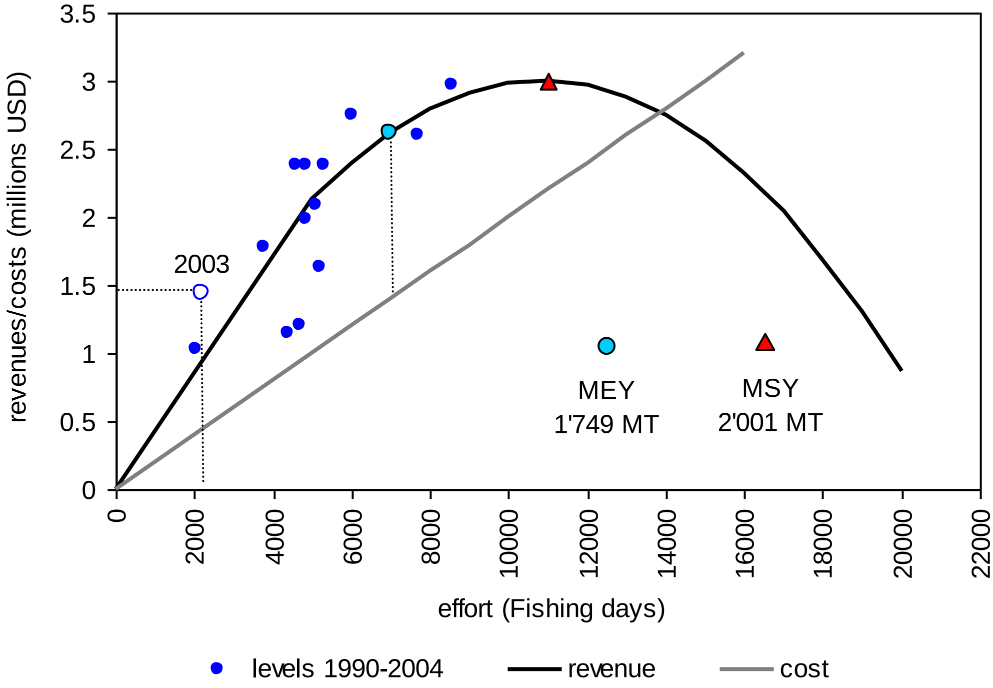


Figure 12: Surplus production model (Schaefer) for the Cuban tuna fishery.

The exploitation level for the past 15 years has been below the MEY except for two years and the current effort level is 2,181 fishing days for a yield of 956 MT (appears as a hollow circle). This effort point is still far from the MEY and the trend has been decreasing in the period studied. This could be an due to the limited benefits obtained because of the time and effort spent searching the live bait and targeting the tuna schools, despite being a very productive fishery. The tuna fishery is expected to grow in the future if current drawbacks are solved (Baisre 2004). These constraints are limited boat autonomy and live bait conservation as well as a rudimentary technique.

The results for the hypothesis test are shown in Table 8. There the estimated parameters can be seen.

Table 8: Results for the hypothesis test in the tuna fishery, 1980-2003.

a_1	b_1	a_2	b_2	r^2	a_1+a_2	b_1+b_2	F	P
0.294	-0.0000094	0.150	-0.000023	0.63	0.45	-0.000033	2.36	0.120

The hypothesis that the regulations after 1996 have had no effect is accepted for the tuna fishery, so implying that there was no change after 1996. This is despite the fact that the tuna fishery is subject to the same economic constraints as the other fisheries. Yet, the trend followed in this fishery is towards a reduced effort, supporting the theory that economic constraints might be behind this, besides the fishing regulations.

4.4 Other fin fish fisheries

The trend of catches and effort for the fishery of other fishes from 1990 to 2003 is presented in Figure 13. The decrease in both catch and effort in the early 1990s is attributed by Claro *et al.* (2001) to the economic crisis after the collapse of Soviet Union. The same authors state that the improved but still lower level in catches might be a result of habitat degradation.

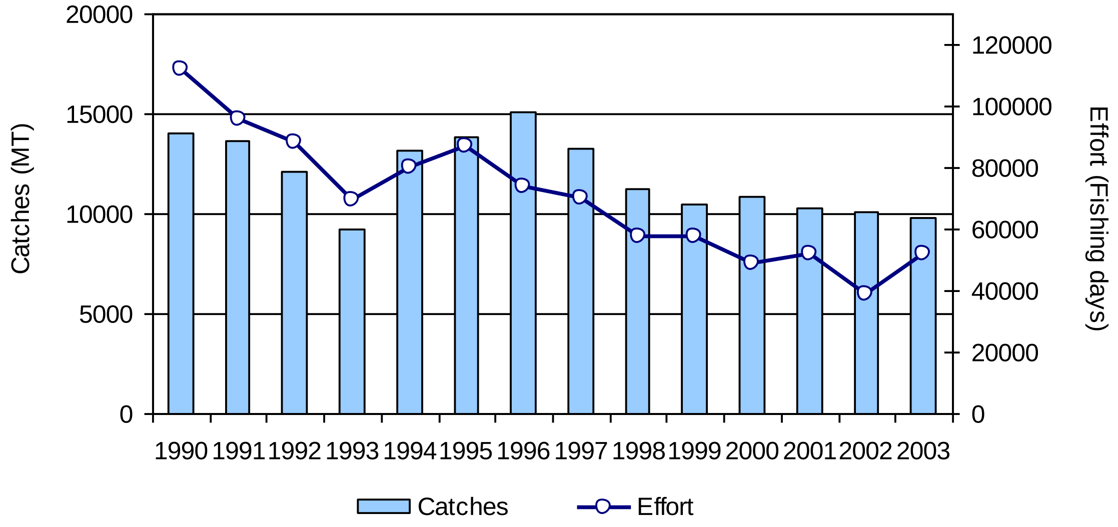


Figure 13: Fishes catches and effort, 1990-2003.

The Schaefer model was applied to the catch and effort data from 1980 to 2003 and the parameters estimation results appear in Table 9.

Table 9: Results for the Schaefer model in the other fisheries, 1980-2003.

Schaefer model	a	B	MSY	f_{MSY}	r2
y(t) = a*f(t)+b*f(t)2	0.266	-0.0000012	14´728	110´785	0.80

The MSY is 14,728 MT obtained at an effort level of 110,785 fishing days. The MEY is 11,633 MT with an effort of 60,000 fishing days (Figure 14).

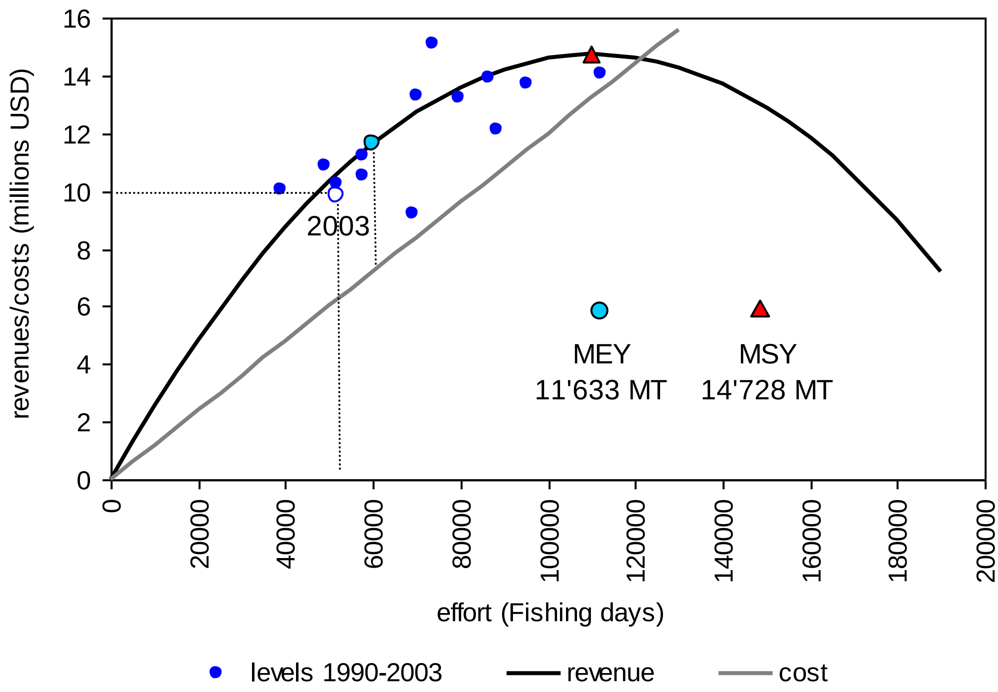


Figure 14: Surplus production model (Schaefer) for the Cuban other fisheries.

This is the less homogeneous group since it includes demersal and pelagic fishes and therefore the data is less accurate making it difficult to assess and manage (Baisre 2004). Some fisheries in this group are fully exploited or even have experienced overfishing like the lane snapper and Nassau grouper (Baisre 2000a, Claro *et al.* 2001) while other stocks are in good shape. This may contribute to the large variation in exploitation levels in this group for the past 15 years and the fact that it ranges from beyond the MSY to below the MEY. Another factor that affects the yield of this group is the lack of territorial rights, leading to several boats fishing the same areas and competing for the same fishing resources (Baisre 2004). Nevertheless, the present effort level is 51,877 fishing days for a yield of 9,827 MT (hollow circle) which means that the management regime has been ecologically and economically successful by reducing the effort below the MSY and MEY from higher levels. One of the most important measures is the ban on the use of set nets, a highly efficient and unselective gear that was used mainly during the reproductive period (in reproductive runs).

Table 10 shows the results for the hypothesis test. There can be seen the estimated parameters for the second equation after 1996.

Table 10: Results for the hypothesis test in the other fisheries, 1980-2003.

a_1	b_1	a_2	b_2	r^2	a_1+a_2	b_1+b_2	F	P
0.187	-0.00000048	0.096	-0.00000089	0.63	0.282	-0.0000014	6.92	0.005

The hypothesis that the regulations after 1996 have had no effect is rejected for this fishery. It implies that there was a change after 1996. Nevertheless, it does not mean that the changes were due only to the regulatory measures but may also be due to economic constraints, as in the cases of the tests for the other fisheries.

4.5 Bycatch

Several low value species landed as bycatch from shrimp are mainly used for human consumption and for animal feed and collectively known as *morralla*. Most of this bycatch comes from the shrimp fishery, around 75% of the total (Baisre *et al*. 2003). The trend of shrimp catch and bycatch is presented in Figure 15.

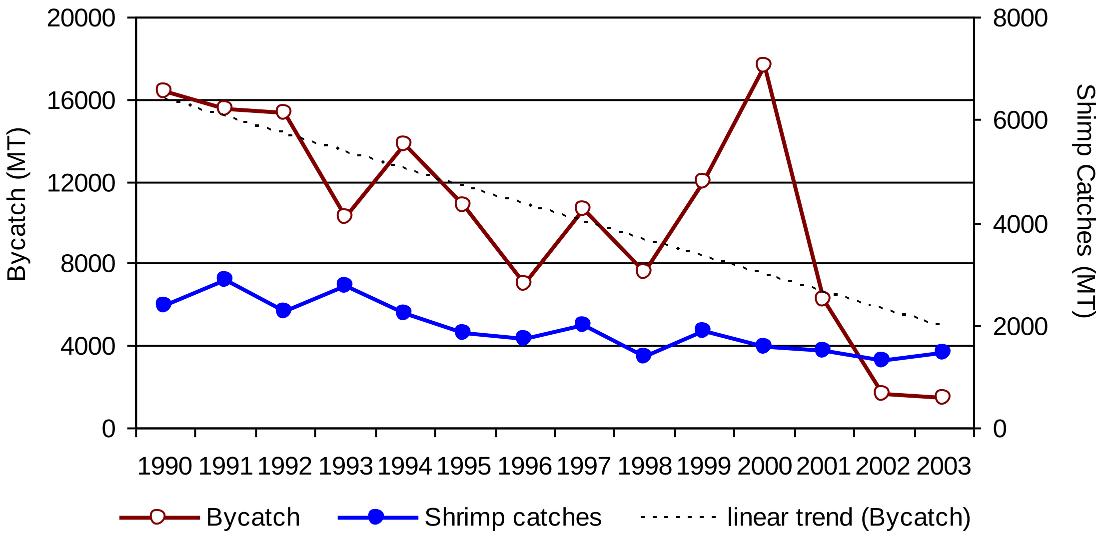


Figure 15: Shrimp catches and associated bycatch with its linear trend, 1990-2003.

The tendency in bycatch naturally follows a downward pattern similar to the shrimp catch. This observed trend is partly explained by the reduced effort in the shrimp fishery but also due to the implementation of regulatory measures. These include increased mesh size, use of excluding devices in trawl nets and permanent prohibition of trawling in the nursery areas (1-2 Nautical miles offshore).

4.6 Conclusions and recommendations

The studies on the status of Cuban fishing resources by Baisre (2000) and Claro *et al.* (2001) have influenced the management regime. The latest changes included licensing fishing boats, increasing the closed season for several species, increasing mesh size in trawl nets, creating marine protected areas and the elimination of unselective gear like set nets, as well as strengthening the property rights in the existing cases.

The four analysed fisheries show levels below the MEY and general trends to decreased effort levels in recent years. The test of the hypothesis that the same Schaefer model applies to the period before the implementation of Decree-Law 164 is rejected for all the species except tuna. Although these tests lend support to the hypothesis that the Decree-Law 164 has had a significant effect on stocks, it is not conclusive since other factors such as general economic conditions may also have contributed to the changes by restricting effort. However, tuna, a migratory species that is not greatly affected by the management rules as seen in Table 2, is the only fishery where the hypothesis of no significant change cannot be rejected. It seems to further support the theory that the

regulatory changes rather than economic conditions have had a significant effect on stocks.
Claro *et al.* (2001) claim that the current institutional structure could jeopardise the ecological objective favouring the economic one because conservation and production are managed by the same entity. But the present study shows that these two functions in the Ministry of Fishing Industry are working separately and the fisheries policy is proving to be successful. Therefore the current management rules are recommended to be maintained and a study to implement Territorial Use Rights in Fisheries (TURFs) is also recommended for demersal fishes and other fisheries as an added regulatory measure.

A more detailed study using biological indicators like age size, catch composition and spawning stock biomass can be recommended. Such studies should be carried out using analytical tools like the Beverton and Holt model. An additional work on the category "Other Fishes" which splits the category in further groups and/or species is also recommended.

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