Falkland Island Fisheries Department

Fishery Report

Loligo gahi, First Season 2006

Fishery Statistics, Biological Trends and Stock Assessment

SUMMARY

First season (February/24-April/14, 2006) total catch by the *Loligo* fleet was 19056 tons, an intermediate catch level in relation to the catch of first seasons for the last 10 years. Total effort was 8521 hours of trawling, a low level similar to the last three years. Virtually all the catch was taken from the Beauchene area. Biological trends in proportion of mature individuals and proportion of females were similar to recent seasons, but squids were smaller than in previous years, with an average mantle length of 10 cm. Stock assessment was undertaken using FIFD implementation of the stock depletion model. Biomass at the start of the season was estimated at 38212 tons, whereas biomass at the end of the season was estimated at 16282. Using a stochastic biomass projection model, a total of 16495 tons were estimated as left in the sea as spawning biomass in the Beauchene area at a fixed spawning date (30th/May). We conclude that the management objective of leaving between 10 and 20 thousand tons of spawning stock in the sea after the season was met.

INTRODUCTION

We have continued applying the methods of stock assessment based on FIFD's implementation of the stock depletion model, as described in previous reports. In addition, we have improved the determination of the starting day of the depletion episode by analysing the movement of the fleet in relation to the assumption that the stock is fished in its whole spatial extension during the depletion episode. Also, we have applied a new stochastic version of the biomass projection model that allows predicting the biomass at the time of spawning, by updating the length structure of the stock, as well as total numbers, for every daily time step.

The first season of 2006 started on the 24th of February and lasted until the 14th of April. Our daily fishery statistics and biological data cover all this period, except for a five-day interruption of biological sampling. Almost all the fishing activity was carried out in the Beauchene area (Fig. 1), so the biological information as well as the fishery results and the stock assessment refer exclusively to this area.

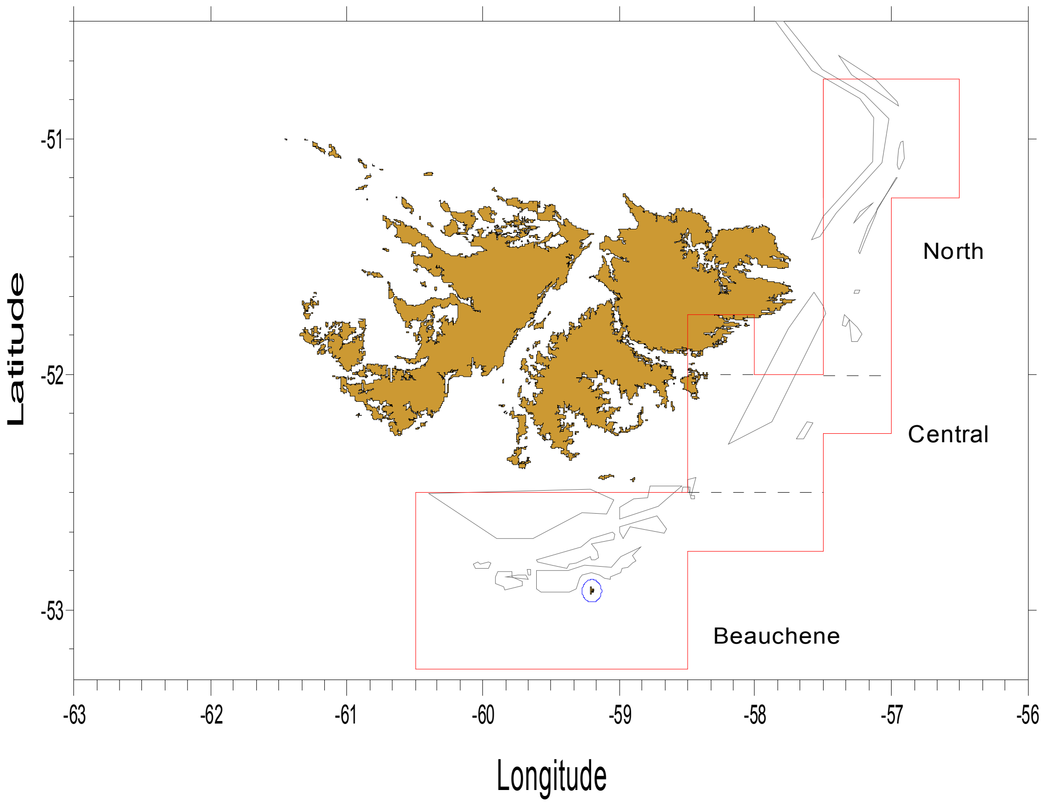

Fig. 1.- Fishing grounds and rocky bottom around the Falkland Islands. In red, the *Loligo* box, and in blue, the three-nm exclusion area around Beauchene Island.

PART 1 – FISHERY STATISTICS

Total Catch and Total Effort in Historical Perspective

This year catch in the first season was of medium level, lower than 2005 but greater than 2004, though if we consider all recorded history, catch followed a global decreasing trend (**Fig. 2 and Table 1**). This trend may not only represent squid abundance fluctuations but also changes in management. Fishing effort was similar to the three previous years and significantly lower than the years before 2003 (**Fig. 2 and Table 1**).

CPUE was lower than in the first season of 2005, but still was high in relation with the last 10 years (**Fig. 3 and Table 1**). There is a strong historical relationship between initial biomass and CPUE (**Fig.3**) although there have been methodological changes since the second season of 2004 and it is necessary to carry out a re-analysis of the old data.

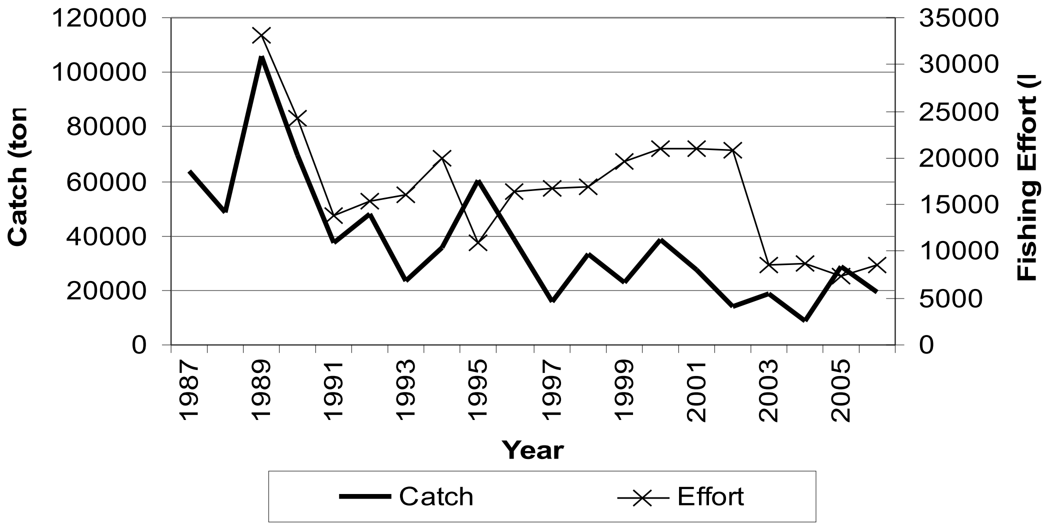

Fig. 2.- Historical catches and fishing effort of the first fisheries season.

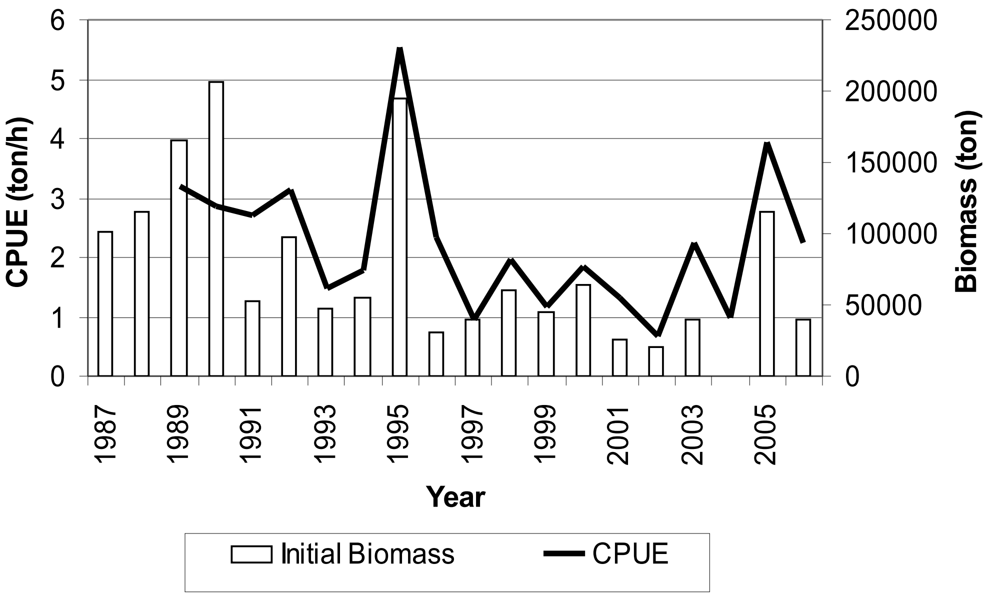

Fig. 3.- Historical CPUE and initial biomass of the first season.

Table 1.- Fishery statistics and initial biomass for the known history of the *Loligo gahi* fishery of the Falkland Islands. 'Failure' indicates that stock depletion model could not produce a reasonable estimate of initial biomass. From 1970 to 1985 the source is Csirke (1986), from 1987 to the present the source is either RRAG (for initial biomass up to 2003) or FIFD (catch and effort and initial biomass from 2004).

	First Fishing Season			Second Fishing Season			Annual
Year	Catch (ton)	Effort (h)	Initial Biomass (ton)	Catch (ton)	Effort (h)	Initial Biomass (ton)	Catch (ton)
1970							200
1971							100
1972							100
1973							250
1974							200
1975							140
1976							129
1977							354
1978							911
1979							925
1980							1111
1981							631
1982							18452
1983							38256
1984							36450
1985							36430
1986							
1987	64063		101000	18484		202000	82547
1988	48664		115000	5267		39000	53931
1989	106186	33159	165000	11671	16881	46000	117857
1990	69366	24177	206000	13624	15713	104000	82990
1991	37353	13808	53000	16462	16610	146000	53815
1992	48157	15406	97000	35227	19291	264000	83384
1993	23567	16065	47000	28711	32950	90000	52278
1994	35502	19891	55000	30254	29687	116000	65756
1995	60293	10913	195000	37486	22365	141000	98409
1996	38679	16438	31000	22694	28420	130000	61373
1997	15962	16766	40000	10159	18486	82000	26121
1998	33379	16835	60000	18178	22762	Failure	51557
1999	22863	19642	44826	12008	18266	53737	34871
2000	38713	21034	63683	25781	18869	Failure	64494
2001	27624	20955	26000	25935	19841	162234	53559
2002	14198	20824	21000	9513	11570	Failure	23711
2003	18973	8494	40350	28447	16166	Failure	47420
2004	8609	8740	Failure	18229	17024	62732	26838
2005	28747	7292	114878	30047	17658	47201	58794
2006	19056	8521	39218				

Catch and Effort per Fishing Ground and Cumulative Catch

Virtually all fishing was carried out in the Beauchene area and only a small amount of squid was caught in Central and North area (**Table 2**).

Table 2.- Effort and catch statistics of *Loligo* first season 2006 by fishing ground.

Fishing Ground (Area)	Total Catch (ton)	Effort (Vessel-Day)	Effort (hour)	Average CPUE ton/V-D	Average CPUE ton/h
Beauchene	18895	750	8377	25.193	2.256
Central	91	9	60	10.166	1.517
North	70	12	84	5.811	0.826
Total	19056	771	8521	24.716	2.236

The daily cumulative catch was closer to the best year during the first week but later this decreased to a medium level and finally was closer to the worst rather than to the best first season on record (**Fig. 4**). It is probable that the first week of fishing was highly successful because the fleet knew in advance, as a result of the research survey, where to find the highest concentration of squids.

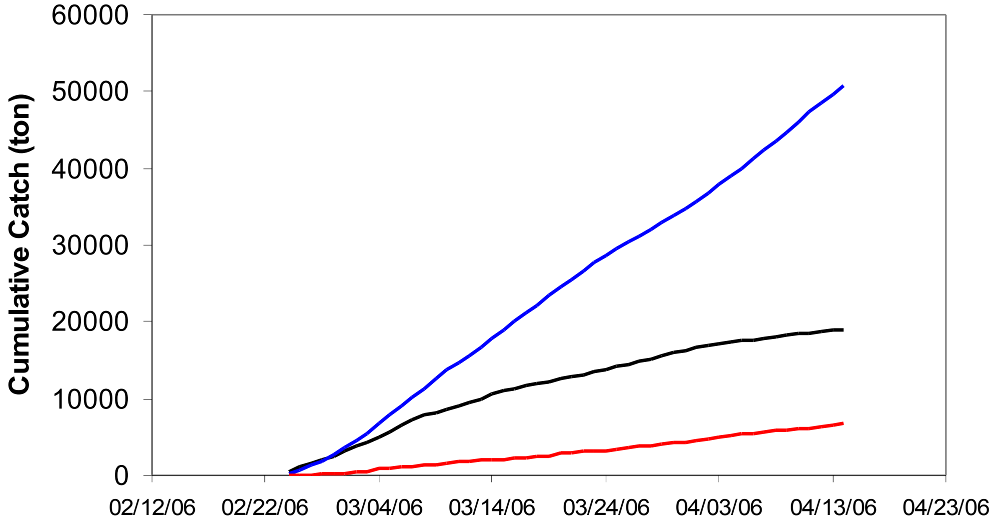

Fig. 4.- Cumulative catch versus date (mo/day/yr) in the first season of 2006 compared with the cumulative catch of the first seasons that yielded the highest and lowest historical catches on exactly the same date range.

Fleet Movement Dynamics, Catch and Catch Rate

Most of the time the fleet remained in the Beauchene fishing grounds, but at the end of the season there were occasional operations in the other areas (**Fig. 5a**). The small effort applied in central and north area had poor results and practically all the catch was made in the Beauchene area (**Fig. 5b**). During the first two weeks the CPUE was high (30-40 ton/vessel-day) and reached its maximum value on the 6th of March (54 ton/vessel-day) and then it declined until the end of the season (**Fig. 5c**). It seems that the advance knowledge of squid hot spots from the research survey was fairly useful from a purely fishing point of view, during the first two weeks.

PART 2 – BIOLOGICAL TRENDS

Biological trends of the stock were based on a sample of animals taken by one scientific observer onboard of commercial vessels. The observer takes a sample of approximately 400 animals per day. Unfortunately, during this season there were 5 days without observer data.

Comparison of Daily Mean Biological Characteristics with Recent Years

The proportion of sexually mature squid in the catch closely followed trends observed in the previous five years (**Fig. 6**). Most of the females were immature or maturing during the whole season. Conversely, males showed early signs of sexual maturation though still a majority remained immature. The sex ratio showed high variability but remained around the 0.5 value, as in most previous seasons (**Fig. 7**). The average dorsal mantle length, in both sexes, was about 10 cm during the whole season and was smaller than in the previous five years (**Fig. 8**). The dorsal mantle length distributions were uni-modals (**Fig.9**). There was a five-day interruption of the biological sampling that is shown on **Fig 9.**

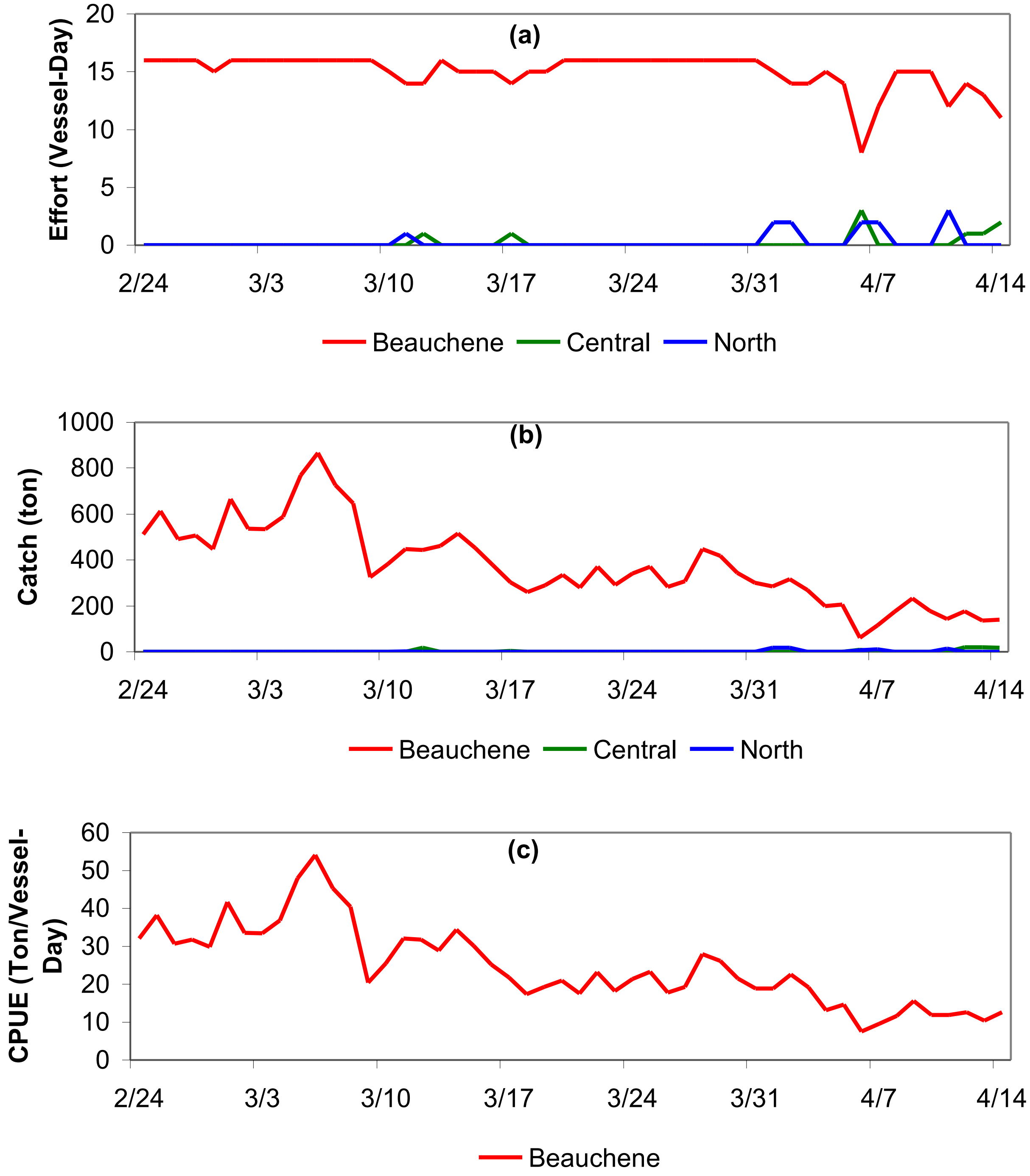

Fig. 5.- Daily evolution of effort (a), catch (b), and average catch per unit of effort (c) in the *Loligo* fishery during the first season of 2006.

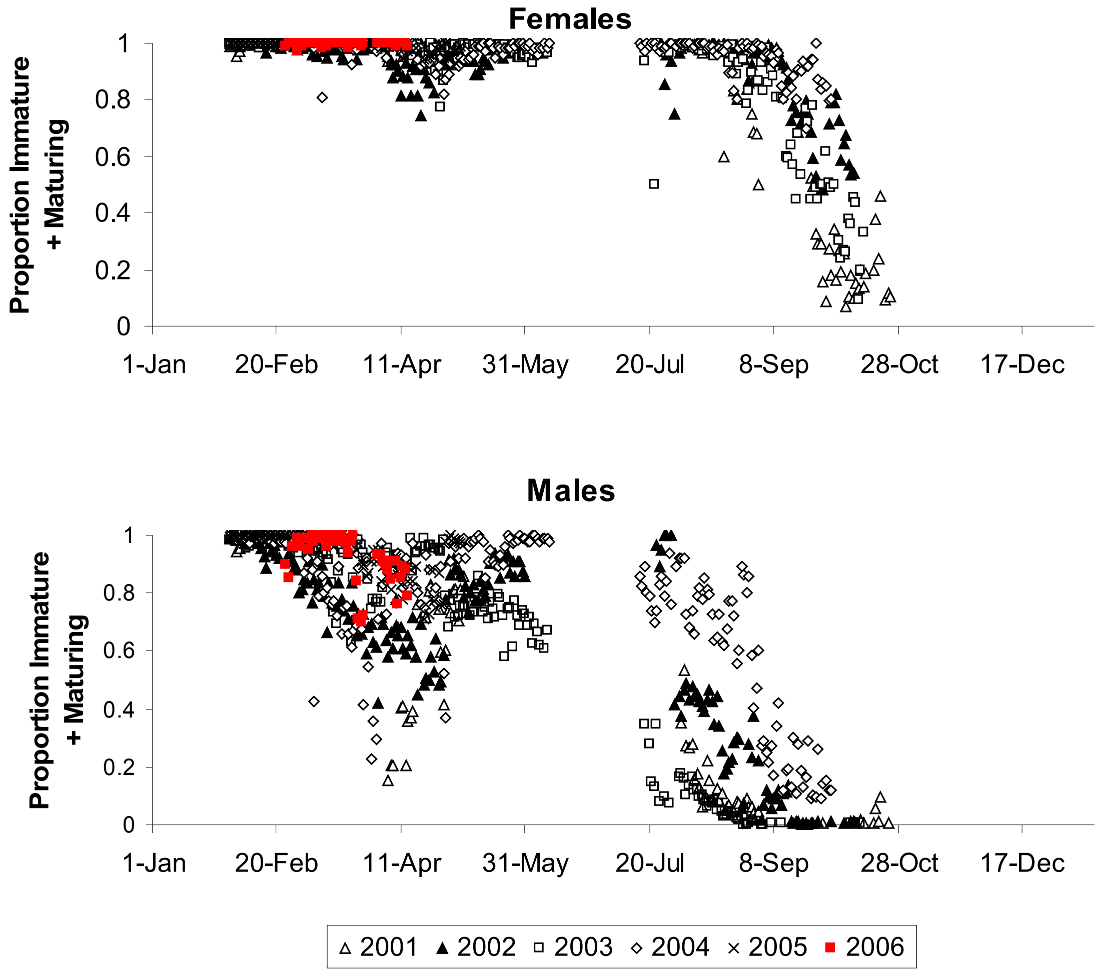

Fig. 6.- Current year trends in the proportion of sexually immature squids in the catch, compared with five previous years.

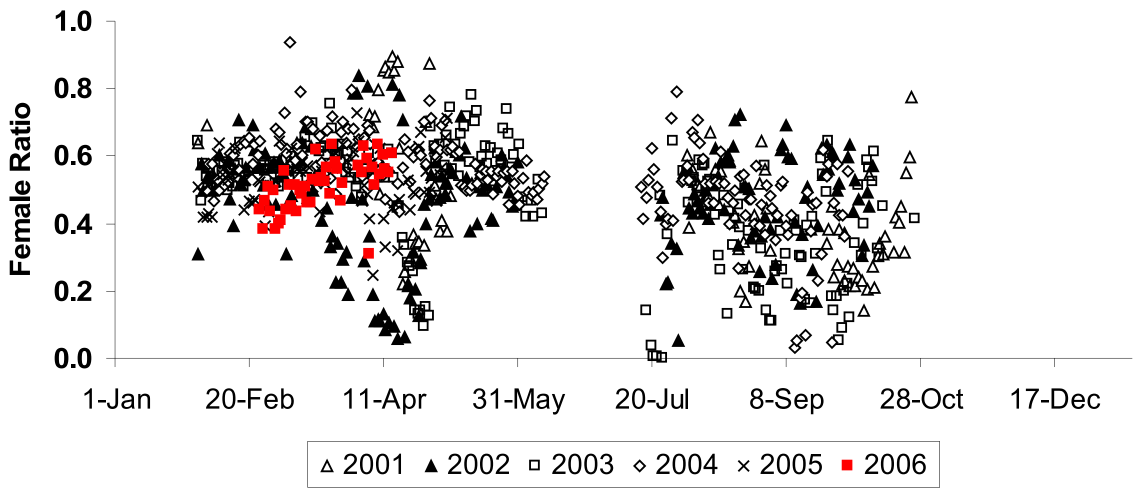

Fig. 7.- Current year trends in the daily evolution of the proportion of female squids in the catch, compared with five previous years.

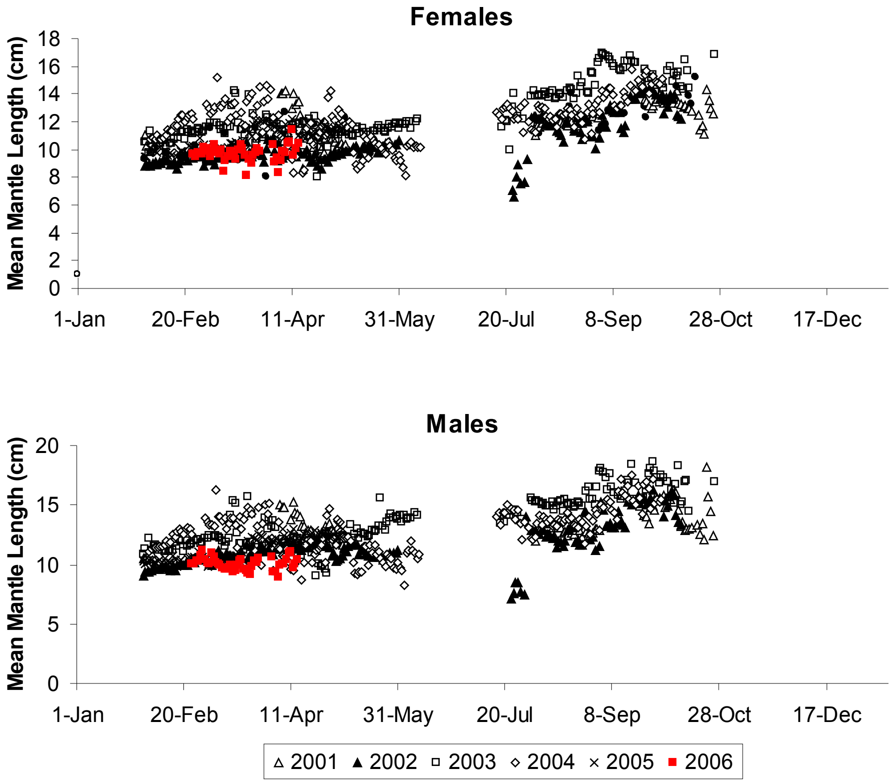

Fig. 8.- Current year trends in the mantle size by sexes, compared with five previous years.

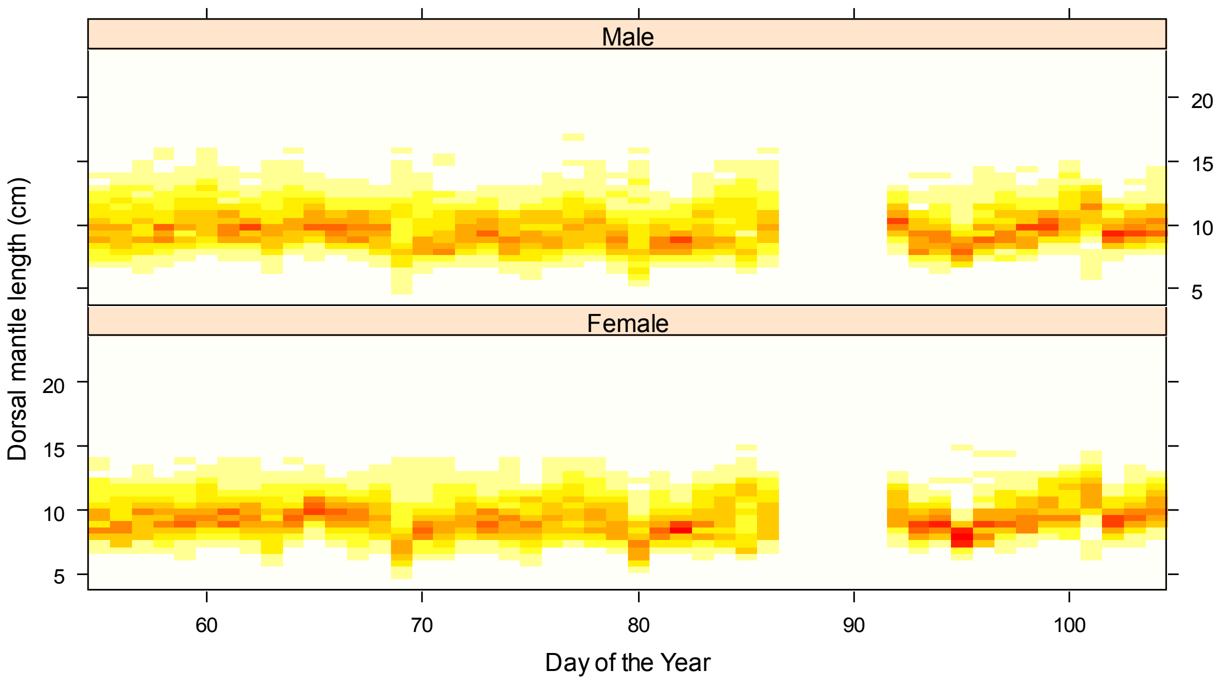

Fig. 9.- Time series of proportions of dorsal mantle length of squid in the catch during the first season, 2006.

PART 3 – STOCK ASSESSMENT

In the depletion stock-assessment model by daily time steps implemented by FIFD scientists, the starting day of the depletion process is recognized as a free parameter. Ideally, when the season starts the fleet disperses covering the whole spatial extension of the stock and starts depleting it by taking small bits from everywhere. In this case the starting day of the depletion process is identical to the starting day of the season. However, when there is pre-season information on specific locations of high stock abundance the fleet may not cover the entire extension of the stock in the first few days of the season. This seems to happen as a result of the pre-season surveys that have been introduced recently, as well as the old experimental licenses. To fix the starting day of the depletion process we have used the INMARSAT data on vessel location, choosing this day as a day close to the start of the season when the fleet disperses and cover the entire spatial extension of the stock. During the first season of 2006 the fleet fished almost exclusively in the Beauchene region, so the stock assessment results pertain to the extension of the stock in the Beauchene area only. **Fig. 10** shows the results of exploratory analysis of the INMARSAT data. We found a specific day when the fleet dispersed and covered the whole Beauchene area: the 8th of March. This was fixed as the starting day for the stock depletion model. Since the fleet dispersion at that day must be related to diminishing fishing yields, we have also plotted the relation between the variance of location (a measure of spatial dispersion) and catch per hour of trawling (**Fig. 11**). It can be seen that at yields of 3 ton/h or higher fleet location variance next day is minimum, i.e. skippers prefer to stay put. When plotting the yield for every time step (**Fig. 12**) it is observed that the yield threshold for dispersion is reached on the 8th of March, further supporting the choice of that particular day for the fit of the depletion model.

As in previous seasons since the implementation of FIFD stock assessment methods, the variation in daily catch in numbers was well captured by the stock assessment model (**Fig. 13**), although some extreme lows and highs are not explained by the depletion dynamics. Biomass decreased rather abruptly but the short season meant that when the end of the season was reached, biomass was at safe levels (**Fig. 14**).

The abundance of squid in numbers at the start of the season was high (more than half the abundance in the previous first season) though abundance in biomass was only moderate (**Table 3**). Biomass at the end of the season was well within the safe range (**Table 3**). Likewise, from the projection of the biomass at the end of the season to the presumed spawning rate, the spawning biomass was close to 17 thousand tons (**Table 4**).

CONCLUSIONS

1) Total catch (19056 tons) reached an intermediate level considering the last 10 years, while total effort (8521 hours of trawling) was of rather low level compared with the levels at the last 10 years.
2) Initial squid biomass presented at 8th of March was estimated in 38212 tons.
3) The spawning biomass left after the season was estimated as 16282 tons, so the management target, namely leaving 10 to 20 thousand tons of spawning biomass at sea, was met.

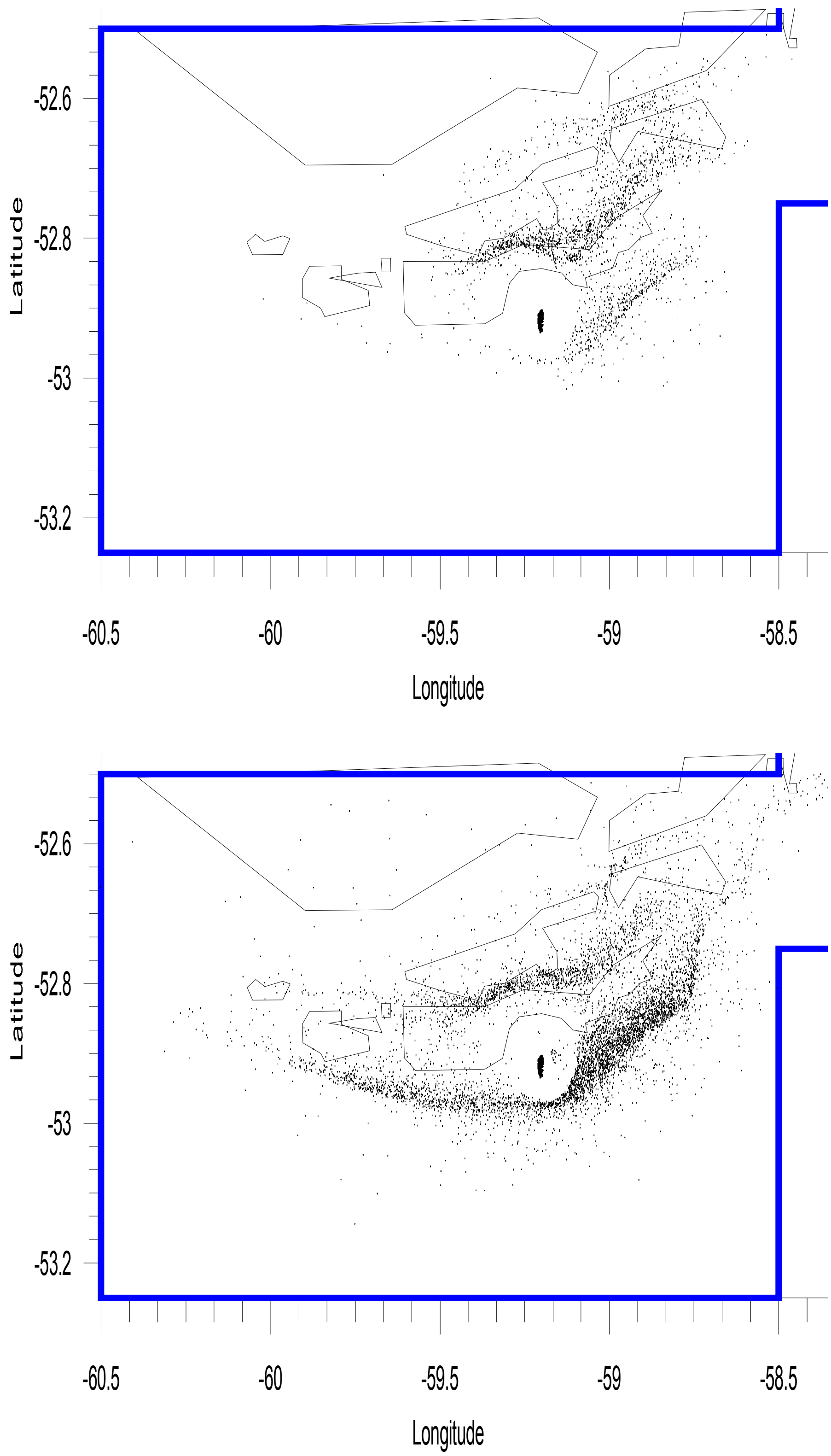

Fig. 10.- Vessel positioning data up to the 7th of March 2006 (top panel) and from 8th of March 2006 onwards (bottom panel).

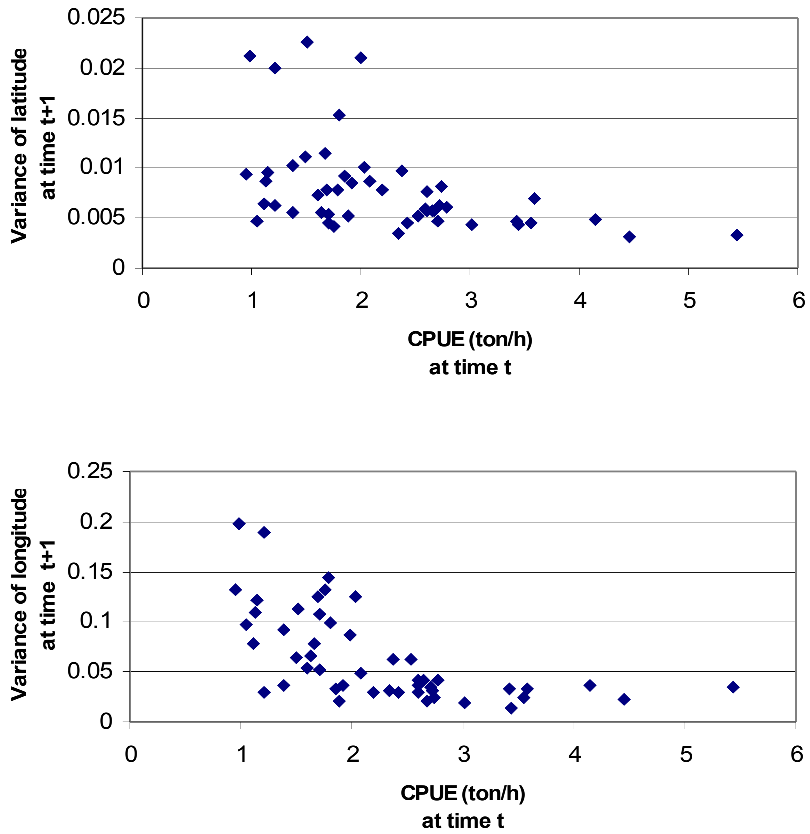

Fig. 11.- Dispersion of the fleet (variance of coordinate from INMARSAT data) and mean daily yield (ton/h). It is assumed that skippers react with a one-day delay.

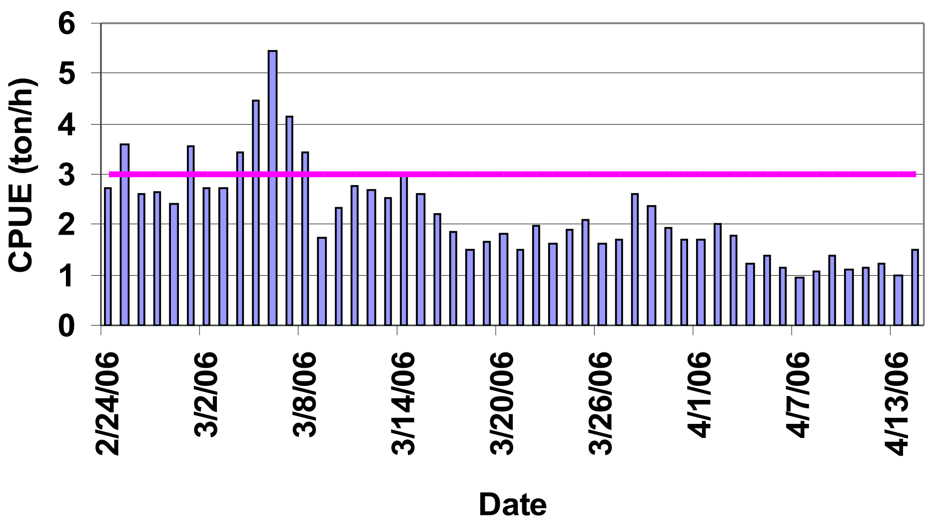

Fig. 12.- Daily evolution of the yield (bars) and threshold value (pink line) when the depletion process is assumed to start.

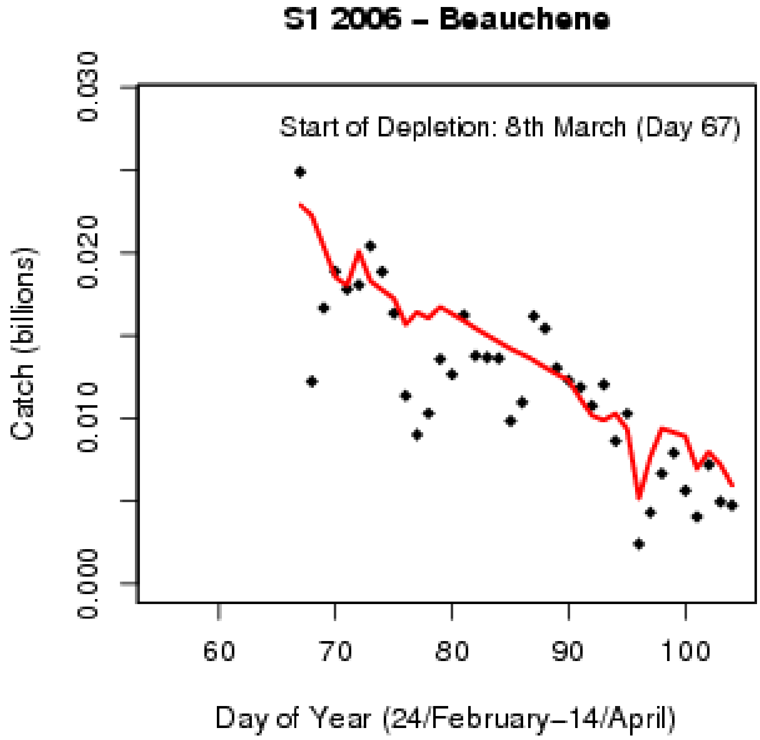

Fig. 13.- Observed (dots) and predicted (red line) daily *Loligo* catch in numbers according to FIFD implementation of the stock depletion model.

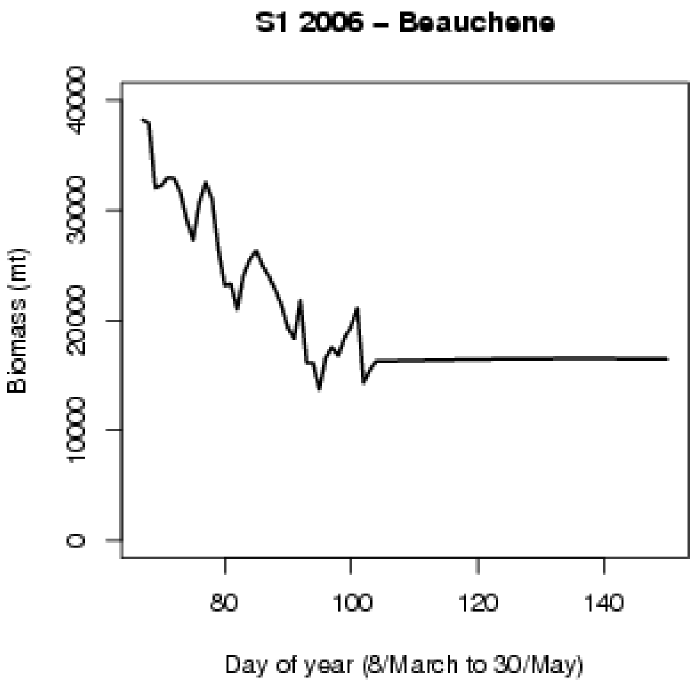

Fig. 14.- Daily evolution of stock biomass from stock depletion model and biological sampling by observers at sea.

Table 3.- Stock assessment of *Loligo gahi* in the Falkland Islands by a stock depletion model. Numbers in parentheses are the measures of statistical precision (coefficients of variation).

	2nd Season 2004			1st Season 2005		2nd Season 2005		1st Season 2006
Parameter	Beauchene	Central	North	Beauchene Inshore	Beauchene Offshore	Beauchene	North	Beauchene
Starting Date	15/07	16/08	28/07	10/03	22/03	10/08	21/07	8/3
Final Date	30/09	30/09	30/09	21/03	14/04	30/09	30/09	14/4
N° of days	66	16	58	12	24	52	39	32
Catchability	$6.0x10^{-4}$	$3.6x10^{-3}$	$2.6x10^{-3}$	$1.7x10^{-3}$	$6.1x10^{-4}$	$2.2x10^{-3}$	$2.1x10^{-3}$	$9.8x10^{-4}$
(1/vessel-day)	(49.7)	(8.4)	(38.5)	(0.6)	(10.7)	(0.9)	(9.7)	(34.2)
Initial numbers	$8.6x10^{-1}$	$1.5x10^{-1}$	$2.6x10^{-1}$	$8.5x10^{-1}$	2.3	$3.1x10^{-1}$	$3.9x10^{-1}$	1.47
(billions)	(9.3)	(21.2)	(48.5)	(12.9)	(5.7)	(4.1)	(14.8)	(5.5)
Initial biomass (ton)	44080	7775	13538	21816	82247	20274	25401	38212
	(62.2)	(74.4)	(58.2)	(53.0)	(55.6)	(59.9)	(60.2)	(53.1)
Final Numbers N_T	$2.3x10^{-1}$	$3.9x10^{-2}$ (84.9)	$4.3x10^{-2}$	$5.4x10^{-1}$	1.4	$6.0x10^{-2}$	$5.3x10^{-2}$	$5.6x10^{-1}$
(billions)	(30.2)		(21.1)	(54.0)	(3.6)	(14.3)	(98.4)	(2.5)
Final Biomass (ton)	16306	2758	3045	15594	52834	5264	4430	16282
	(67.6)	(104.2)	(64.0)	(55.7)	(56.2)	(63.6)	(75.6)	(54.0)

Table 4.- Biomass of squid projected from the end of the season with starting numbers as estimated from the stock depletion model. The numbers in parentheses are the measures of statistical precision (percentage coefficients of variation).

	Dates	Biomass (mt)
Second Season 2004	30/09 to 15/10	20250 (22.6)
First Season 2005	21/03[1] and 14/04[2] to 30/05	70114 (9.9)
Second Season 2005	30/09 to 15/10	8897 (41.9)
First Season 2006	14/4 to 30/5	16495 (9.1)

[1]Inshore Beauchene and [2]Offshore Beauchene