FISHERIES TRAINING PROGRAMME
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MANAGEMENT OF THE ARGENTINE HAKE

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ABSTRACT

Before the Federal Fishing Law was established, there was little political support for an adequate fisheries management regime. Over-investment in fishing capital and excessive effort dissipated the economic rents of the Argentine hake fishery. As a result the resource has been overexploited in recent years and in danger of collapse. The purpose of this project is to propose a rationalization of the Argentine hake fishery in order to increase its economic efficiency and contribute to the recovery and conservation of the hake stock. A bio-economic model to study economically efficient management of the hake fishery in Argentina is developed. The project identifies the optimal sustainable position for the fishery, designs a reasonable efficient dynamic path towards the optimal sustainable point and finally makes some recommendations to improve the fisheries management system.

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1 INTRODUCTION

The fishing sector in Argentine is in critical state due to a severe decline in some of its major resources, mainly the Argentine hake and squid. The situation is difficult to solve, as stakeholders do not want the restrictive measures that the government should implement in order to protect the resource.

Many commercial fisheries around the world appear to suffer from mismanagement and Argentina is no exception (Hannesson 1996). Yet, the current fisheries management system simply does not provide an adequate basis for effective management. Today the urgent requirement is to recover and maintain Argentine hake at sustainable levels. The challenge is how it can be managed in order to maximize its value, both today and in the future.

Given the current situation of the fishery, the purpose of this project is to propose a rationalization of Argentine hake fishery in order to increase its economic efficiency and contribute to the recovery and conservation of the hake stock.

Keeping in mind that a successful fishery project must be defined within minimum requirements such as a valuable fish resource, an appropriate fisheries management regime and finally the ability to conduct fishery effectively. The project will focus on these main areas.

2 THEORETICAL CONSIDERATIONS

The history of most current ocean fisheries has been alarmingly similar. Initially, when the fishery is first being developed, catches are good and the fishermen earn a high return on their investment and effort. This fact encourages the fishermen to expand the level of their fishing operations and attracts new fishermen to the fishery. Thus, an investment in fishing capacity takes place and fishing effort rises. The fish stocks will eventually decline due to over-fishing and the catch per unit of effort declines. Economic returns from the fishery are correspondingly reduced. This, however, does not put an end to the expansion of fishing capacity. The expansion continues, for as long as the fishermen can reasonably hope to extract a positive rate of return from the fishery. Long before that happens, however, the fish stock has normally been reduced far below the level corresponding to a maximum sustainable yield, and total annual catches have been reduced in spite of greatly increased fishing effort.

From figure 1 the maximum sustainable yield can easily be identified at the fishing effort level E_{MSY}. *"Stocks that have been reduced by fishing to below the MSY level are usually considered overfished"* (National Research Council 1999). Yet, after the cost of fishing has been taken into account, the long-term average rent from the fishery will usually be maximized at the point of maximum sustainable yield.

Significant net returns from a fishery can, however, be generated by controlling effort at the optimal economic yield level (E*) where the difference between total revenues and total costs is the greatest. It is found at the effort level where the distance between the sustainable revenue curve and the total cost curve is maximized.

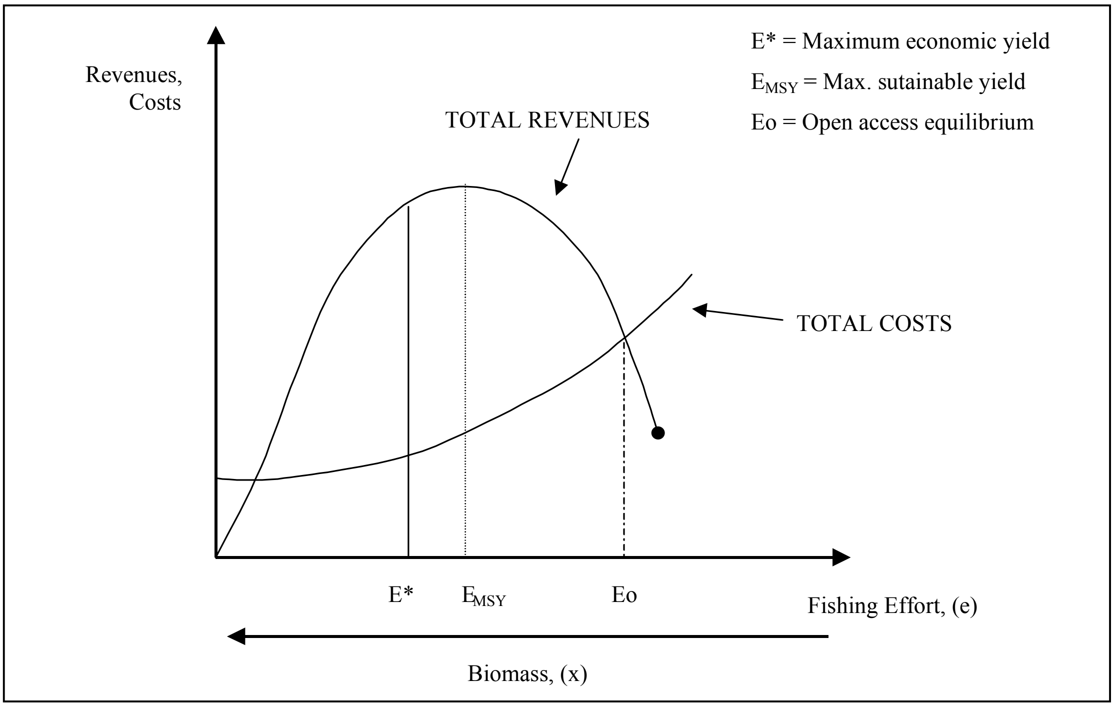

Figure 1: The sustainable fisheries model.

The problem, however, is that a reduction in fishing effort to E* will never be supported by free access, competitive fisheries. The common property nature of fisheries under free access fisheries leads to excessive exploitation and zero economic returns to fishing nations. As a result, many fisheries are characterized by long-term sustainable over-fishing (Arnason 1995).

Moreover, if the costs of harvest is lowered (e.g. by government subsidized vessel purchases) or revenues increases (e.g. higher prices of fish in market), this may lead to the collapse of the fishery.

Probably the most extreme "undesirable event" that fisheries managers wish to avoid is the collapse of the fishery. By "collapse" we mean a severe and persistent decline in biomass, despite a reduction in the fishing mortality rate (for a definition of collapse, see Francis and Shotton 1997). Such an event implies a long term severe drop in production and thus in the operation of the fishery.

This can be summarized in what Garret Hardin has called "The Tragedy of Commons" (Harding 1968). There is a great connection between common ownership of resources and their risk of collapse. Their potential benefits, no matter how great, tend to become dissipated when a large number of users converge to the same resource. Thus, it is clearly demonstrated the need for special management of fisheries if the potential benefits of ocean fisheries are to be realized.

3 THE FISHING SECTOR IN THE ARGENTINE ECONOMY

Historically, fisheries have not been important for the national economy. The development of the fishing industry has taken place in the past 25 years. In 1998 the fisheries sector contributed about 0.2% of GDP and about 3.5% of the country's total exports by value[1].

The sector, though small relative to overall GDP, has grown at an average annual rate of 15% for the past 10 years. Fish and fish products generated more than US$ 0.9 billion in revenues in 1998 (MEyOySP 1999) of which almost 90% were exported. The industry directly employs approximately 25 000 workers, of which 12 000 depend on the hake fishery. Based on National Institute of Fisheries Research and Development (INIDEP) estimates, 3 630 of the workers are contractors belonging to workers cooperatives, which are outside a formal employer/employee system of job security and do not enjoy normal workers social security.
In 1998, 86% of the country's total catch was landed in four ports Mar del Plata, Comodoro Rivadavia, Puerto Madryn and Puerto Deseado. Patagonia region increased their share of landings from 39% to 61% between 1991 and 1997 replacing Mar del Plata as the nation's leading port (World Bank 1999). For the hake fishery Table 1 illustrates proportion of landing by main ports.

Table 1: 1998 Argentine hake landings in tons per port (MEyOySP 1999).

Species	Mar del Plata	C. Rivadavia	Pto. Madryn	Pto. Deseado	Others	Total
Merluza (hubbsi)	199931	54418.2	85498.9	52591.2	66129.9	**458569.2**
Percentage	**43.6**	**11.9**	**18.6**	**11.5**	**14.4**	**100.0**

The shift in landings to the Patagonia region in the recent years reflects in part its proximity to the newly developed fishing grounds in the South Atlantic (See figure 2).

Fishing effort is estimated to have increased by 83% between 1986-1997. Catch Per Unit of Effort (CPUE) for the area south of 41°S has decreased by approximately 60%. South of the 41°S the CPUE has decline from 2 tons/hour in 1986 to 0.8 tons/hour in 1996 (Annala et al 1997). In the last few years, the fishing industry has been showing signs of declining economic returns due to the decline of the hake stocks and lower export market prices.

In 1994 the Parliament (Law 24.315) ratified a fisheries agreement between Argentine and European Union. This agreement granted European fishing companies access to Argentine fish stocks in exchange for financial assistance and increased access to their markets. The agreement was supposed to introduce 29 E.U. vessels (mostly freezers) into the fishery and a limited harvest of 120.000 tons of hake per year. In 1997, E.U. vessels landed 136,764 tons, of which 96,002 tons were hake comparable to 16,5% of Argentina's hake landings (World Bank 1999).

[1] In 1998, Argentina's estimated GDP and total exports were approximately US$ 298,131 billion and US$ 26.4 billion, respectively.

Figure 2: Argentine hake distribution and main ports

Since 1995 the total hake landings have been much higher than the established Total Allowable Catch (TAC). The increase of Argentine landings was the result of an increase of the fishing effort.

3.1 The industry

Marine resources all over the Argentine continental shelf are caught by different kinds of fishing vessels (see Table 2).

Table 2: Size of Argentine fleet, arts used and percentages of catches (SAGPyA and INIDEP 1997).

1997		
Total Fleet	**# vessels**	**% Total Catches**
Artisanal	186	25
Coastal	124	17
Ice trawlers	133	18
Freezers	103	14
Factory	17	2
Jiggers	104	14
Long Liners	23	3
Surimi	5	1
Scallop vessels	4	1
Double Jiggers	32	4
Total	**731**	**100 %**

The inshore fleet (up to 690 HP) consists of artisanal and coastal boats. The artisanal fleet is made up of boats ranging from 10 to 17 meters in length, with limited hold capacity (4 to 14 tons) and no trawling equipment. Fishing trips usually last one day. Main ports are Mar del Plata (70% of total landings) and Quequen (8%). The coastal inshore fleet is technologically more advanced than the artisanal fleet. It consists of boats ranging from 17 to 25 meters in length and possessing larger (18-40 tons) holds with trawlers equipment. Their fishing trips last from 1 to 12 days. Main ports are Mar del Plata (65%) and Rawson (21%).

Ice trawler fleet (290 - 1800 HP) ranges from 25 to 63 meters in length and has refrigerated holds. The fleet provides chilled product to processing plants on land. Fishing trips last from 4 to 15 days. Most of the ice trawlers operate from Mar del Plata (77%), and to a lesser extent from Puerto Madryn (7%) and Comodoro Rivadavia (5%).

The so-called "processing" fleet consists of freezer (600 - 4400 HP) and factory vessels, jiggers, long liners, surimi boats, scallop boats and shrimp trawlers. The trawler component of the processing fleet varies in size depending on the resource they exploit. The smaller trawlers (30 to 42 meters in length) primarily harvest shrimp, whereas the larger trawlers (up to 70 meters) target squid and hake. The processing fleet trips last up to 60-70 days. Most of the freezer fleet operates from Puerto Madryn (26%), Puerto Deseado (25%), Punta Quilla (19%) and Mar del Plata (18%). On the other hand, most of the factory vessels operate mainly from Ushuaia (24%), Puerto Deseado (24%), and Puerto Madryn (19%) (Verona, C. 1998).

3.2 Markets

The domestic seafood market is relatively small. It is estimated that less than 10% of the country's landings go to the domestic market with Mar del Plata supplying over 85% of the seafood products (World Bank 1999). Hake, squid, anchovy, club mackerel, white croaker, Patagonian smoothhound and kingclip are the most important species.

The share of hake in the domestic market decreased from about 58% in 1992 to about 50% in 1995 (SAGPyA 1996). Hake is supplied mainly as a whole fish or as headed and gutted (H&G) (see table 3).

Table 3: Estimated supply of Argentine hake fish in domestic market 1995 (SAGPyA and INIDEP 1997).

Catches in T. (a)	**Exports in T. (b)**	**Gross domestic supply (a-b)**	**Whole**	**H&G**	**Fillet**	**Total**
574 314	411 512	162 802	147	30 966	56 554	87 668

Over 90% of Argentina's landings of hake are exported, mainly as frozen products. Export market prices for hake products have gone down, since 1992 from US $ 1 779 to US$ 1 247 per ton of exported products in 1997. Last year, 1998 showed an increase to US $ 1 603 per ton of fish exported, and the market price is expected to continue increasing in the near future (MEyOySP 1999).

The main destinations of the Argentine hake are: the EU with 45.5% (mainly Spain Netherlands and Italy), NAFTA 7.7% (mainly USA), MERCOSUR 6.6 % (mainly Brazil) and others countries 40% (mainly Japan, China and Taiwan) (MEyOySP 1999).

Prices of fresh hake have been reported up to US$ 800 per ton of whole round fish on the Mar del Plata market in 1996. The amount cannot be explained by higher export prices for hake products. The explanation has rather explained by reduced supply (Annala et al. 1997).

Argentina's customers opinion is that the price of fish is high compared to beef (SAGPyA 1996). As shown in figure 3, the hake fillet competes with beef and chicken. It is disadvantaged because of its low level of processing (it needs more handling and cleaning before cooking) and also because of some of the negative aspects that consumer's associate with fish (e.g. strong smell) (Appendix 1).

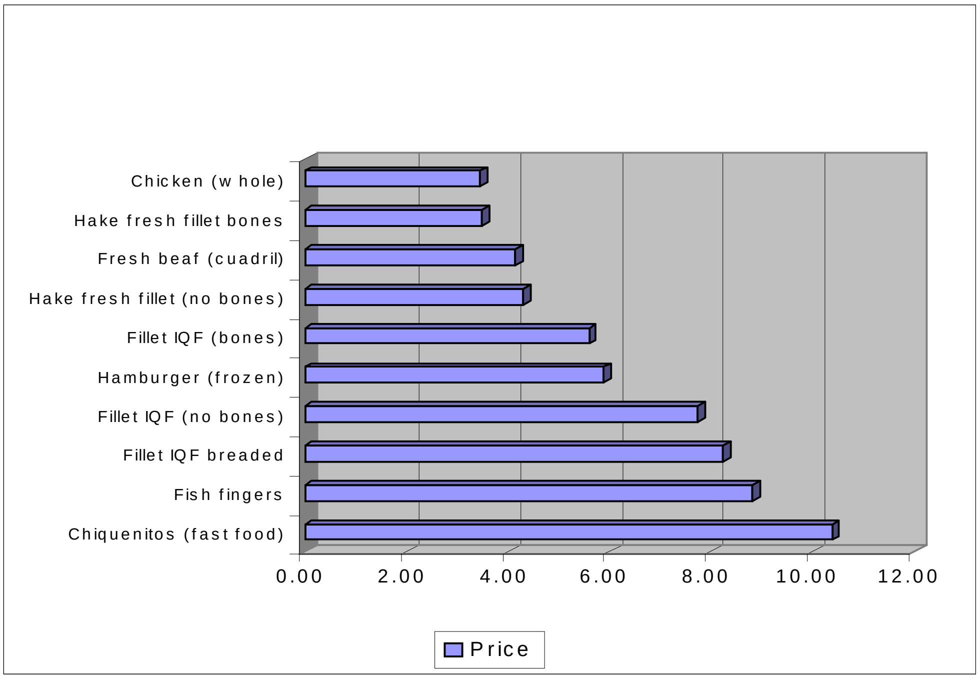

Figure 3: Fish and fish products and its competitors in the domestic market in 1996.

4 ARGENTINE HAKE FISHERY

4.1 The biology of Argentine hake

The Argentine hake is a typical species of the mild to cold waters. It is distributed over the continental shelves of Argentina and Uruguay, mainly between 80 and 800 meters depth and 35°S and 54°S latitude. (SAGPyA-SSP 1998).

Three main water bodies define the hydrographic habitat of the hake:

1. The Brazil current
2. The Malvinas current
3. The shelf water.

The warm waters of the Brazil current constitute the northern and eastern boundary of the distribution of the hake. The shelf waters are found between the coast and the Malvinas current. Together with the Malvinas current, these waters constitute the main habitat of the Argentine hake (Bezzi et al 1993).

The hake in the Argentine and Uruguay EEZ is thought to be two separate stocks. The stock north of the latitude 41°S, having its spawning and nursery grounds located between 34°S and 35°S spreads as far south as 41°S. The stock south of the latitude 41°S having its spawning area at Isla Escondida (SSP 1998) (See figure 1). Hake has feeding and reproductive migrations between 36°S and 38°S in winter and between 42°S and 48°S in spring and summer. The temperature of the continental shelf waters and the reproductive cycle are important factors for the latitudinal migration in the north-south direction (Bezzi et al 1993).

Besides the migrations to spawning and feeding, there are other migrations between the coast and the continental slope, which are accompanied by concentration and dispersion movements of schools of adult hake. They are partly the result of hake pursuing squid, anchovy schools or other prey.

This simple theory of two hake stocks has been challenged recently. INIDEP researchers established that San Matías Gulf hake grow differently when compared with the hake of the shelf (Bezzi et al. 1993). This evidence and the presence of an independent spring spawning ground suggest a third distinctive hake population in San Matías Gulf.

Assumptions of this paper will be done for the Argentine hake fishery as one stock.

Assessment of hake biology is based on data from INIDEP mainly from 1978-1991. Due to the lack of updated data, we will assume that the values of the biological parameters have not changed.

4.1.1 Growth and sexual maturity

Hake is a long-lived species (13-15 years). The males and the females differ in terms of length and age at sexual maturity. The maximum length of females is about 92 cm (total length) and 64 cm for the males. At age 2, 79% of the males and 53% of the females have reached sexual maturity, but generally, all three-year olds are sexually mature (SAGPyA-SSP. 1998).

The average weight-at-age for the period 1978-1991 is shown in figure 4.

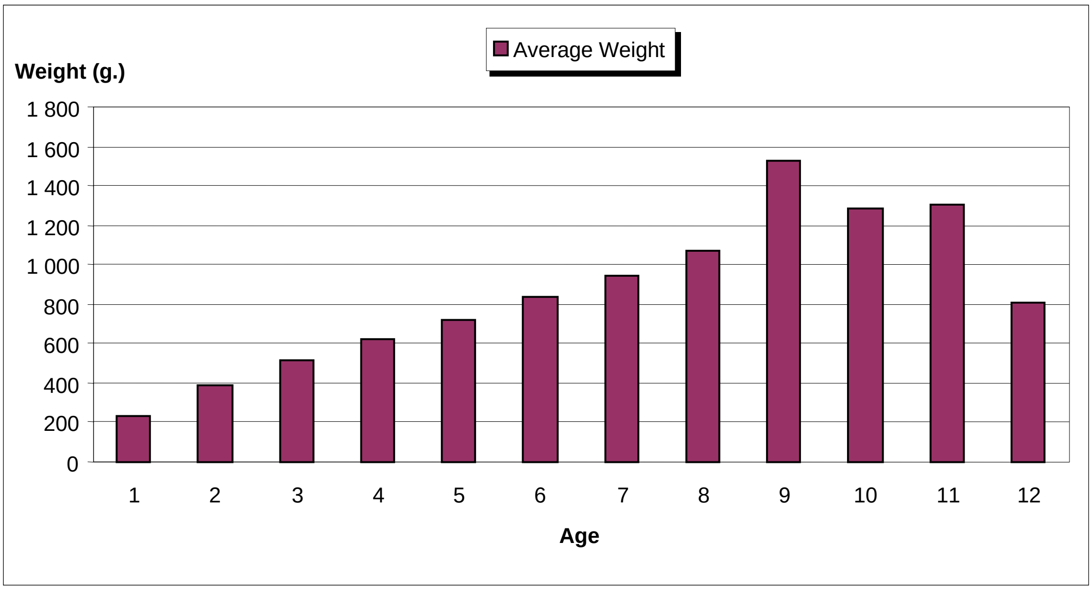

Figure 4: Argentine hake average weight, period 1978 - 1991.

For more detailed data of hake fishing mortality, stock numbers at age and stock biomass at age from the period 1983 - 1991 refer to Appendix 2.

4.1.2 Natural mortality and the predator - prey relationship

Natural mortality rate (M) for hake was estimated 0.3 per year for all ages in 1981, but in 1994 the natural mortality was estimated 0.58. An important part of natural mortality is due to cannibalism. Increase fishing on hake produces great change in natural mortality as cannibalism decreases. The maximum intensity of cannibalism occurs on juveniles during the winter months (Bezzi et al. 1994). The most important predators on hake are mainly: Bony dogfish *(Squalus spp.)*, Kingclip *(Genypterus blacodes)*, long tail hake *(Macruronus magellanicus)*, Austral cod *(Salolita australis)* and Austral hake *(Merluccius australis)* (Bezzi et al. 1993). The most important prey items of hake are squid, anchovy, myctophids and hake. Hake preys all year round on anchovy. Predation of hake on myctophids is along the continental shelf, especially during winter.

4.2 Conditions of the resource

It is generally accepted that the hake resource is heavily exploited and in danger of collapsing. There are several indicators of concern:

- Reliance of the fishery in recent years on the youngest fish indicates the decline of the hake stock. At least 30% of the 2 year-old fish is immature.
- Lack of older fish in both the population and the catches.
- Fishing mortality has risen to levels causing growth overfishing, so effectively reducing yield.
- Qualitative reports of extensive discarding of small 1 and 2 year-old fish owing to present harvesting practices.
- Hake is not a species that easily benefits from mesh selectivity control. Experiments elsewhere in the world have questioned whether a fish escaping through a mesh has any chance of survival at all (Annala et al. 1997).

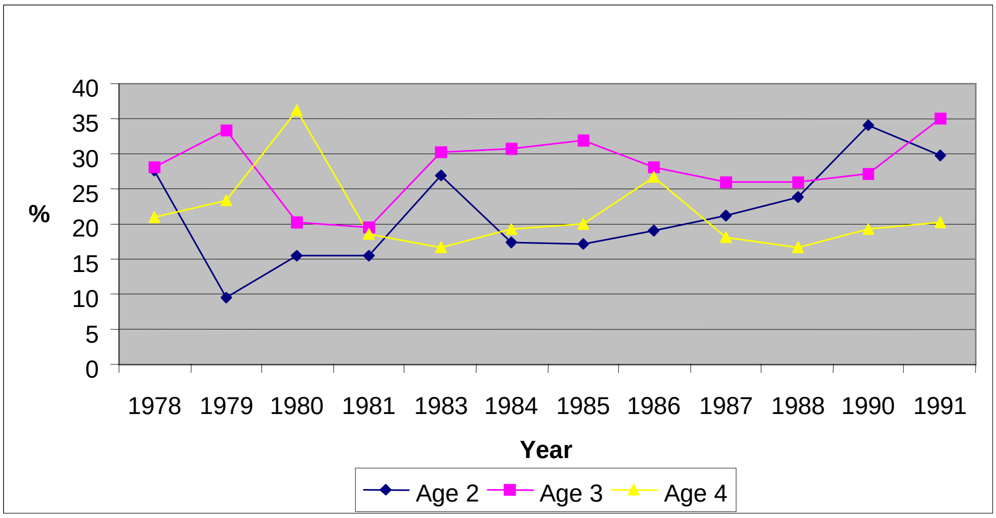

Figure 5: Percentage of hake catches at age during 1978 - 1991.

Figure 5 shows the reliance of the fishery in age classes 2, 3 and 4 for the period 1978 - 1991. Comparing percentages of catch per age the reliance of catch of 2 year-old fish is increasing from about 16% in 1980 to 30% in 1991. Recruitment to the fishery takes place at age 2 (Bezzi et al. 1994). There is no data available for the hake catch per age for the last decade.

4.3 Stock assessment

There is considerable uncertainty in stock assessment, due primarily to problems with catch and effort statistics. Nevertheless, the trends in the estimates of stock and exploitation rate do provide information.

In 1996, the total hake stock size was estimated by INIDEP at 2 million metric tons, in the area from 34°30´S to 48°S at depths between 50 and 400 meters.

A similar assessment during 1997 estimated for the same area a total biomass of 1.5 million tones. The area that contributed the most to the total biomass was between 41°S and 48°S (86%), while the area north of 41°S contributed 14%. In this area, the fishing common zone with Uruguay (FCZ) contributed 9%. These proportions were similar in 1996. As regard CPUE, the area south of 41°S showed the highest rates, while the FCZ shows yields that were slightly higher than those for the area north of 41°S.

Biomass estimates and CPUE decreased in 1997 as compared to the year before. Total biomass was reduced by 27%, and so did the 41°S-48°S area biomass. Biomass for the area north of 41°S decreased by 28%, while biomass for the FCZ dropped by 15%. Table 4 summarizes the results of research conducted in 1996 and 1997.

Table 4. Difference in Biomass in years 1996 and 1997 (Percentages of total biomass in parenthesis) (SAGPyA).

	AREA	1996	1997	Difference %
BIOMASS tons	FCZ *	159 351 (8)	135 241 (9)	-15
	34°30´- 40°59´	282 471 (14)	202 301(14)	-28
	41°- 48°	1 716 379 (86)	1 252 698 (86)	-27
	34°30´- 48°	1.998.850	1.454.999	-27

FCZ *: Fishing Common Zone with Uruguay

Data provided by INIDEP shows a severe decline of the total biomass since 1995. There is no formal analysis of the implications on the fishery of the Agreement with the E.U. during 1994 to 1998. Many Argentine stakeholders claim that the vessels that entered the Argentina EEZ in the frame of this agreement are the cause of the overexploitation of the fishery in terms of increase in effort above the capacity of the fishery.

It is well known that the most common fisheries management method is to impose an upper limit on total allowable catch (TAC). If adhered to, which is not always the case, TAC restrictions are indeed well suited to conserve the fish stocks.

Regarding the setting of the TAC by the Argentine government, history indicates that the main problem was perhaps not how the administration acted on the information from INIDEP by setting TAC, but rather how it has enforced the TACs (Appendix 3). This is clearly visible in figure 6.

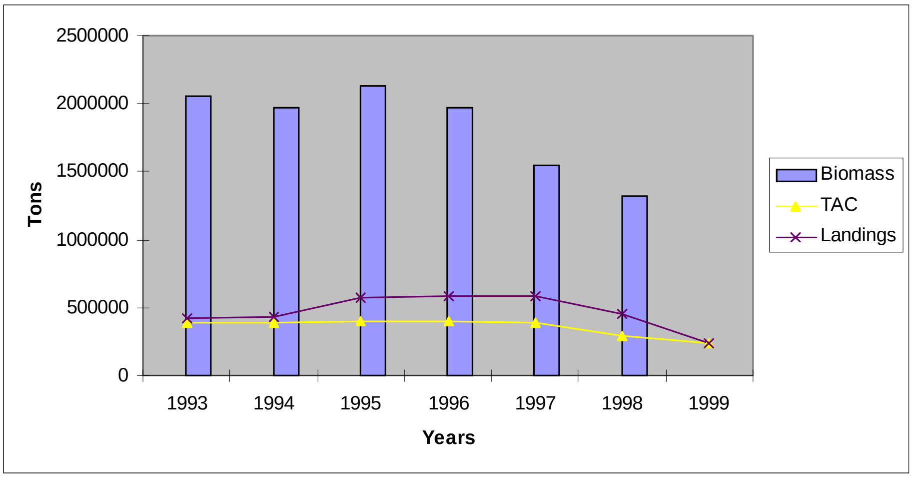

Figure 6: Argentine hake biomass, TAC and landings in tons.

Another problem is discarding and illegal catch. In 1997 it was estimated that discarded and illegal catch was about 37% of the TAC. As illustrated in Table 5, the actual catch of hake reached an estimated 823 048 metric tons compared to the recommended TAC of 395 000 m. tons.

Table 5: Estimated hake catch in 1997 (SAGPyA and INIDEP 1997).

Source of Fishing Mortality	**Catches (tons)**
Argentine "officially" reported landings	584,048
Discards and unreported landings (25%)	149,000
Uruguayan reported landings	50,000
High seas catches	40,000
Total	**823,048**

4.4 The harvest of hake

As shown in figure 7, hake is harvested not only by the Argentine fleet but also by Uruguay in the area of the FCZ. Vessels from other countries are mainly Spanish.

Uruguay had approximately 35 trawlers in the hake fishery in 1994 with engine power between 600-900 HP. There is no data available from Uruguay landings since 1997. Other countries, mainly Spain, have large factory vessels processing hake on board and occasionally there were vessels from the Russian Federation (Bezzi et al. 1994).

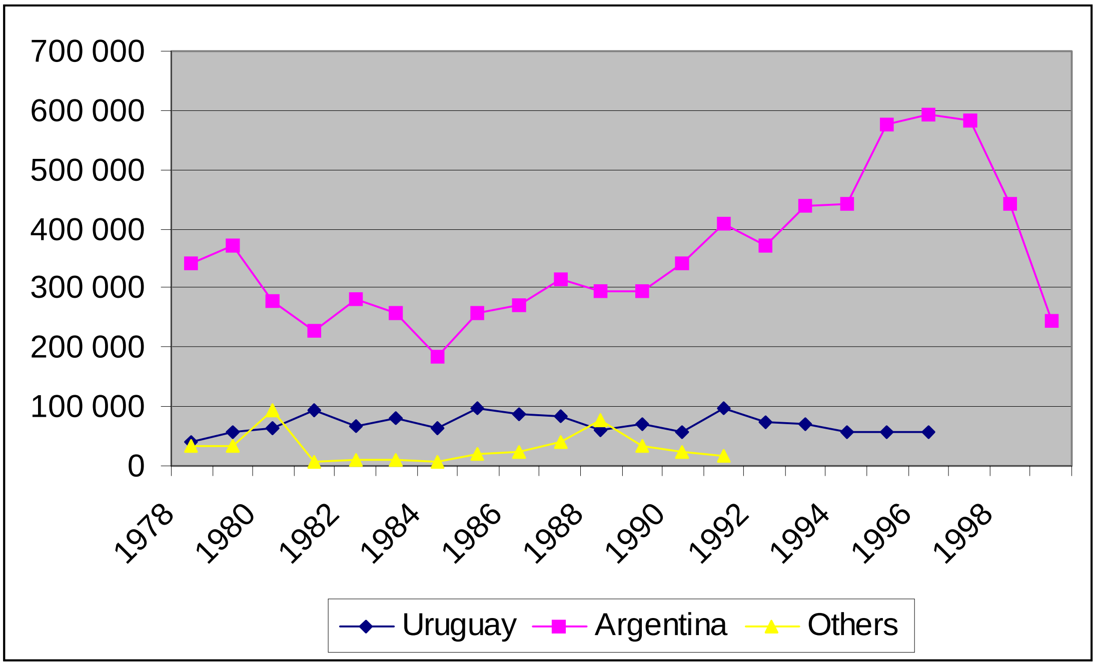

Figure 7: Landings of hake in tons per country 1978-1999.

Of the Argentine fleet, ice trawler vessels have historically harvested hake. During the current decade there have been market changes in the share of the hake taken by different types of vessels (figure 8). The share of ice trawler vessels dropped from 64% to 46%, while freezer vessels increased their share from 19% to 32% (SSP 1999).

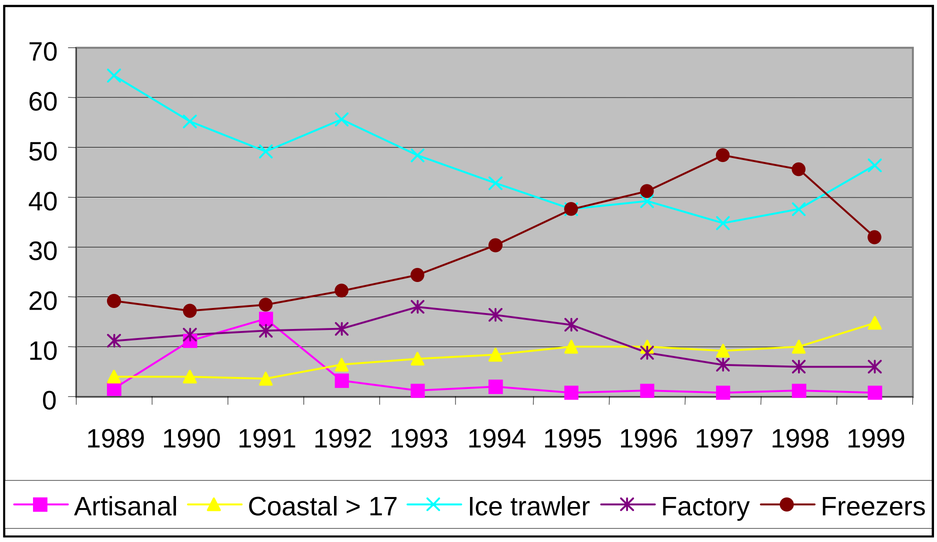

Figure 8: Percentages of Argentinean hake catches in metric tons per type of fleet from 1988 to 1999.

During the first three months of 1999, the fishing sector increased their catch of the total harvest about 26% compared to the same period the year before (MEyOySP. 1999). Aware of the expected measures to come from the government to limit the harvest of hake, fishermen caught 12% more of this species than during the same period last year. For a comparative analysis of catch per month see Appendix 4.

5 THE FISHERIES MANAGEMENT REGIME

5.1 Legal framework

Prior to the establishment of the new Federal Fisheries Law in 1998, there was no political support to enact an efficient fishing management regime. Fishing activity was regulated by a scattered set of laws, decrees, regulations, and resolutions.

Under the previous system, management was based on license limitation (Decree 2236/91), vessels were required to have fishing permits. Most of the permits had no limitations on the quantity or type of species that could be landed. The objective was to control effort through limitations on the number of licenses awarded, restrictions to land only in national ports, and catch reports.

Regarding the TAC setting by the Argentine government, it was generally supported by scientific advice but not lately binding.

Reliance of catch and effort controls is on self-reporting by fishermen following each trip. Responsibility for the collection and quality of the reports rests with the fisheries administration.

There are scattered sets of regulations and technical measures (Resolutions from the Secretary of Agriculture, Fisheries and Food - SAGPyA) for monitoring mesh size, area and seasonal closures, gear restrictions, fish size restrictions, etc. Within these measures, and in order to protect juveniles, the government took the following measures as shown in figure 9.

a) Permanent closed area: Hake fishing is prohibited in the breeding area in order to protect adult and juvenile specimens within the following limits: parallels 43°30´ and 45°S, meridian 63°30´S and the coastline (Res 447/97).

b) Other permanent prohibition areas for trawler vessels were established to protect juveniles in the Patagonian breeding area. The limits of this area are 43°S and 44°S and meridians 60°W and the provincial line, 44°S and 45°S and meridians 61°W and the provincial line, parallel 45°S and 47°S and meridians 63°W and the provincial line (Resolution SAGPyA 96/98).

c) Hake is also a resource our country shares with Uruguay. By virtue of a Treaty ("Tratado del Rio de la Plata y su Frente Marítimo"), signed by the Argentine Republic and Uruguay in 1973, The FCZ was established (See figure 10). Within this zone there are juvenile concentration areas which enjoy protection nine months of the year (summer, autumn and spring months) (SAGPyA-SSP 1998).

The new Federal Fisheries Law N°24922 of 1998 constitutes the first attempt towards a coherent fishing policy. It regulates fishing activity under Individual Transferable Quota System, and supports a wide range of management measures including area and time closures, vessel replacement rules, TACs and fleet quotas.

The goal of the new law is to promote the development of fishing activity commensurate with the rational use of living marine resources while encouraging the use of environmentally friendly industrial processes that achieve the highest value added and generate the most employment for Argentine workers.

The new law:

- Creates the Federal Fisheries Council (CFP),
- Introduces a Quota Management System based on ITQ,
- Extends provincial jurisdiction from 3 to 12 miles,
- Sets aside quotas for the artisanal sector,
- Establishes a National Fisheries Fund,
- Establishes a Resource Extraction Fee,
- Establishes a minimum requirement for Argentinean crews on fishing vessels - all officers and 70% of crew must be Argentine,
- Establishes a strict penalty and infraction regime.

The CFP is composed of 5 provincial and 5 national representatives. Its responsibility is to:
a) Define the national fisheries management,
b) Set the TAC by species based on the advice from the INIDEP,
c) Set the annual catch quotas by vessel, species, fishing area and type of fleet,
d) Regulate the artisanal fleet by establishing a reserve quota for this sector,
e) Development and research policy,
f) Approving commercial and experimental fisheries permits,
g) Advise the SAGPyA in international negotiations,
h) Establish fishing rights and setting royalties.

In order to allocate quotas the CFP must prioritize the following issues:

- ✓ Number of national employed in the fishery
- ✓ Effective investments in the domestic fishing industry
- ✓ Average harvest over the last 8 years, until 31/Dec/96
- ✓ Average of fish processing (on board or on land) during the same period
- ✓ Absence of infraction record

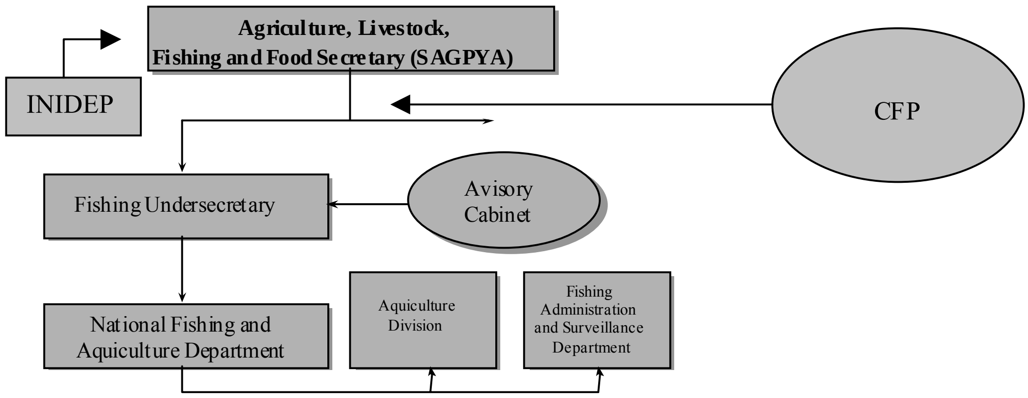

Figure 11: Fisheries National Organigram

Yet, 2 years after the law was enacted there is little progress implementing the ITQs system. Only one of the coastal provinces committed fully to the Federal Fisheries Council. As a result the fishery is still operated according to the old management regime.

5.2 Enforcement

5.2.1 Catch and effort monitoring

Until 1995, controls were limited to the surveillance of direct vessel-to-vessel transshipments and minor operations of little significance.

During 1996, the controlling activities were enhanced with the supply of more suitable working clothes, as well as equipment needed for controlling operations (transmission bases and radio receivers, vehicles, etc.) by the utilization of a fund derived from the Agreement with the European Union.

The current system relies on self-reporting by fishermen following each trip. Responsibility for the collection and quality of the reports rests with the fisheries administration. The Control Unit (Enforcement) belonging to the Fishing Administration and Surveillance Department (FA&SD) collects the reports and reviews them (See figure 11). The Statistics Group, from the same department, controls the information technology, data processing and database administration through which information is provided to other users.

The National Fishing and Aquaculture Department (NF&AD) arranges monitoring and control by local officers in most of the important ports (see Table 6). Two types of tasks are performed: administrative tasks, such as statistics, data entry of fishing reports, surveillance proceedings, fishing licenses proceedings, secretariat, reception desk, communications, etc. and inspection tasks as landings controls, transshipment and fishing gear, verification of fishing products, quality control, etc.

In early 1998, there were five local offices with permanent and hired staff, at each of the five main Argentine ports where fishing activity is intense.

Table 6: Local officers in main ports (Verona 1998).

Ports	Permanent	Adscript	Contract	Administr.	Inspection
Mar del Plata	7	1	5	6	7
Bahía Blanca	1			½	½
Pto. Madryn	2	1	2	2	3
Pto. Deseado	1			½	½
Ushuaia	1		1	1	1

These same inspectors control other nearby ports, according to the following description:

Mar del Plata: serves La Plata, Punta Atalaya, Río Salado, Gral. Lavalle, San Clemente del Tuyú y Necochea.
Bahía Blanca: serves Ing. White and San Antonio.
Puerto Madryn: serves Rawson, Comodoro Rivadavia, C. Córdova and Camarones.
Puerto Deseado: serves Punta Quilla and San Julián.
Ushuaia: serves Río Grande (refer to figure 2).

Today, many flaws in the system can be identified. The main problems that remain to be addressed are:

1. the control unit is under-resourced and therefore cannot effectively monitor and assure quality of fishing data (shortage of dedicated field personnel, lack of operating budget),
2. the rules and standards to be enforced are poorly defined.

5.2.2 Fisheries judicial system

Any fisheries judicial system requires:

1. a clear, operative definition of violations (law must be written in a operative way), and
2. a clear and fair stipulation of the burden of proof.

But usually this is not enough. For an effective processing of alleged violations it is required that officials, judges and lawyers are well-trained in the purpose of fisheries management and the content of the fishing law.

In regard to the licenses, judicial measures many times allowed the transferability of licenses to vessels under the Agreement with the European Union (Verona, C. 1998). The interpretation of the licenses in civil courts has undermined their limited effectiveness in regulating fishing capacity. The enforcement and penalty regime prescribed in legislation provided no effective deterrent to rule breaking behavior.

6 OTHER FACTORS AFFECTING THE MANAGEMENT REGIME

The project also briefly analyzed the following matters such as:

a) Infrastructure, including information about harbors, fuel supply, maintenance supply, storing, education, trained manpower, transport, etc.

b) Economic environment, meaning: taxes, duties, tariffs, subsidies, access to finance, prices, markets, access to markets,
c) The social structure and social and political constraints (social evolution, geographical migrations, the role of traditional organizations and values, etc.)

a) Infrastructure

Among those involved in fishing activity it is well known that harbor infrastructure is insufficient for the current requirements of the Argentine fleet. This is so, mainly due to the increasing number of vessels in the last few years in these ports. This situation promotes delays and over-capacity creating additional operational costs mainly in Puerto Madryn, Puerto Deseado and Ushuaia (Anon. 1996).

Operational costs for the companies are higher in ports in Patagonia, e.g. fuel and transport. Fishermen must also store their products in cooling chambers due to infrequent shipping from these ports.

Maintenance and/or repair services are insufficient in Patagonian harbors. There are only two ports where the vessels operating in the south of Argentina can be repaired, Puerto Belgrano and Punta Alta and with the inconvenience that the Argentine Navy (AA) has priority, otherwise they have to go to Mar del Plata or Buenos Aires. For example, the trip takes four and five days respectively from Puerto Deseado (Anon. 1996).

Transport is an important factor in the sector, which exports approximately 90% of the harvest. Operating from Patagonian ports transport creates an additional cost to companies which affects directly the competitiveness of their products in the market. For example, from Puerto Madryn to Europe transport costs about US$ 230-250 per ton, while the same service from Mar del Plata or Buenos Aires ports costs about US$ 125 (Anon. 1996).

b) Economic environment

Fishermen, mostly those that operate from ports in the Patagonia region, are claiming that during the last two years the government has taken measures that decreased the profitability of their companies. This situation started with the suspension of the payment of reimbursements from Patagonian ports (Law 23018), the reduction of the amount of exports goods repayment, the elimination of the reimbursement of exports to Brazil, and finally the delay of tax (IVA) reimbursement of exported products (CEPA 1999).

Originally the reimbursement from Patagonian ports and the repayment of exported goods constituted tools to promote fishing activity and exports. Today, the suspension and reduction of these measures affect the competitiveness of this industry. Companies are also complaining that the last tax reform creates additional cost to an economic sector that is already in difficulties.

c) Social and political constraints

As mentioned, before the Federal Fishing Law was established, there was little political support for an adequate fisheries management regime. Fisheries administration and research budgets have been limited by government restraints. This has contributed to loss of job security and caused problems of continuity at the fishing management level. Furthermore, a forum for dialogue between fisheries administrators, researchers, and industry is missing.

INIDEP is well positioned to provide the resource analysis function under the new fisheries regime that is to be introduced and is perhaps the strongest component of the overall system. This is perhaps not well recognized by the fisheries administration and the fishing industry. (Annala et al. 1997)

The setting of a socially beneficial fisheries policy is just as much an economic as a biological problem. Economic data collection currently being carried out in Argentina is inadequate. There is an insufficient number of people and resources allocated to this particular task. Lack of the necessary economic information and analysis almost inevitably lessen the quality of the fisheries management.

7 DEVELOPMENT OF AN BIO-ECONOMIC MODEL

One of the reasons for the dissipation of economic rents in the Argentine hake fishery is over-investment and excessive fishing effort. As a result, the resource has been overexploited in recent years and the stock shows a severe decline in biomass since 1995.

The emphasis in the current chapter is to develop a simple bio-economic model to study an economically efficient management of the hake fishery of Argentina. The main tasks are:

a) Identify an optimal sustainable position for the fishery
b) Move the fishery to its optimal sustainable position, and
c) Make some recommendations to improve the fishing management system and particularly the monitoring, control and surveillance system.

A standard objective for fisheries management, is to make the fishery as profitable as possible. Once the optimal long-term level of fishing effort has been defined, the practical problem is to reduce fleet capacity and fishing effort to that level. An optimal fishing management plan for the Argentine hake fishery will require a significant reduction of the current fishing effort to rebuild the hake stock to the optimal level.

The contribution of the present paper is to provide a strategy to move the fishery to its optimal sustainable position. During the development of the project some technical difficulties appeared mainly because of incomplete data on the hake fishery. Nevertheless, the results obtained appear reasonable and the general approach can certainly be utilized to provide more accurate results on the basis of better data.

The model to be developed is very simple in many respects. It deals only with a single species of fish in isolation and ignores unpredictable environmental fluctuations that give rise to variations in the abundance of fish stocks. It is also aggregative in that it only considers the biomass of the hake ignoring the complications caused by yearclasses. Moreover, the model deals only in a homogeneous unit of fishing effort. Finally it assumes constant prices and costs.

7.1 Biomass growth function

Biomass growth function may be represented in figure 12, where MVS is the minimum viable biomass and VSE the virgin stock equilibrium or the stock without any harvest. Between MVS and VSE the biomass increases, but from MVS to left and from the point of the VSE to right growth decreases due to limitation of the environment or to natural mortality.

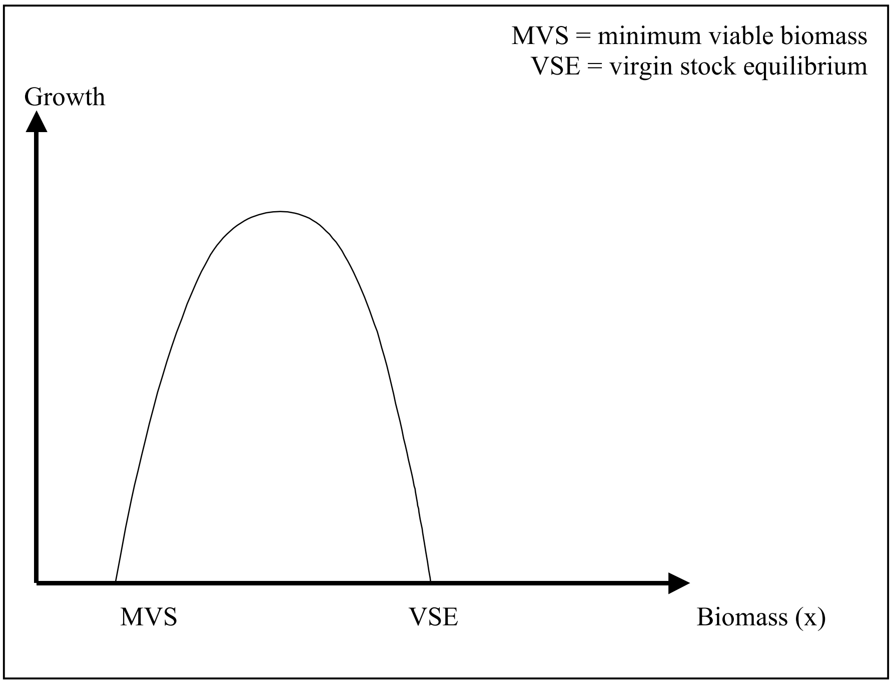

Figure 11: Biomass growth function

The available data on the Argentine hake fishery contain estimates of landings and biomass from 1978-1999 as shown in table 7.

Table 7: Hake landings and biomass, in metric tons.

Year	Argentina	Uruguay	Others	Total Landings	Biomass
1978	341 161	41 326	34 293	416 780	n/a
1979	370 905	57 057	34 077	462 039	n/a
1980	277 350	62 309	95 049	434 708	n/a
1981	228 729	92 268	5 524	326 521	n/a
1982	281 909	68 024	10 452	360 385	n/a
1983	257 100	79 692	10 896	347 688	n/a
1984	183 244	65 051	6 556	254 851	n/a
1985	259 334	97 150	20 012	376 496	n/a
1986	270 558	86 213	24 467	381 238	2 719 164
1987	314 220	83 693	41 008	438 921	2 518 539
1988	296 026	60 736	77 501	434 263	2 224 817
1989	294 333	69 329	34 655	398 317	2 323 980
1990	341 042	55 751	24 101	420 894	2 160 068
1991	409 250	95 890	16 172	521 312	2 528 585
1992	372 300	74 509	n/a	446 809	n/a
1993	438 626	69 910	n/a	508 536	2 060 502
1994	440 931	56 981	n/a	497 912	1 968 696
1995	577 297	57 874	n/a	635 171	2 128 767
1996	592 067	57 937	n/a	650 004	1 970 487
1997	582 096	n/a	n/a	582 096	1 546 632
1998	441 274	n/a	n/a	441 274	1 322 732
1999	245 121	n/a	n/a	245 121	n/a

Source: Based on data from SSP and INIDEP

A simple biomass growth function corresponding to figure 11 is the extended logical function:

$$G(x) = b_0 + \alpha \cdot x + ß \cdot x^2$$

In discrete time this can be written as: $x_{t+1} - x_t = b_0 + \alpha \cdot x_t + ß \cdot x_t^2$, where x denotes aggregate biomass and b_0, α and β are parameters.

From the above time series the equation of the biomass growth function was estimated by OLS. Since most of the coefficients were poorly determined, the following restrictions were initially imposed.

a) $b_0 = 0$
b) $\alpha - 6{,}0\ \beta = 0$

Restriction b) imposes a limit on the maximum sustainable biomass making the maximum biomass approximately equal to the assumed virgin stock equilibrium (6 million tons).

The key estimation results are summarized below:

Parameter	Estimates	t-statistics
α	0,27639	6,557
β	- 0,046064	-6,557

Estimation method: OLS
Dependent variable: biomass growth = $x_{t+1} - x_t + y_t$
$R^2 = 0{,}0615$
Test of restriction b): F(1,13) = 0,15750, (restriction not rejected).

From the equation: MSY = $\alpha^2 / 4\beta$ it was obtained MSY = 415 000 tons and a correspondent biomass of 3 million metric tons. See figures below.

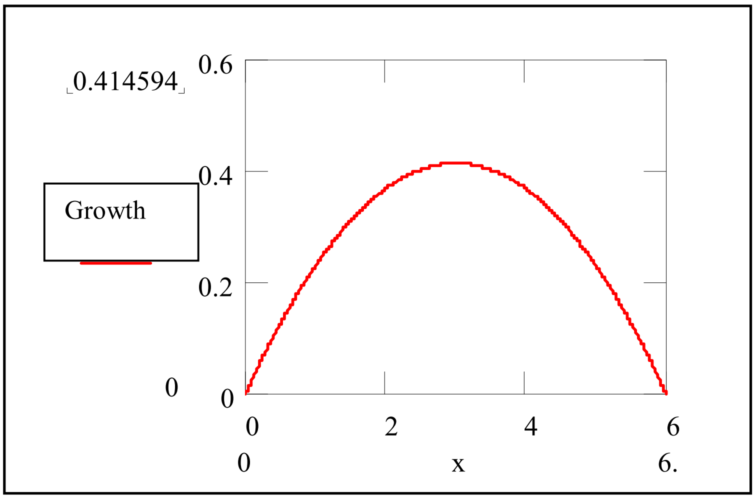

Figure 13: Estimated biomass growth function in million tons.

7.1.1 Minimum viable biomass

Now it should be considered a biomass growth function in terms of a minimum viable biomass. Therefore restriction a) was dropped, and only b) was imposed as follows:
$\alpha - 6{,}0\,\beta = 0$

Key estimation results are represented above:

Parameter	Estimates	t-statistics
α	0,49290	1,037
β	- 0,08215	-1,037
b0	- 0,29951	-0,4574

Estimation method: OLS
Dependent variable: biomass growth = $x_{t+1} - x_t + y_t$
$R^2 = 0{,}0764$
Test of restrictions: F(1,12) = 0,00068311 (restriction not rejected).

The new estimated growth function is illustrated in figure 14:

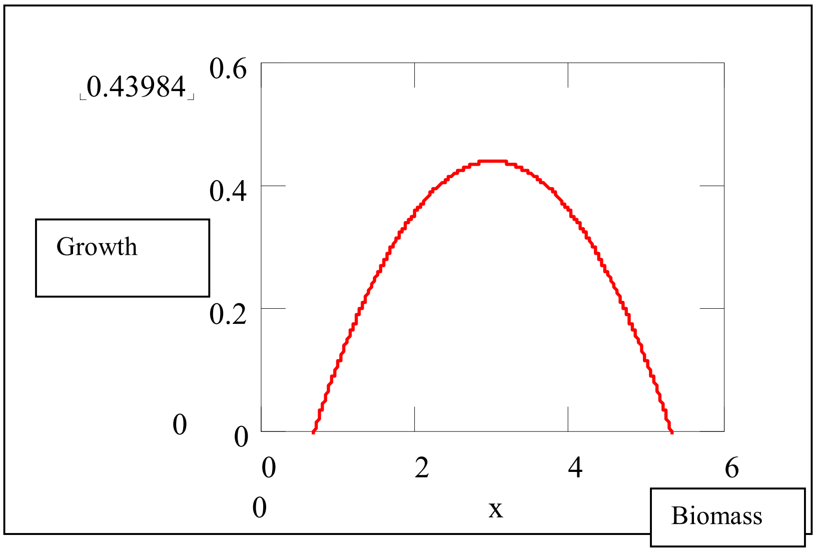

Figure 13: Biomass growth function considering a MVS.

If equal to zero, $0 = b_0 + \alpha \cdot x_t + \beta \cdot x_t^2$, the solution gives the minimum viable stock and the virgin stock equilibrium respectively. From the figure above it is easy to locate these two positions of the fishery. The minimum viable biomass at 0.686 million metric tons, the virgin stock equilibrium at 5.3 million metric tons, the maximum sustainable yield about 0.44 million metric tons and the biomass at the MSY at 3 million metric tons.

Although the estimations appear reasonable, it is important to keep in mind that they are subject to serious statistical problems such as misspecifications and errors in variables.

7.2 Harvest function

The harvest function employed is:

$Y_t = q * e_t * x_t$

where y represents harvest during the interval of time (*t*, *t*+1), e is the fishing effort during the same period and q is the catchability coefficient. This type of a harvesting function is illustrated in figure 15:

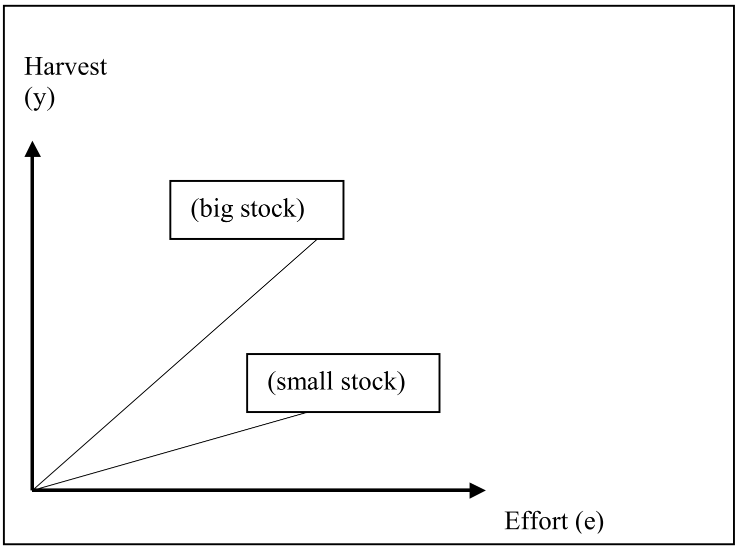

Figure 14: Harvest function.

Fishing effort is standard in units namely ice trawler vessels operating in the hake fishery. The effort of the different vessels have been converted to ice trawler effort. The harvest equation was estimated for the period 1989 to 1999, using data from vessels that fish more than 15% of this resource.

Table 8: Catches of hake per type and number of vessels between 1989 - 1999, in tons (SSP 1999).

	1989	#	1990	#	1991	#	1992	#	1993	#	1994	#
Artisanal	4340	12	38905	15	62831	17	11597	14	5351	17	8597	17
Coastal	11482	29	13443	26	14911	38	23982	57	33359	68	37876	61
Ice trawlers	184841	97	191897	105	200490	100	206365	96	212932	95	188084	83
Factory	31781	10	43198	10	53939	11	51054	15	79735	11	72761	11
Freezers	55175	31	60293	31	74764	45	79302	43	107248	38	133614	38
TOTAL	**287619**	**179**	**347737**	**187**	**406935**	**211**	**372300**	**225**	**438626**	**229**	**440931**	**210**

	1995	#	1996	#	1997	#	1998	#	1999	#
Artisanal	5064	16	6202	19	5674	20	4645	32	2048	25
Coastal	56656	67	59107	69	53919	66	43264	69	36236	72
Ice trawlers	217067	76	232033	87	201835	87	166515	92	113900	92
Factory	82126	11	51354	9	38233	8	25609	7	14697	7
Freezers	216384	78	243371	91	282435	109	201240	90	78241	58
TOTAL	**577297**	**248**	**592067**	**275**	**582096**	**290**	**441274**	**290**	**245121**	**254**

The key estimation results for the harvest function are summarized below:

Parameter	Estimates	t-statistics
q	0,0010350	17,36

Estimation method: OLS

Dependent variable: = y_t
R^2 = 0,7287

7.3 Cost function

In the present paper the cost function is defined as:

$C = cc \cdot e + ccc \cdot y(e)$

where the parameter cc represents the effort costs of the industry equal to 0,0013 and ccc is a parameter specifying the cost of harvest equal to 0,15. Due to the lack of data these parameters were not estimated, they were simply given plausible values. Cost function is illustrated in figure 16. The end of the curve means no costs at effort level 174 where the fishery collapses.

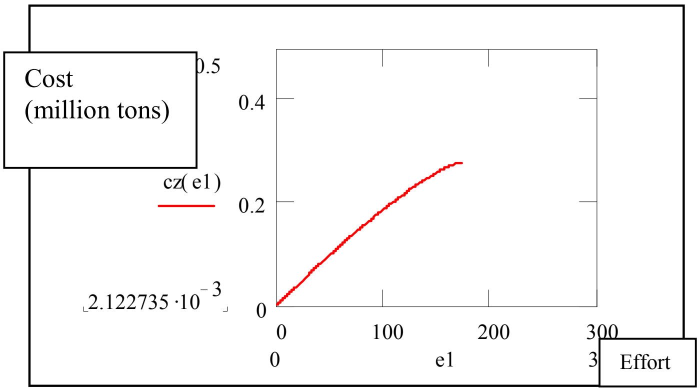

Figure 15: Cost function measured in million tons of hake as a function of fishing effort.

7.4 Sustainable yield function

Without the restriction of a minimum viable biomass the sustainable yield function is given by $y_t = a^*e_t - b^* e_t^z$. Under the specifications of the biomass growth and harvesting function above and imposing the relation $b_0 = B$ we may illustrate this function in the following figure.

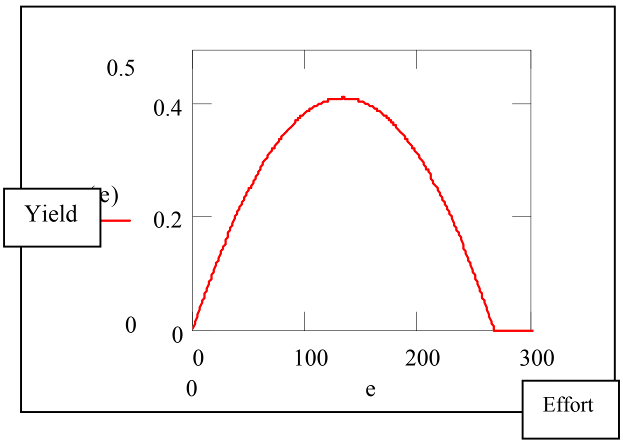

Figure 17: Estimated yield in million tons as a function of fishing effort in terms of number of vessels.

In the minimum viable biomass case we have a much more complex expression for the sustainable yield function.

$Y(e) = 1/2ß. [-a \cdot e + \alpha + (a^2 \cdot e^2 - 2\alpha \cdot a \cdot e + \alpha^2 - 4ß \cdot b_0)^{1/2}]\, e \cdot a$

where b0, a, α, and ß, are the same parameters as to the earlier biomass growth function.

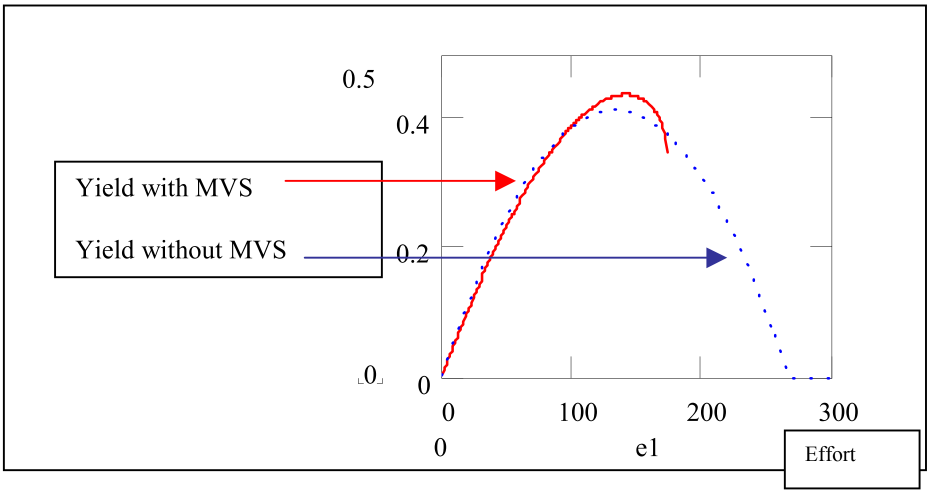

Figure 18: Estimated yield assuming a MVS, in million tons, as a function of fishing effort in terms of number of vessels.

Effort at MSY = 144 equivalent ice trawlers
Point of collapse = > 174 equivalent ice trawler vessels.

7.5 The profit function

Profits equal revenues minus costs. In terms of fishing effort the function is:

Pro (e) = y (e) - c (e)
or replacing yield and cost by its formulas:

$Pro = \alpha \cdot e - ß \cdot e^2 - cc \cdot e + ccc \cdot y(e)$

Note that profits are measured in tons of hake[2].

Profits and optimality assuming a minimum viable stock

[2] By dividing through by the hake price (0,55).

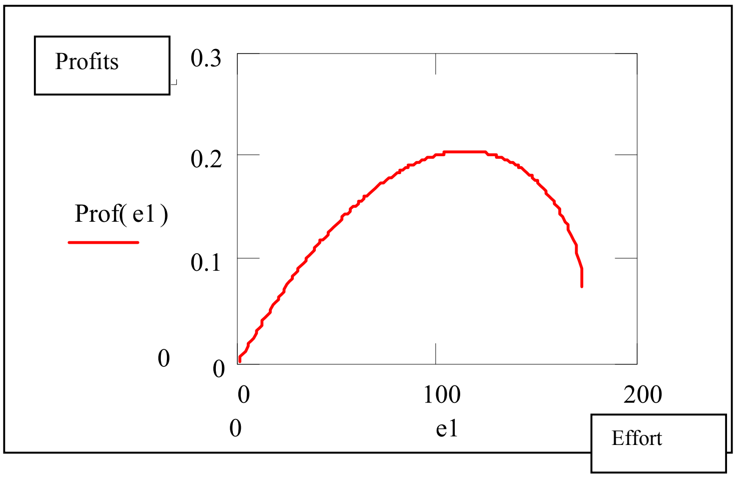

Figure 19: Profits expressed in million tons of hake as a function of fishing effort.

The optimal effort level, e* which maximizes profits, is equivalent to 119 ice trawlers vessels with a maximum profit equal to 206 000 tons of hake for the whole fishery, a total harvest of 424 000 tons and a corresponding biomass level of 3.4 million tons of hake. Notice that there is a significant gap at fishing effort equivalent to 174 ice trawlers where the fishery will collapse and consequently profits are zero (see figure 19).

In open access or competitive fishery, potential benefits tend to become dissipated when a larger number of vessels converge to the same resource. In the case of the Argentine hake management, the collapse of the fishery takes place before perceiving negative rents from the fishery as a whole.

8 OPTIMAL ADJUSTED PATH

Once being defined the optimal sustainable position of the fishery takes place the design of the optimal path towards it.

In table 9 the design of a management plan for the next 17 years is illustrated considering a starting biomass approximately 1 million metric tons. This value was estimated considering a biomass about 1,5 and 1,3 in 1997 and 1998 respectively and probably is still optimistic. Management started reducing fishing effort to the equivalent of 20 ice trawlers vessels with a fixed yield or TAC of 50.000 metric tons for the whole fishery for the next two years. After this period, the stock may support a gradual increase of effort and yield but effort should not increase more than to the equivalent of 110 ice trawlers vessels.

Table 9: Hake fishery management plan 2000-2016.

Year	Yield (y)	Effort (e)	Biomass 1/I x0	Biomass 31/XII x1	Costs (c)	Profits (Pro)	Profits in m. pesos
2000	0.050	20	1.000	1.061	0.034	0.017	9.1
2001	0.050	20	1.061	1.142	0.034	0.017	9.1
2002	0.075	30	1.142	1.224	0.050	0.025	13.6
2003	0.100	50	1.224	1.304	0.080	0.020	11.0
2004	0.100	50	1.304	1.408	0.080	0.020	11.0
2005	0.150	90	1.408	1.489	0.140	0.011	5.8
2006	0.160	100	1.489	1.582	0.154	0.006	3.3
2007	0.180	110	1.582	1.676	0.170	0.010	5.5
2008	0.200	110	1.676	1.772	0.173	0.027	14.9
2009	0.230	110	1.772	1.858	0.178	0.053	28.9
2010	0.260	110	1.858	1.931	0.182	0.078	42.9
2011	0.290	110	1.931	1.987	0.187	0.104	56.9
2012	0.300	110	1.987	2.043	0.188	0.112	61.6
2013	0.300	110	2.043	2.107	0.188	0.112	61.6
2014	0.350	110	2.107	2.132	0.196	0.155	85.0
2015	0.400	110	2.132	2.110	0.203	0.197	108.4
2016	0.400	110	2.110	2.084	0.203	0.197	108.4
					NPV:	0.360	197.868

The proposed yield in terms of TAC which should be established by the CFP, for the next 17 years is a result of adjusting yield and fishing effort in the best way to rebuild the hake stock without closing the fishery. Yet, the recovery of the stock will be faster by closing the fishery at least for one year. See figure 20. Note that the historic average catch of the fishery is about 0.435 million tons, meaning a significant reduction on catch in the proposed policy in order to recover the stock in the long term.

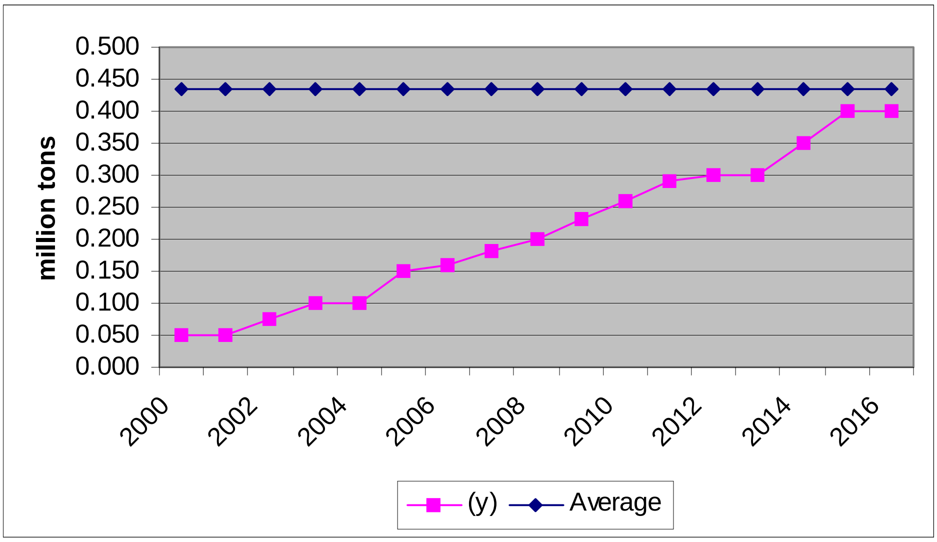

Figure 20: Recommended yield per year.

The same methodology applies to defining the fishing effort. As illustrated in figure 21 there is a gradually increase in effort after the year 2002 reaching the 110 vessels in 2007. This number should be maintained constant until the end of the period.

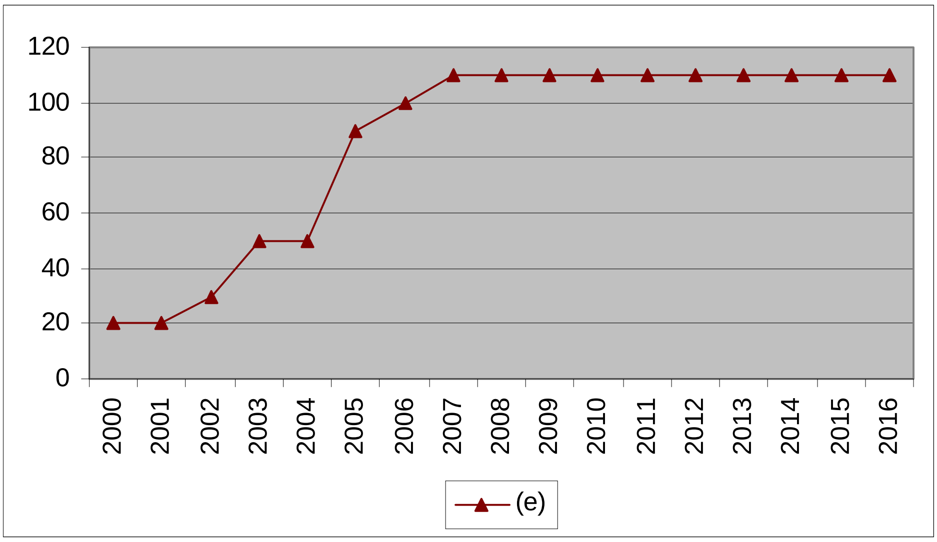

Figure 21: Proposed fishing effort (e) in number of vessels per year

Figure 22 illustrates the estimated biomass for the whole period, by combining TAC and number of vessels. As a result we can say that the fishery will not support a fishing effort above the equivalence of 110 ice trawlers, at least in the period considered.

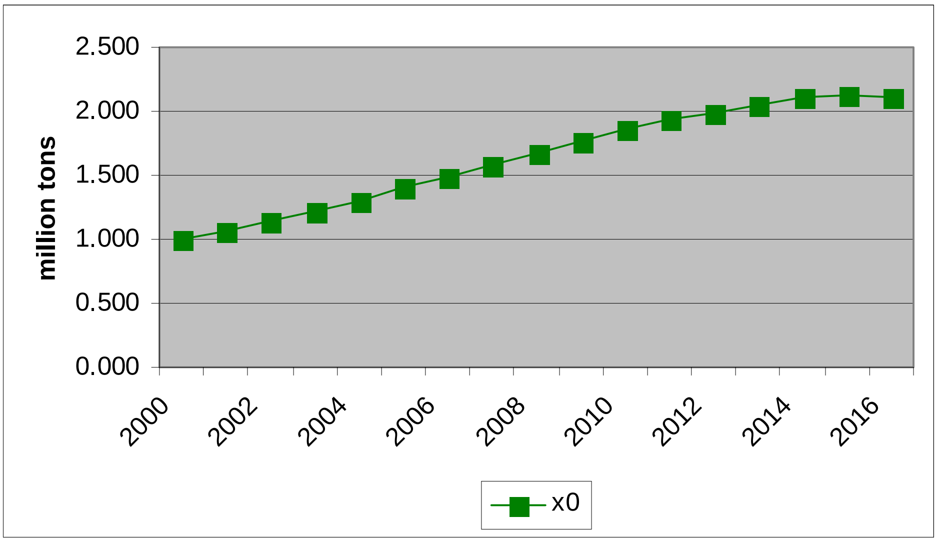

Figure 22: Predicted biomass per year.

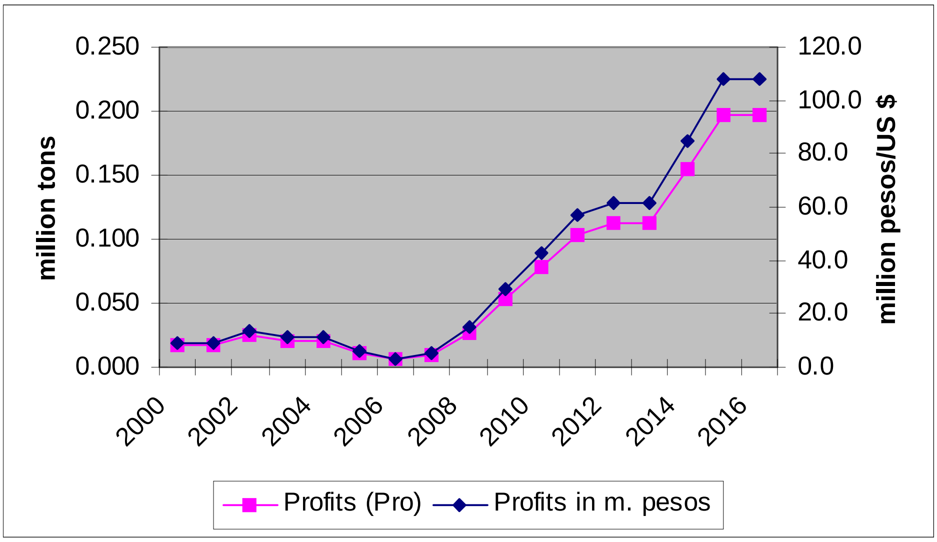

Figure 23: Estimated profits per year in terms of million tons of hake and in million pesos.

From the above figure it is clear that the fishery although profitable will not make important profits in the short term, in the long term the fishery will recover as the result of this policy.

8.1 Net present value

The formula utilized is:

$$NPV = \Sigma^{n}_{I=1}\ pro^{t} / (1 + r)^{t}$$

The parameter r is rate of discount and it was taken to be 10 %.
The net present value (NVP) of the proposed policy is estimated equal to 360 000 tons of hake or equal to 198 million pesos. Compared to the present situation of the hake fishing management where profits are equal to zero or even less, note that even with a high rate of discount and a low initial biomass, the NPV is not particularly high. From 2016 however, when biomass has been recovered, NPV is over 1 billion pesos.

8.2 Monitoring, control and surveillance system under ITQs

The plan will take for granted the fully implementation of the ITQ system for the hake fishery in Argentina. Experience all over the world suggests that ITQ systems offer a particularly simple way to achieve the highest possible success in the management of fisheries.

If TAC is set at the level near MSY, the biological risk of, and costs associated with, a stock decline is greater. However, if TAC is set at the proposed level (e*) and the fishing effort is significantly reduced, management will recover the resource and produce economic rent in the medium term.

The size of the fleet, number of landing ports, and frequency of landings influence the design of an approach of a fisheries monitoring system. By international standards

Argentina has a relatively small fleet, approximately 730 vessels, of which 290 catch hake equivalent to 198 ice trawlers vessels, and relatively few ports 18 in total but only 4 accommodate 86% of all landings in 1998. Thus, there should be good conditions for a cost-effective dockside monitoring system.

Catch and effort monitoring minimum requirements

A catch report with information about the area of catch (amount and type of fish) and effort must follow every trip and an integrated catch and effort dockside monitoring program needs to be established as well. About 30 to 40 well-trained inspectors could monitor and control landings. The agents would work on an as needed basis, 24 hrs/day and 7 days a week.

Note that the cost of providing a dockside monitoring service is greatly influenced by the industry's cooperation in scheduling the place and time of landing, and in providing convenient access to the catch. A long-term commitment to enforcement is required. Enforcement should focus on compliance/control. Though much of the work can be scheduled with the industry, budgets must be adequate to support field operations on a 24 hour basis where required.

To monitor catch activity, at sea monitoring is also required. Satellite tracking is a baseline tool to managing the EEZ. Since the last quarter of 1997, Monpesat devices (satellite tracking) track areas fished. At sea monitoring can also reduce incidence of discarding (unauthorized species) and high-grading (small fish). On board observers can be a practical option in monitoring fishing activity for at least every freezer and trawler vessel.

Training related to the new law and its ensuing regulations is suggested. It should be presented in the context of the underlying fisheries policy so that the inspectors understand the socio-economic context for the rules. Any new technologies have to be accompanied with adequate training.

Furthermore, in order to achieve the commitment to enforce, agreements or memoranda of understanding should be developed with the Coast Guard and Navy for the air and ship enforcement.

Agreements with Uruguay should be done through the Ministry of Foreign Affairs about monitoring measures within the Fishing Common Zone (FCZ). And also agreements within areas managed by international regulations as Antarctic Treaty (Tratado Antártico), Convention for the Conservation of Antarctic Marine Living Resources, etc.

An interesting task for a future research will be to define an optimal age to harvest by gear restrictions, mesh size restrictions, area closures, etc.

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APPENDIX 1: FISH AND FISH PRODUCTS AND ITS COMPETITORS. COMPARATIVE PRICES - 1996 (PESOS)

Product	Leading Mark	Second Mark	Sale
Fresh beef (cuadril)	4.15	3.85	3.69
Hamburger (frozen)	5.89	5.49	4.45
Chicken (whole)	3.45	5.84	1.65
Chiquenitos (fast food)	10.38	9.35	7.87
Hake fresh fillet (no bones)	4.30	4.00	3.89
Hake fresh fillet (bones)	3.50	3.15	2.80
Fillet IQF (no bones)	7.75	5.70	4.50
Fillet IQF (bones)	5.60	5.20	3.80
Fillet IQF breaded	8.25	6.90	6.13
Fish fingers	8.82	8.50	7.92

Source: SAGPyA - SSP, 1996

APPENDIX 2: HAKE FISHING MORTALITY (F) AT AGE

Year age	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0,0118	0,0029	0,0087	0,0060	0,0091	0,0173	0,0047	0,0167	0,0086
2	0,1615	0,0756	0,0920	0,1914	0,3047	0,2788	0,2056	0,3400	0,2805
3	0,2591	0,1694	0,2310	0,1770	0,3749	0,6564	0,4074	0,3382	0,6920
4	0,2945	0,1696	0,2179	0,2777	0,1589	0,4434	0,3200	0,5242	0,5225
5	0,2759	0,1805	0,2478	0,1724	0,2281	0,1160	0,3190	0,5870	0,5296
6	0,2765	0,1732	0,2322	0,2090	0,2540	0,4053	0,3488	0,4831	0,5813
7+g	0,2765	0,1732	0,2322	0,2090	0,2540	0,4053	0,3488	0,4831	0,5813
Av 3-4	0,2765	0,1732	0,2322	0,2090	0,2540	0,4053	0,3488	0,4831	0,5814

Source: INIDEP Documento Científico 3, 1994

APPENDIX 3: STOCK BIOMASS AT AGE (START OF YEAR). TONS *10**3

Year age	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	2.617.523	2.942.527	1.651.495	1.321.192	1.765.836	1.962.657	1.970.964	2.536.592	1.968.828
2	1.855.851	1.916.278	2.173.489	1.212.915	972.894	1.296.302	1.429.070	1.453.281	1.848.027
3	996.704	1.169.851	1.316.207	1.468.708	742.027	531.453	726.642	861.896	766.329
4	387.898	569.864	731.605	773.925	911.550	377.864	204.228	358.184	455.295
5	217.186	214.063	356.300	435.890	434.326	576.081	179.670	109.862	157.095
6	82.750	122.099	132.386	206.011	271.772	256.133	380.028	96.753	45.250
7+g	166.446	299.468	202.718	102.724	184.908	150.428	219.015	47.312	29.755
Total	6.324.358	7.234.150	6.564.200	5.521.365	5.283.313	5.150.918	5.109.616	5.463.880	5.270.579

Source: INIDEP Documento Científico 3, 1994

APPENDIX 4: STOCK BIOMASS AT AGE (START OF YEAR). TONS *10**3

Year age	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	574.965	505.879	353.816	322.582	414.459	446.328	458.269	602.694	890.209
2	719.216	701.224	840.206	477.937	380.460	494.358	562.411	589.655	726.570
3	527.665	578.491	666.698	757.839	388.652	269.813	382.562	469.966	413.212
4	260.275	364.069	440.551	478.588	577.567	234.998	130.320	234.364	294.721
5	161.836	155.448	262.098	330.152	294.851	407.329	132.965	84.925	121.336
6	67.953	103.646	113.493	185.856	238.097	200.721	312.459	83.278	42.023
7+g	282.358	366.304	289.865	166.210	224.453	171.270	344.994	95.186	40.514
Totbio	2.594.268	2.775.061	2.966.727	2.719.164	2.518.539	2.224.817	2.323.980	2.160.068	2.528.585

APPENDIX 5: ARGENTINE HAKE BIOMASS, TOTAL ALLOWABLE CATCHES AND LANDINGS IN TONS

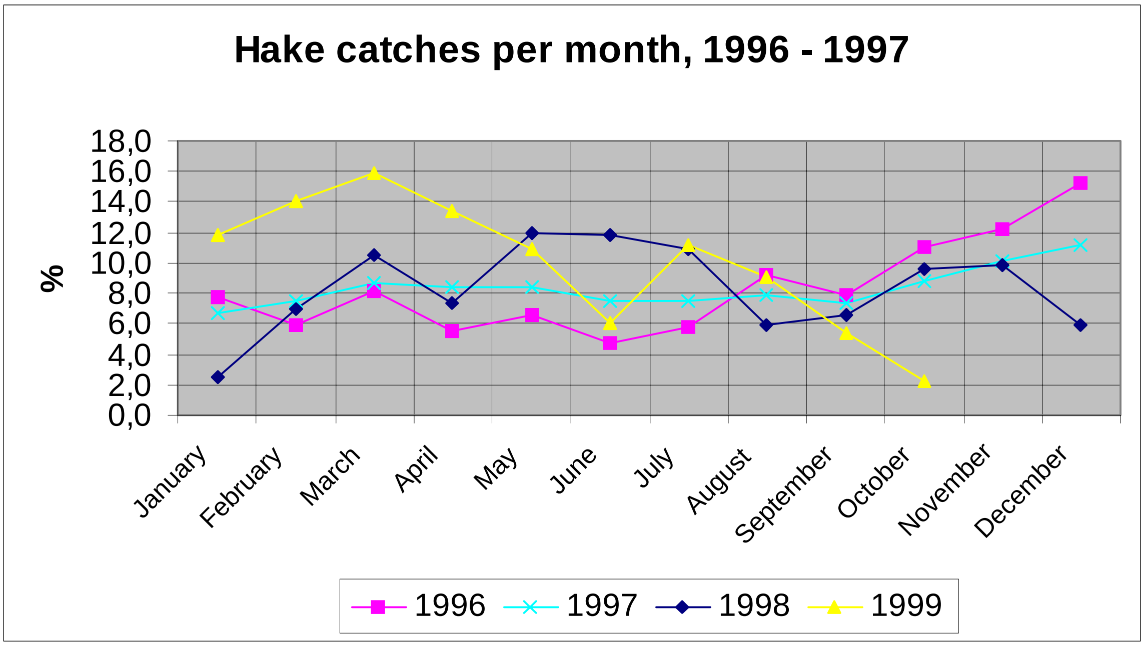
Year	Biomass	TAC	Landings
1993	2 060 502	390 000	422 195
1994	1 968 696	390 000	435 788
1995	2 128 767	398 000	574 314
1996	1 970 487	398 000	589 766
1997	1 546 632	395 000	584 048
1998	1 322 732	289 000	458 569
1999		238 200	245 121

Source: Based on data from SAGPyA and INIDEP

* Up to November 1999.

APPENDIX 6: ARGENTINE HAKE LANDINGS PER MONTH IN TONS, 1996 AND 1999 AND HAKE CATCHES

Month	1996	%	1997	%	1998	%	1999	%
January	45.715	7,8	39.334	6,7	11.450	2,5	27.672	11,9
February	34.772	5,9	43.756	7,5	31.762	6,9	32.735	14,1
March	47.836	8,1	50.842	8,7	48.273	10,5	36.932	15,9
April	32.366	5,5	49.111	8,4	33.597	7,3	31.348	13,5
May	38.433	6,5	48.819	8,4	55.123	12,0	25.471	10,9
June	28.231	4,8	43.844	7,5	54.205	11,8	13.937	6,0
July	34.392	5,8	43.828	7,5	49.795	10,9	25.958	11,1
August	54.487	9,2	46.246	7,9	27.213	5,9	21.181	9,1
September	46.438	7,9	42.694	7,3	30.289	6,6	12.404	5,3
October	65.254	11,1	51.459	8,8	44.172	9,6	5.218	2,2
November	71.976	12,2	58.787	10,1	45.331	9,9		
December	89.866	15,2	65.328	11,2	27.360	6,0		
Total	**589.766**	**100**	**584.048**	**100**	**458.570**	**100**	**232.856**	**100**



Source: SAGPyA - SSP, 1999