Falkland Island Fisheries Department

Fishery Report

Loligo gahi, First Season 2009

Fishery Statistics, Biological Trends, Stock Assessment and Risk Analysis

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- October 2009 -

INDEX

Page

I. SUMMARY

Loligo catch during the first season (February/24-Arpil/14, 2009) was 12764 tonnes, which was 48% less than in first season 2008 and 43% less than the average of the last 5 years first seasons. In the historical context, this season was of low-medium level. The 70% of *Loligo* catch was fished in southern area, 2% in the central area and 28% in northern area. The CPUE fluctuated between 7.7 and 37.9 tonnes/vessel-day, with maximum values of 26.9, 33.8 and 37.9 tonnes/vessel-day in the southern area and 37.9 tonnes/vessel-day in the central area. Biological trends in proportion of mature individuals and proportion of females were similar to previous first seasons. The average dorsal mantle length for the whole season was 12.1 cm (11 cm for females and 12.4 cm for males), which was similar to sizes in first seasons 2008 and 2007 and 2 cm larger than in 2006. Three squid groups arrived sequentially to the Beauchene area and two groups to the centre-north area. In-season stock assessment estimated a projected escapement biomass greater than 10000-tonne limit and therefore the season had a normal end. After-season stock assessment was done using the *Loligo* survey biomass as prior information in the Bayesian depletion model. The relative fishing powers were correlated with the gross registered tonnage (R^2=0.78) and the main engine horse power (R^2=0.68). The whole biomass that arrived to the fishing grounds was estimated at 38179tonnes, the survival spawning biomass was estimated at 15315 tonnes. The risk of leaving an escapement biomass less than 10000 tonnes was estimated at 0.1.

II. INTRODUCTION

The first season of 2009 started on the 24th of February and lasted until the 14th of April. This fishing season began the day after the *Loligo* survey, which estimated the biomass at 21636 tonnes in the whole *Loligo* box, but highly concentrated in southern area (Payá 2009). The fleet started fishing in the same place where the survey had found the best *Loligo* concentrations and had similar CPUE than the *Loligo* survey. The depletion of *Loligo* catches started from the beginning of the fishing season in the southern area. The catches were supported by three squid groups in the southern area, and two in the central-northern area.

Daily fishery statistics and biological data covered the whole fishing season, except for a two-day interruption of biological sampling. During first season 2008 a new site was opened to the fishery, which was restricted to the depth range of the natural northward continuity of trawling tracks that come from the central area. This area was added to the central area and therefore the boundary between the central and northern area was moved northward (Fig. 1).

In-season stock assessment was done using the last FIFD's implementation of the stock depletion model with includes several sequential depletion events by area (Payá 2007). In order to warn the fishing industry with two weeks in advance of any chance of early fishery closure the catch during these two weeks and the spawning biomass were projected and the risk of leaving less than 10000 tonnes was calculated.

In-season stock assessment did not show any significant risk that projected spawning biomass could be lower than 10000 tonnes and therefore the season had a normal end. After-season stock assessment was made using the biomasses estimated by the pre-season *Loligo* survey as prior information in the Bayesian depletion model. The whole biomass that arrived to the fishing grounds was estimated at 38179 tonnes and escapement spawning biomass was estimated at 15315 tonnes.

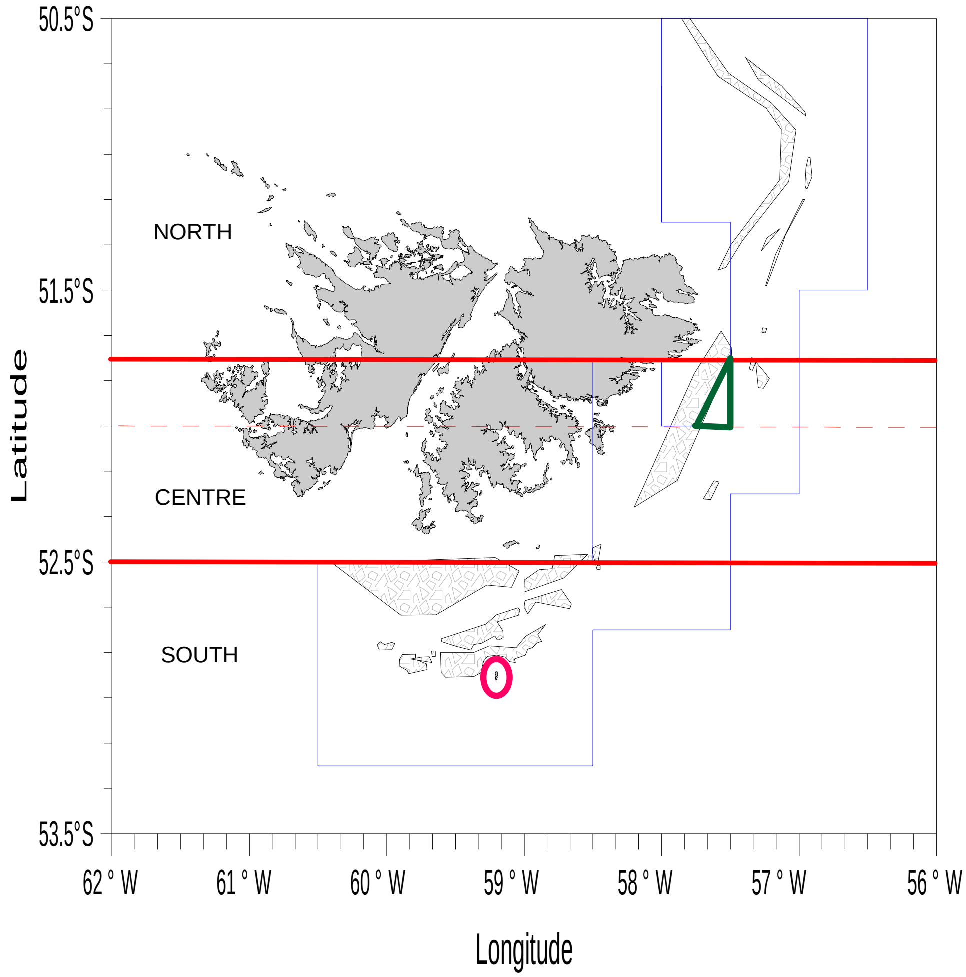


Fig. 1.- Fishing grounds and rocky bottom around the Falkland Islands. In blue, the *Loligo* box, in green, the new fishing area opened in 2008, and in magenta, the three-nm exclusion area around Beauchene Island. The border between the northern and central area was moved northward according to the new opened area, the previous border is shown by a broken red line

III. FISHERY STATISTICS

1. Total Catch and Total Effort in Historical Perspective

The whole catch in the first season was 12764 tonnes, which was 48% less than in first season 2008 and 43% less than the average of the last 5 years first seasons. In a historical perspective the decreasing trend stopped in 2004 and in the last six years the catches have been fluctuated around 20000 tonnes (**Fig. 2 and Table 1**). The fishing effort has been relatively constant since 2003 (**Fig. 2 and Table 1**).

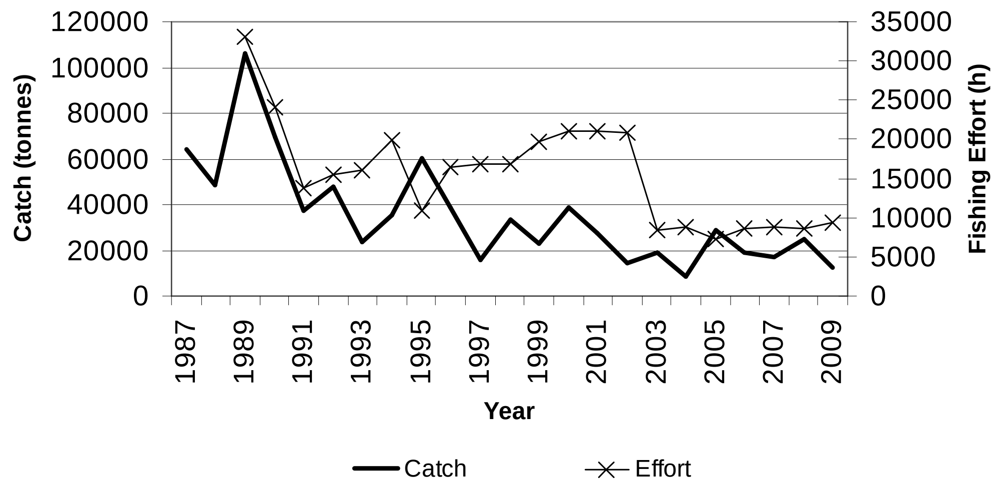
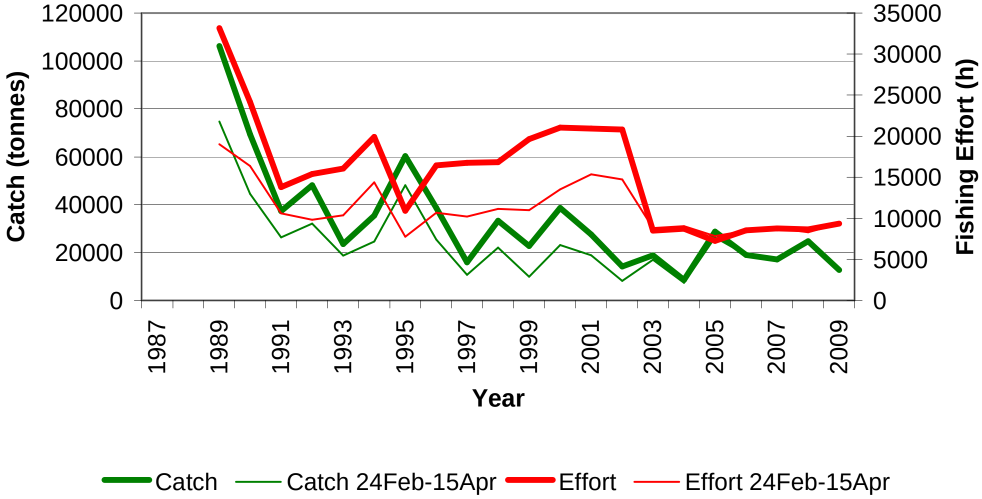


Fig. 2.- Historical catches and fishing effort of the first season.

In order to do historical comparisons, the catches, the fishing efforts and the CPUEs were calculated for the period from 24 February to 15 April, which corresponds to the length of the first seasons since 2003. The statistics of the vessels that had annual catches less than 100 tonnes were not included. The catches and fishing efforts during this period represented most of the total figures and therefore the CPUE trend for this period was similar than the CPUE trend for the whole first seasons (**Fig. 3**). The CPUE 2009 was 1.36 tonnes/h (47% of CPUE 2008), and stopped the increasing CPUE trend observed since 2003. Nevertheless, the CPUE 2009 was greater than the CPUE in 2004 and 1999.

There is a strong historical relationship between initial biomass and CPUE, although there have been methodological changes since the second season of 2004 and a reduction of the length of fishing seasons since 2003 (**Fig. 3**). The historical decreasing trend of CPUE stopped in 2002 and since then there has been an increasing trend, but variable. Since 2003, the biomass has been around 37000-40000 tonnes, except for 2005 and 2008, when it was 96000-115000 tonnes.



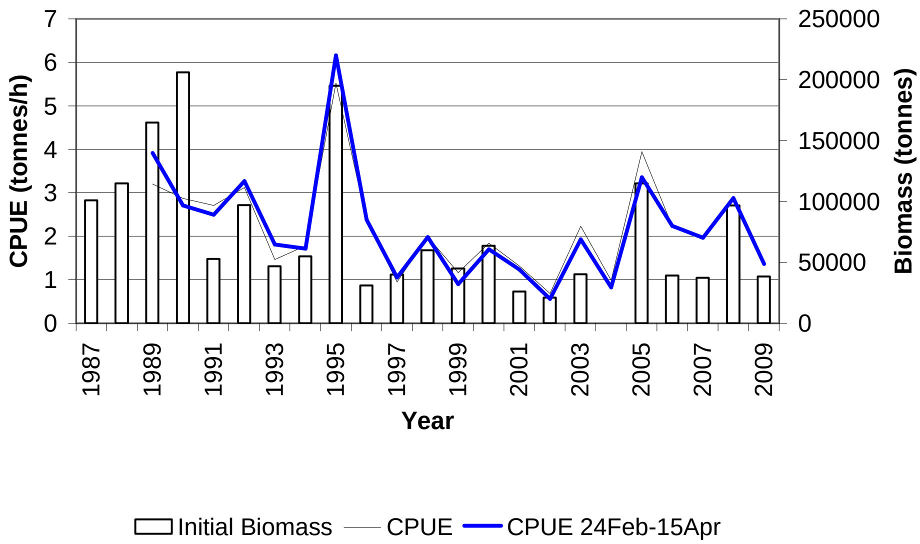


Fig. 3.- Historical catch and fishing effort (upper plot) and CPUE and initial biomass (down plot) of the first season. For comparisons the catch, effort and CPUE for the period 24 February to 15 April are also shown. Since 2007 the biomass is the sum of the biomass at the beginning of the season and the biomass of the squid groups that arrived during the 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). Since 2007 the initial biomass is the sum of the biomass at the beginning of the season and the biomass of the squid groups that arrived during the season.

Year	First Fishing Season			Second Fishing Season			Annual
	Catch (tonnes)	Effort (h)	Initial Biomass (tonnes)	Catch (tonnes)	Effort (h)	Initial Biomass (tonnes)	Catch (tonnes)
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	97779
1996	38679	16438	31000	22694	28420	130000	61373
1997	15962	16766	40000	10159	18486	82000	26121
1998	33379	16835	60000	18178	22762		51557
1999	22863	19642	44826	12008	18266	53737	34871
2000	38713	21034	63683	25781	18869		64494
2001	27624	20955	26000	25935	19841	162234	53559
2002	14198	20824	21000	9513	11570		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	23238	13150	26500	42294
2007	17229	8780	***37517***	24171	14740	48500	41400
2008	24752	8657	***96753***	26996	18489	40228	51748
2009	12764	9367	***38179***				

2. Catch and Effort per Fishing Ground and Cumulative Catch

The 70% of the squid were caught in southern area, 2% in the central area and 28% in the northern area (**Table 2**). The highest catch rates (1.6 tonnes/h) were achieved in northern area and the lowest ones in the central area (1.1 tonnes/h). The percentages of fishing effort by area were similar to the catch percentage per area.

Table 2.- Effort and catch statistics of *Loligo* first season 2009 by fishing ground.

Fishing Ground	Total Catch (tonnes)	Effort (Vessel-Days)	Effort (Hours)	CPUE (tonnes/V-D)	CPUE (tonnes/h)
Beauchene	8967	554	6929	16.187	1.294
Central	270	22	236	12.285	1.146
North	3526	195	2202	18.084	1.601
Total	12764	771	9367	16.555	1.363

The daily cumulative catch was at low-medium level compared with the highest and lowest historical figures (**Fig. 4**).

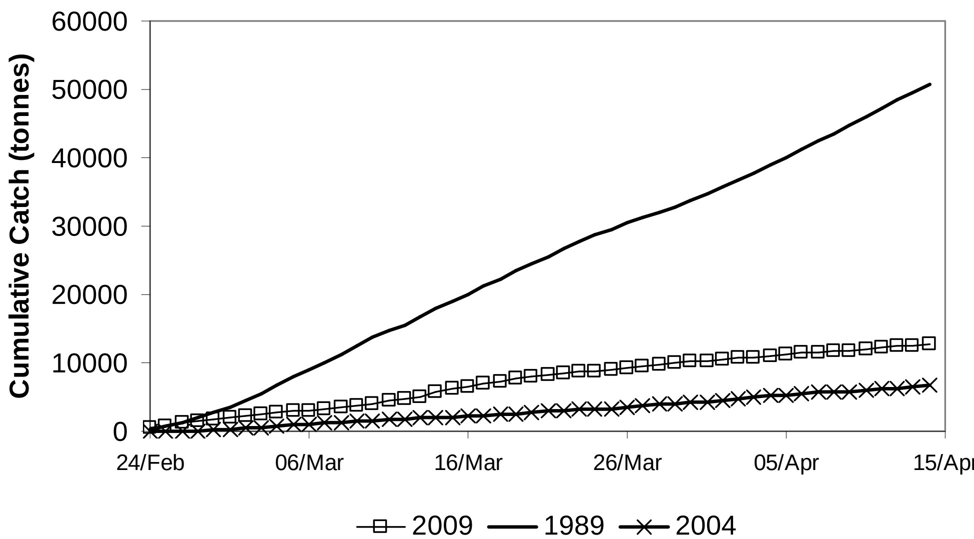


Fig. 4.- Cumulative catch versus date in the first season 2009 compared with the cumulative catch of the first seasons that yielded the highest (year 1989) and lowest (year 2004) historical catches on exactly the same date range.

3. Fleet Movement Dynamics, Catch and Catch Rate

The fleet was fishing mostly in the southern area during the first 3 weeks, in the northern area during the fourth week, in the southern area from the fifth to the seventh week, and in all the areas during the last week (**Fig. 5a**).

In the southern area, the daily fleet catch was 431 tonnes in the first day, then decreased during a week and increased again to 500 tonnes on the 11th of March, after that showed a decreasing trend (**Fig. 5b**). In the northern area, the highest daily fleet catch was 607 tonnes on 14th of March, and after that quickly decreased.

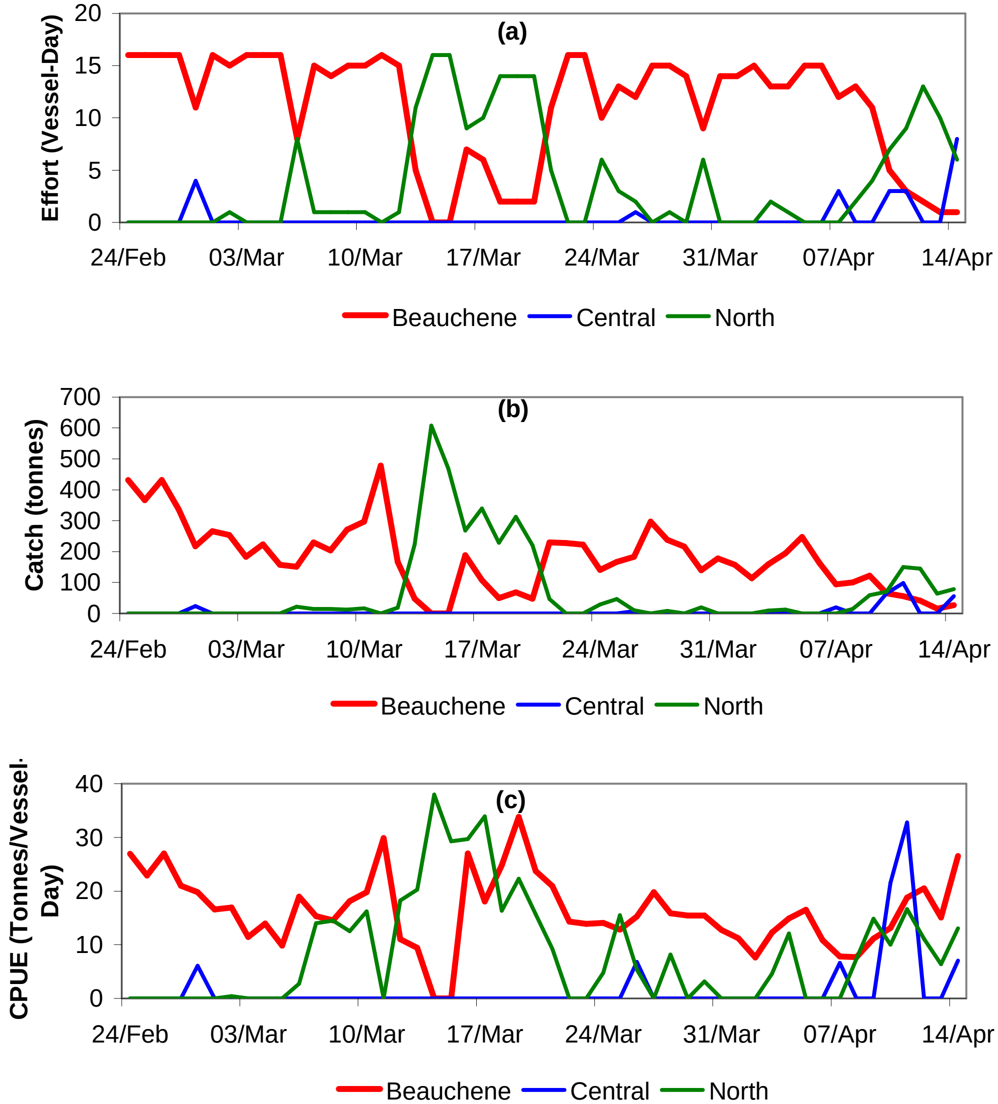


Fig. 5.- Daily evolution of effort (a), catch (b), and average catch per unit of effort (c) in the *Loligo* fishery during the first season of 2009.

In the southern area, the CPUE was 27 tonnes/vessel-day at the first day and then decreased to 9.8 tonnes/vessel-day on the 5th of March, after that the CPUE increased and had the highest levels at 30 tonnes/vessel-day on the 11th of March and at 33.8

tonnes/vessel-day on the 18th of March. After that the CPUE decreased to 7.7 tonnes/vessel-day on 4th of April, and then increased again up to 26.5 tonnes/vessel-day on the last day (**Fig. 5c**). In the northern area, the CPUE increased until to reach 37.9 tonnes/vessel-day on 14th of March and then quickly decreased.

The analysis of the fleet movement based on e-logbooks, showed the sequential arrivals of three *Loligo* groups in the southern area, two in the central-northern area. In the first day the fleet fished in the southern area in locations where the *Loligo* survey had found the highest squid concentrations (**Fig. 6).** In comparison with the first season 2008 the trawls were done in deeper waters (**Fig. 7**). A second squid group appeared in the southern area on the 11th of March in the same fishing grounds that the previous group (**Fig. 8**). The fleet fished in these fishing grounds until the 7th of April (**Fig. 9**). During the last days of the season one vessel remained in the southern area and found an increasing CPUE in shallower fishing grounds close to the north-east of Beauchene Island (**Fig. 10**). This suggests that a new squid group was arriving into the southern area at the end of the season. In the northern area, the first *Loligo* group was found in shallow waters on the 14th of March (**Fig. 11**), and a second one on the 11th of April in intermediate depths (**Fig.12**). The fleet remained fishing in this fishing ground until the end of the fishing season (**Fig. 13**).

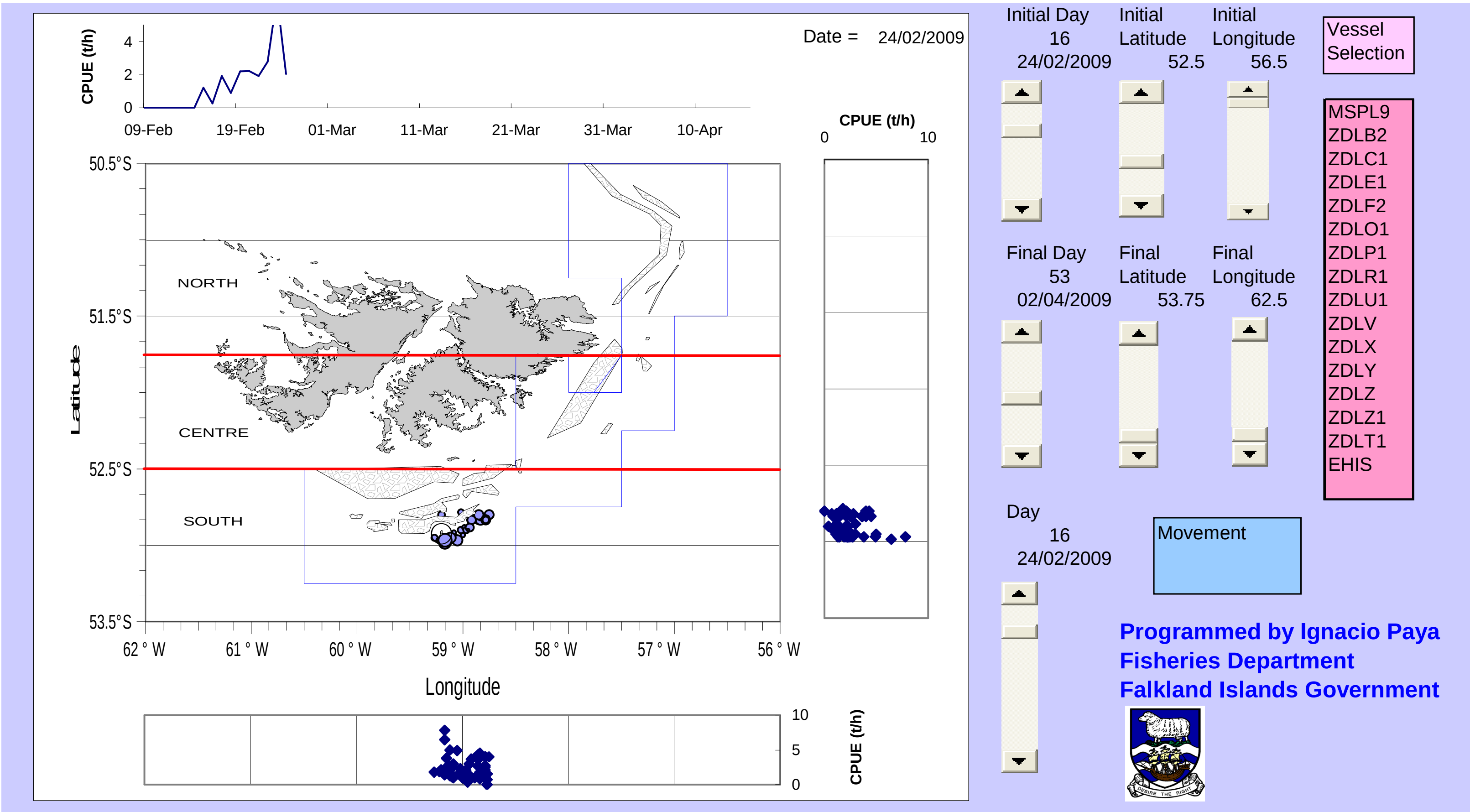


Fig. 6.- On the 24th of February, the first fishing day, the fleet was concentrated in the southern area, where *Loligo* trawl survey had found the best aggregation. The graphical interface displays the fleet movement and CPUE (tonnes/h) and has been described in previous reports.

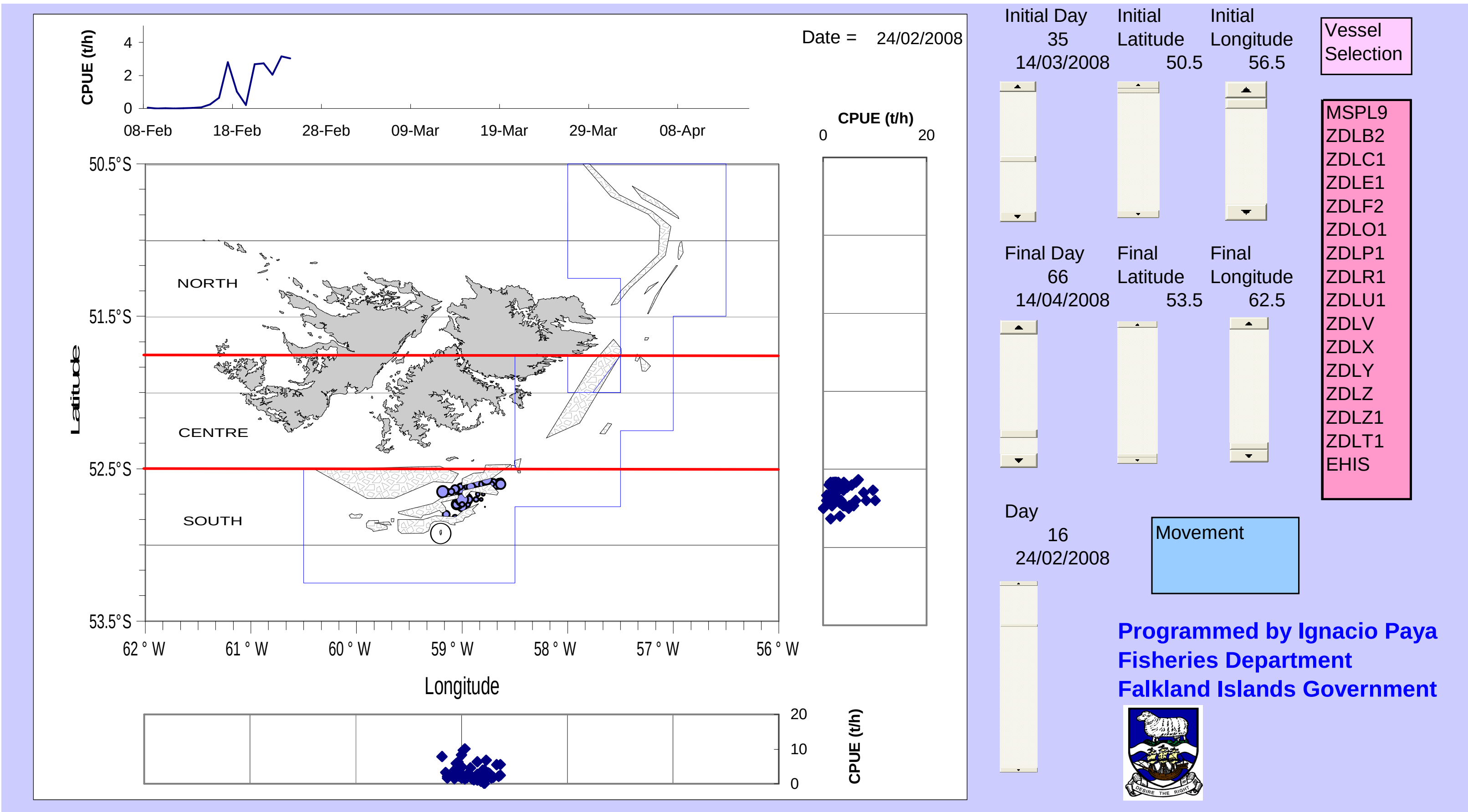


Fig. 7.- On the 24th of February of 2008, the first fishing day, the fleet was concentrated in the southern area**.**

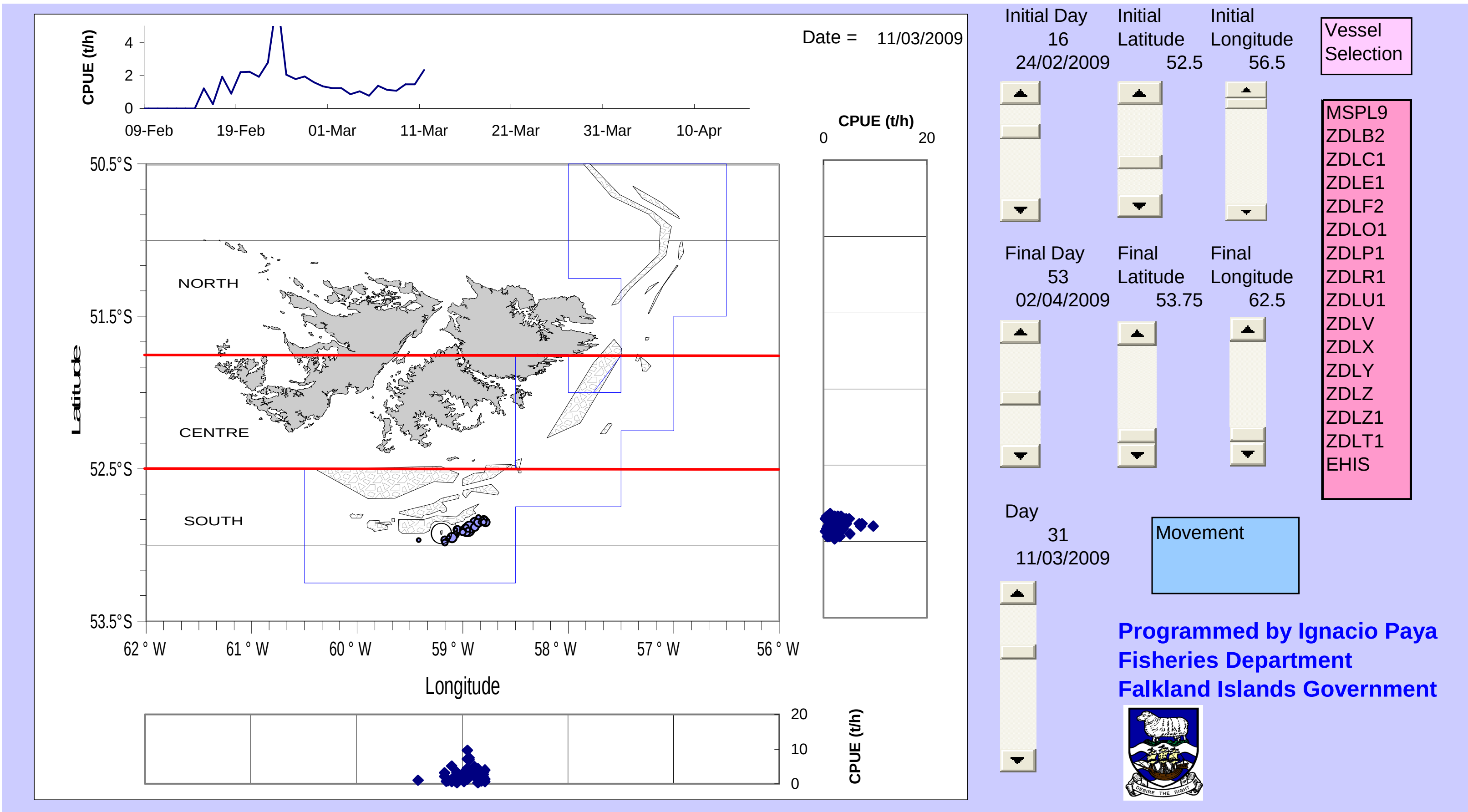


Fig. 8.- On the 11th of March, another squid group appeared in the southern area (only southern area is shown).

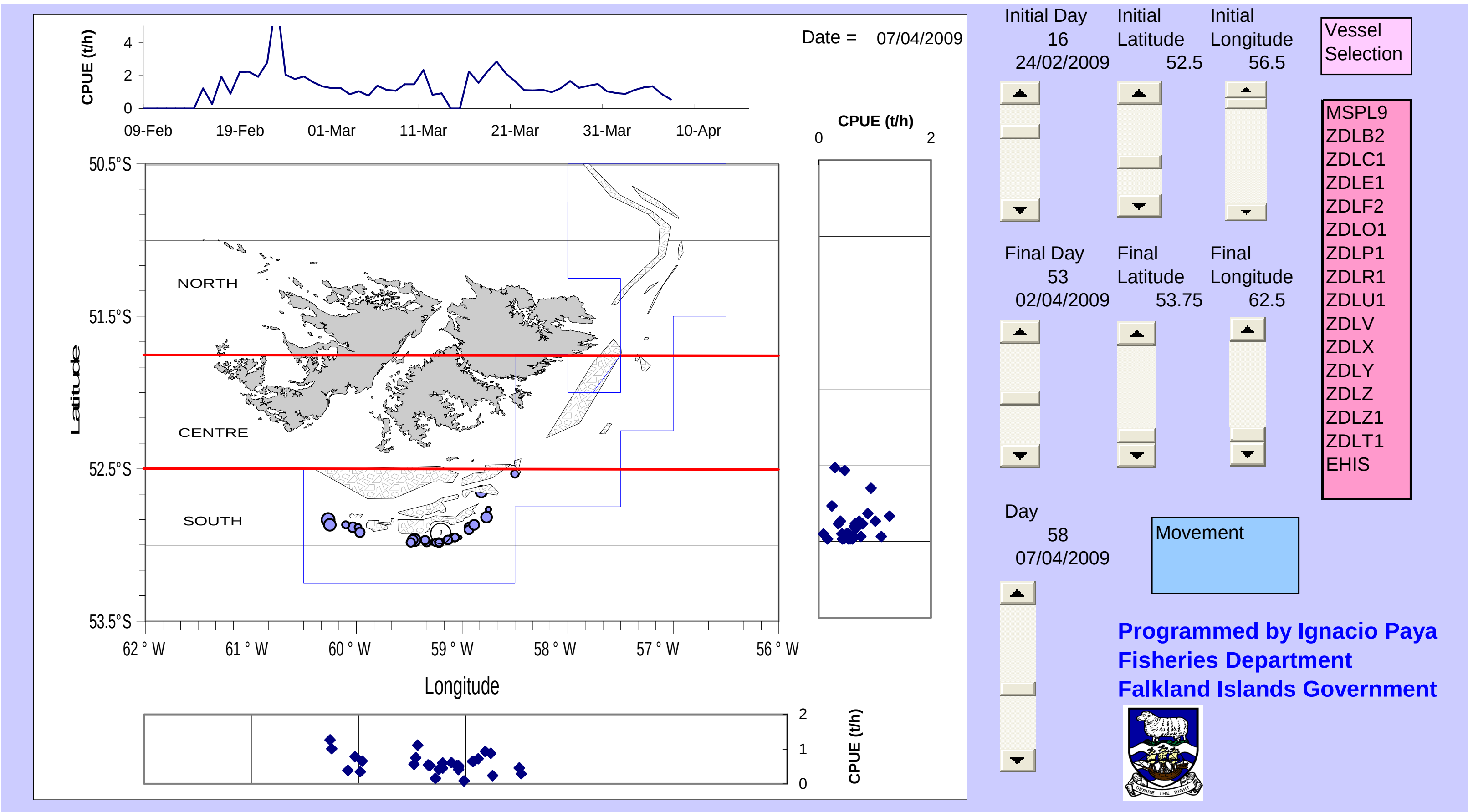


Fig. 9.- On the 7th of April, the CPUE in the southern area were low and the fleet fished in deep waters (only southern area is shown).

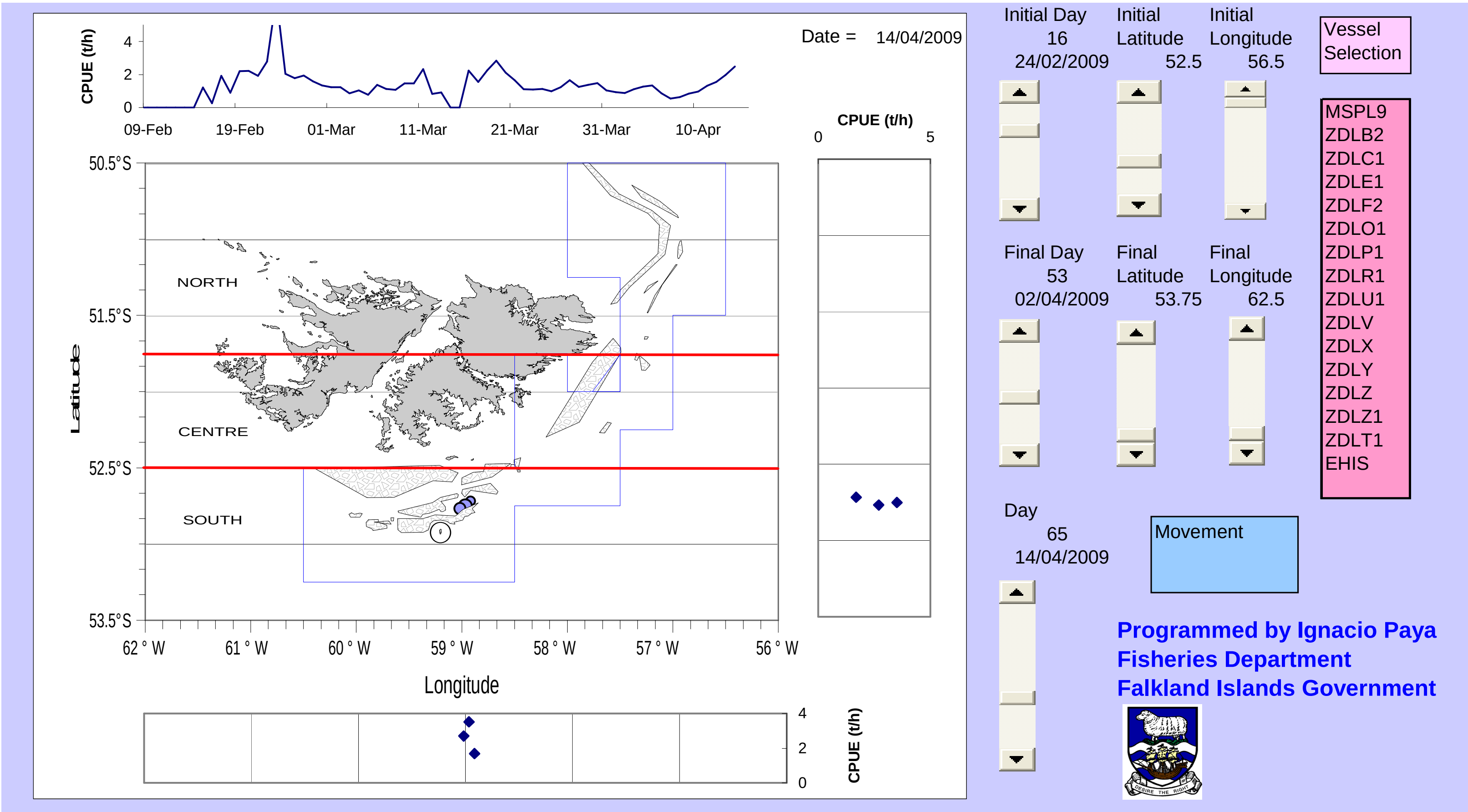


Fig. 10.- On the last two days only one vessel fished in the southern area and have good CPUE (only southern area is shown).

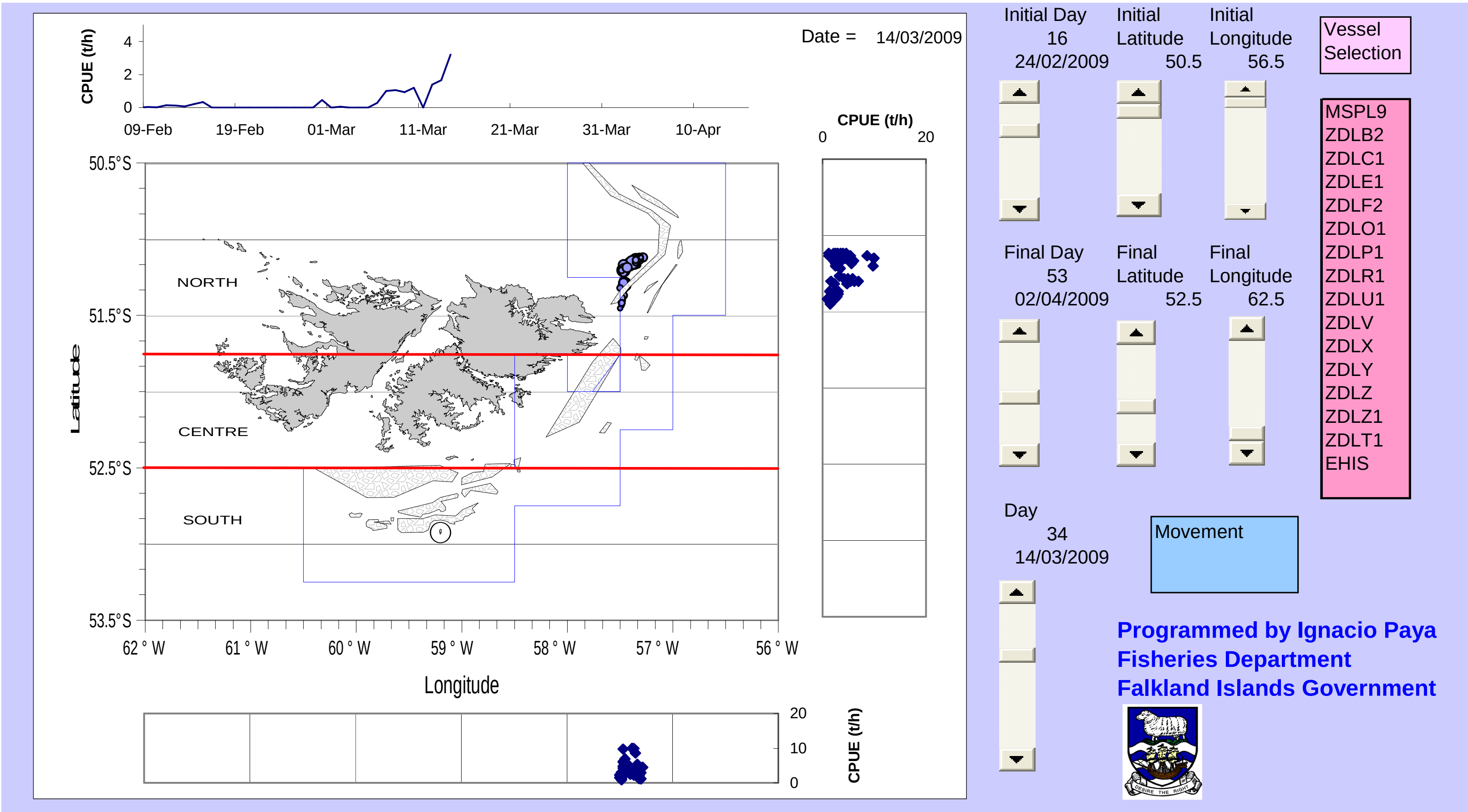


Fig. 11.- On the 14th of March, the first *Loligo* group in the northern area was found at shallow waters (only centre-north area is shown).

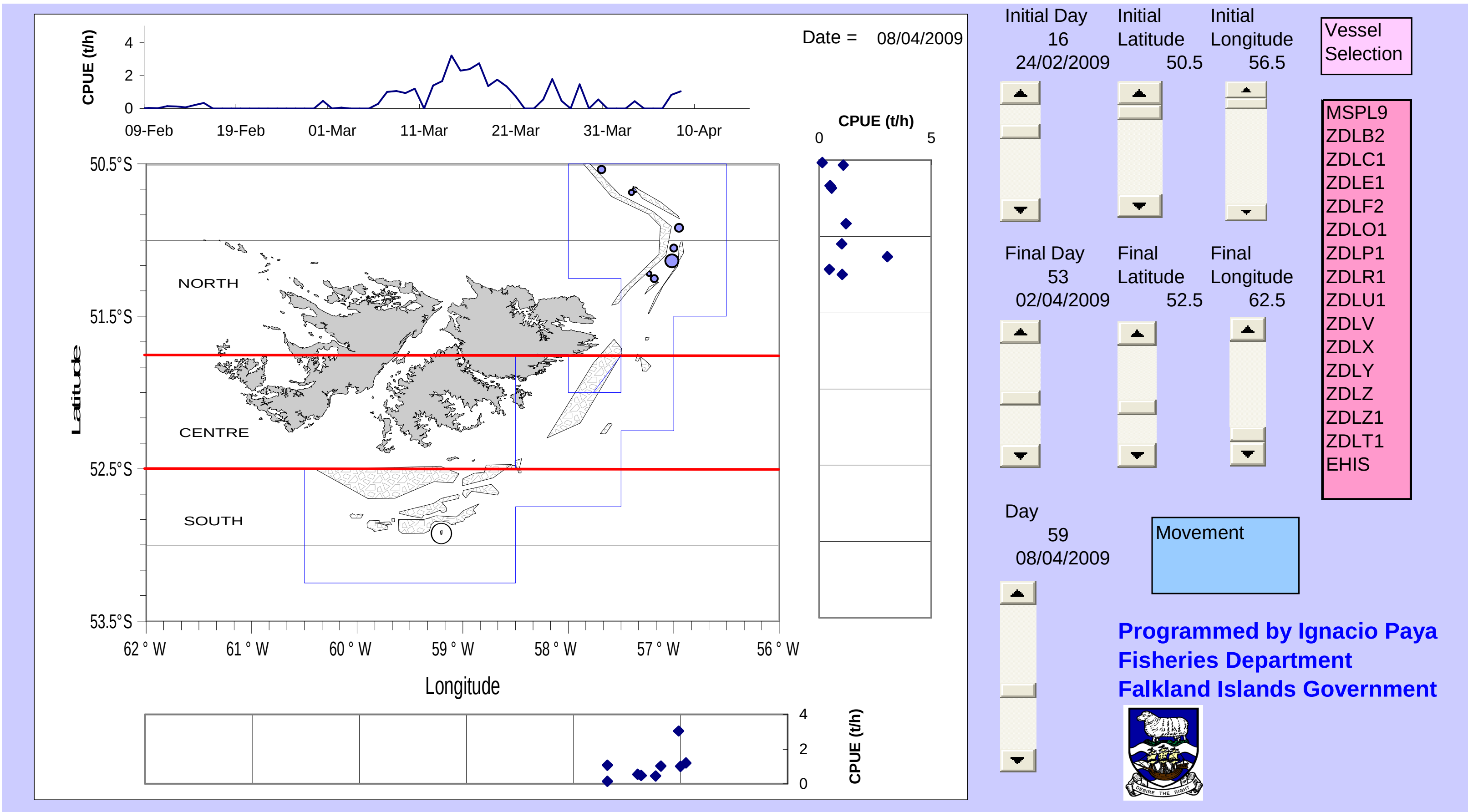


Fig. 12.- On the 8th of April, the second *Loligo* group was found in northern area at intermediate depths (only centre-north area is shown).

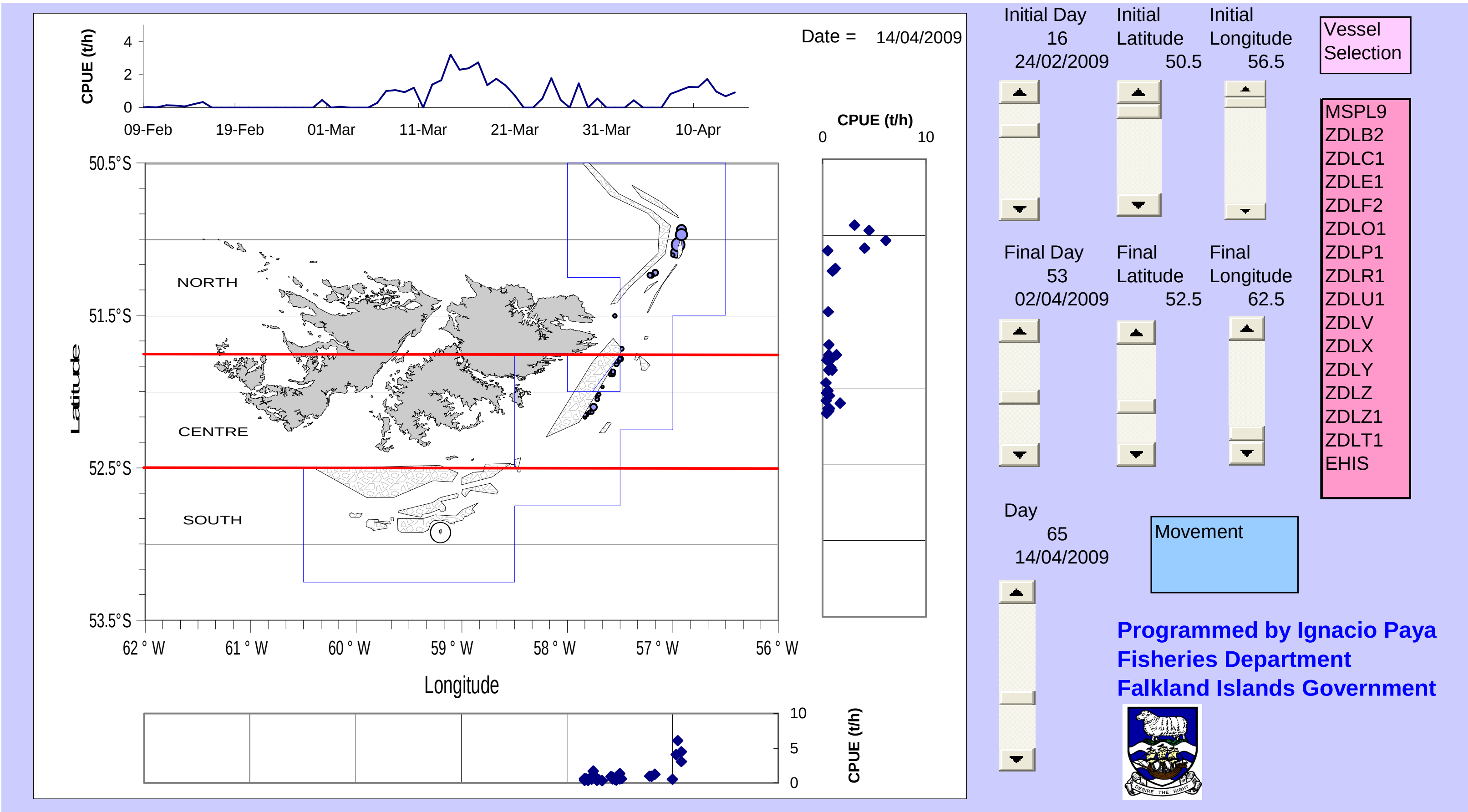


Fig. 13.- On the last day, 14th of April, the fleet fished in the central and in the northern area and had low CPUE (only centre-north area is shown).

IV. BIOLOGICAL TRENDS

Biological trends of the stock were based on sampling taken by scientific observers onboard of commercial vessels. From the start of the season until the 25th of March one observer was onboard and after that two observers were onboard. The observers took a sample of approximately 400 animals per day. There were only two days without biological samples.

1. Comparison of Daily Mean Biological Characteristics with Recent Years

The proportion of sexually immature squid in the catch followed trends observed in the first seasons of the previous six years; both females and males were mostly immature or maturing (**Fig. 14**). The female proportion in the catches increased during the first week and then decreased, but most of the values were between 0.4 and 0.6 (**Fig. 15**). The average dorsal mantle length for the whole season was 12.1 cm (11 cm for females and 12.4 cm for males), which was similar to the ones in first seasons 2008 and 2007 and 2 cm larger than in 2006. The average dorsal mantle length of the females showed a slightly increasing trend during the whole season, but in males the length decreased during the last 2 weeks of the season (**Figs. 16 and 17**). The dorsal mantle length distributions were most of the time uni-modals (**Fig. 17**).

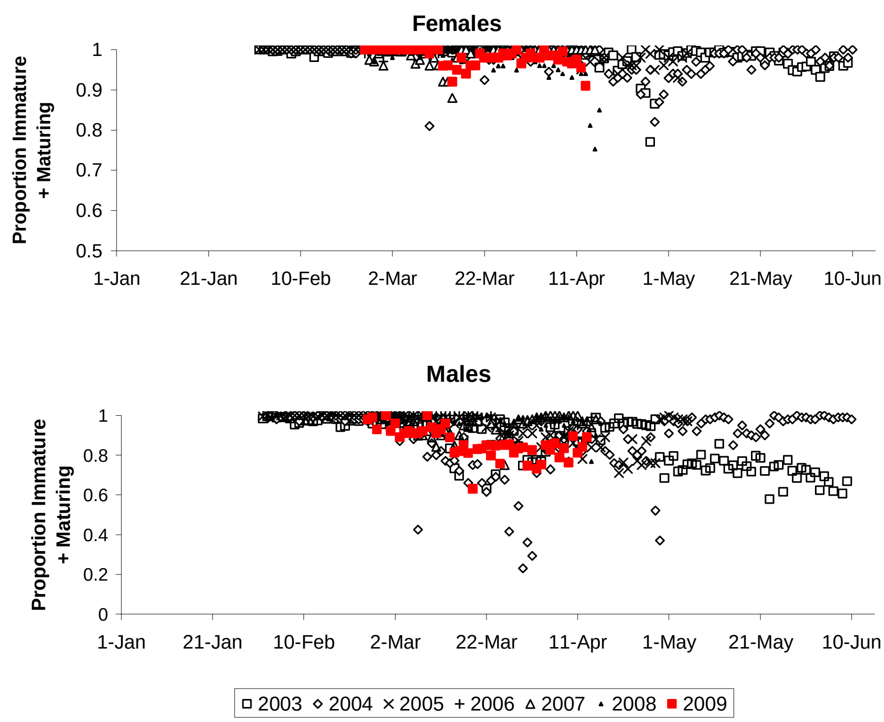


Fig. 14.- Current year trends in the proportion of sexually immature squids in the catch, compared with six previous years.

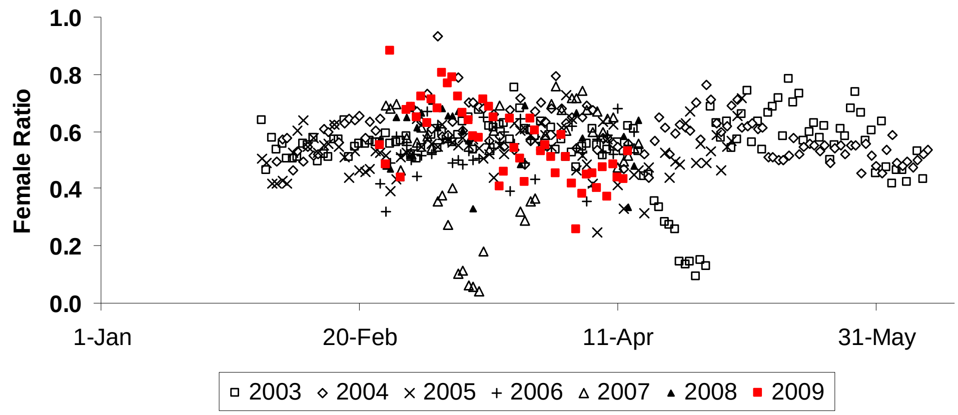


Fig. 15.- Current year trends in the daily evolution of the proportion of female squids in the catch, compared with six previous years.

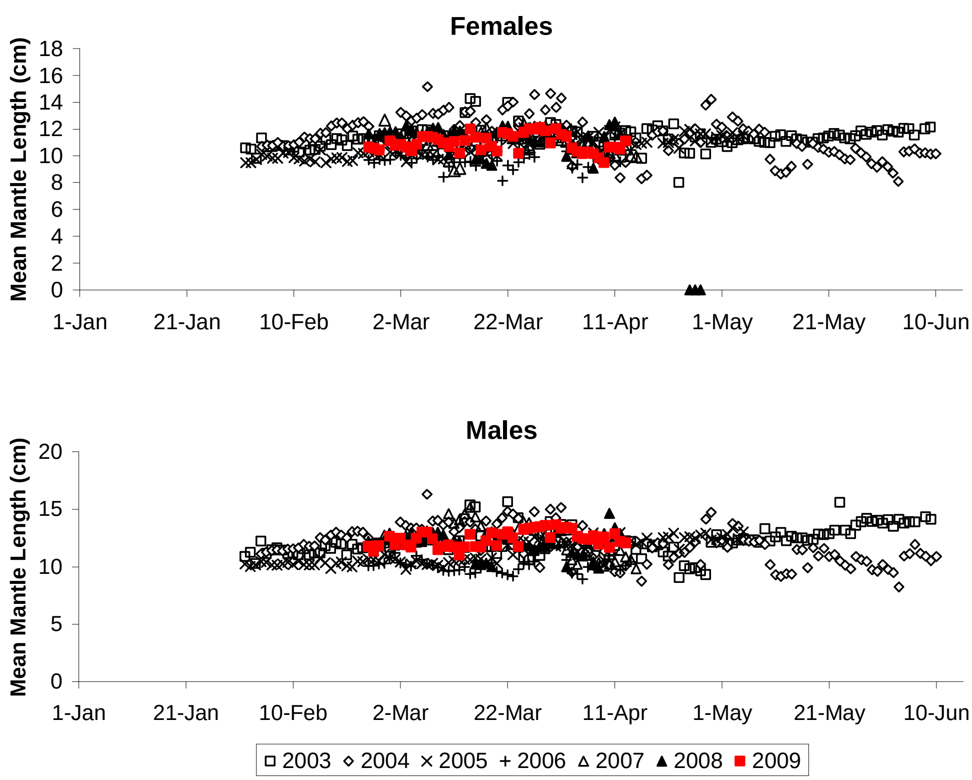


Fig. 16.- Current year trends in the mantle size by sexes, compared with six previous years.

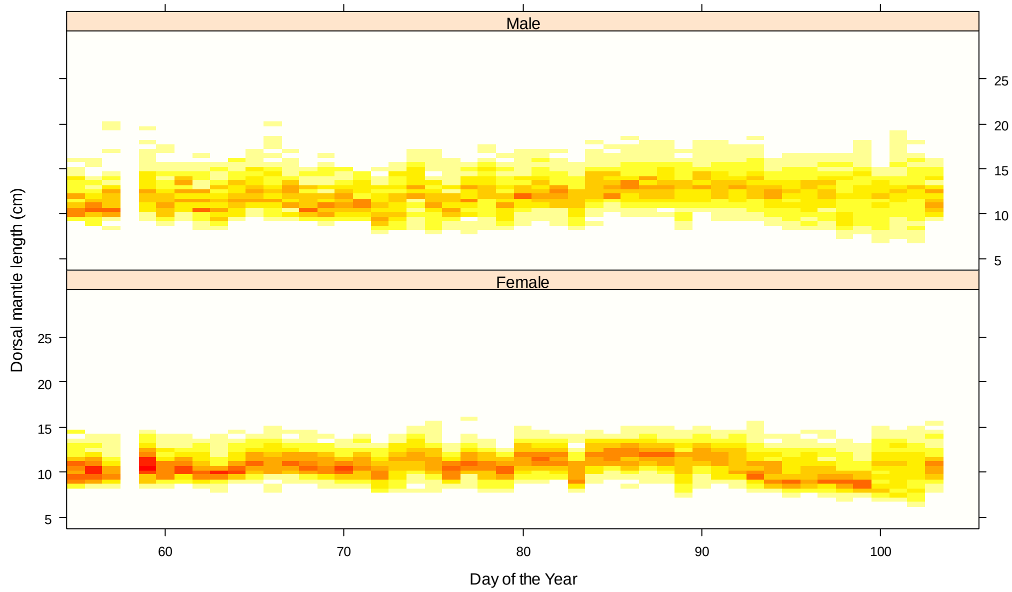


Fig. 17.- Time series of proportions (increases from yellow to red) of dorsal mantle length of squid in the catch during the first season, 2009.

2. Mean Mantle Length and Commercial Size Categories

It was not possible to sample all the areas at the same time with two scientific observers onboard, therefore the mantle sizes were also estimated based on the e-logbook records of production by ***C***ommercial ***S***ize ***C***ategory (***CSC***) by haul and vessel. The procedure for estimation was the one described in the 2006 second season fishery and stock assessment report (Payá 2006). The average mantle lengths estimated based on CSC were similar to the average recorded by the observers in both areas, and therefore they were used in the depletion models (**Fig. 18**).

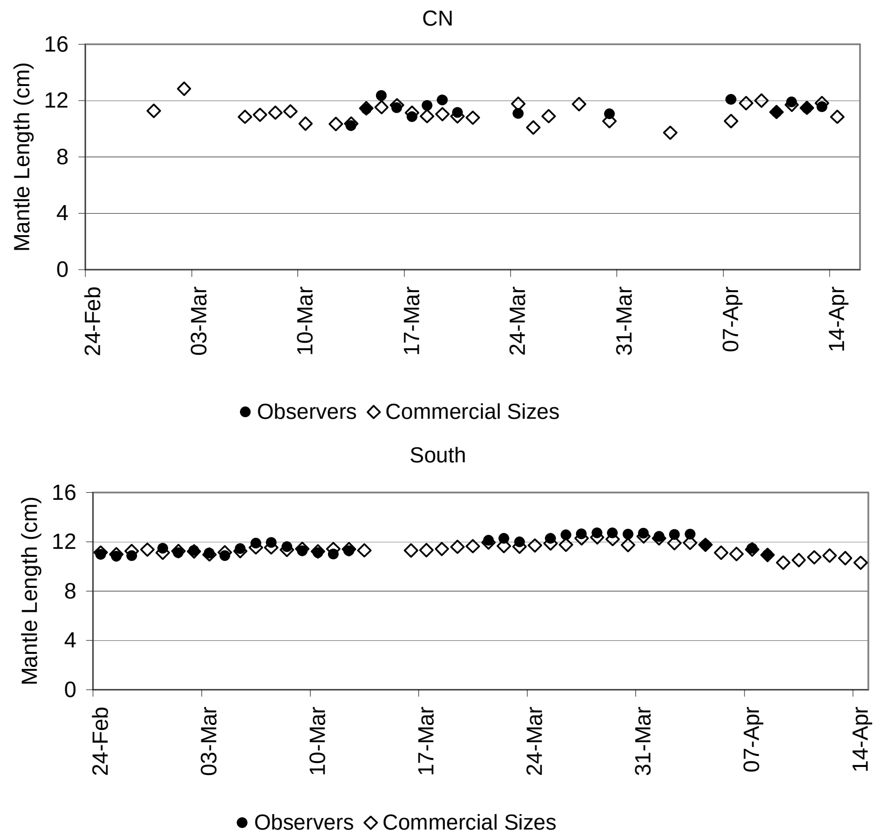
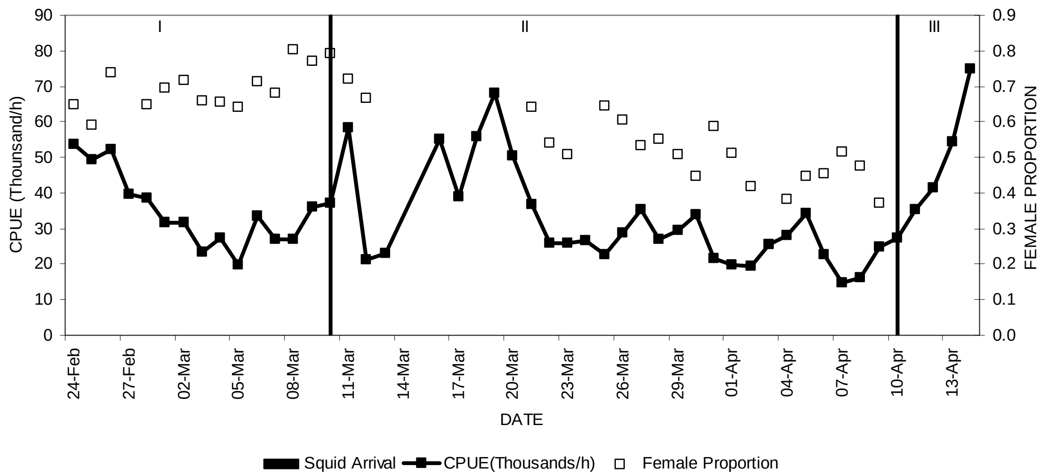


Fig. 18.- Average mantle length by area. Data from scientific observers onboard and estimations based on the commercial size categories (CSC).

3. Arrivals of squid waves by area.

In the southern area, the arrivals of three sequential groups of squid were identified combining the CPUE depletion periods and the biological information (**Fig. 19**). The first group was present at the start of the season and it was composed mainly (60-70%) by females and had a stable mean weight (40 g). The second group arrived on 11th of March, which had higher and more variable CPUE and a decreasing trend in the female proportion and an increasing trend in the mean weight. A third squid group arrive on the 10th of April with lower female proportion and mean weight. In the centre-north area there were two squid groups; the first group depletion started on 10th March and the second one on 8th April (**Fig. 20**).



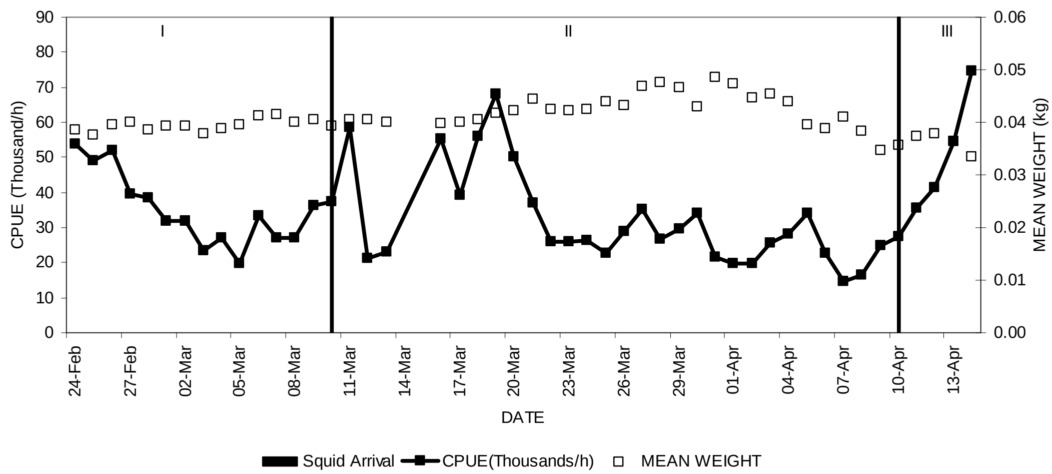
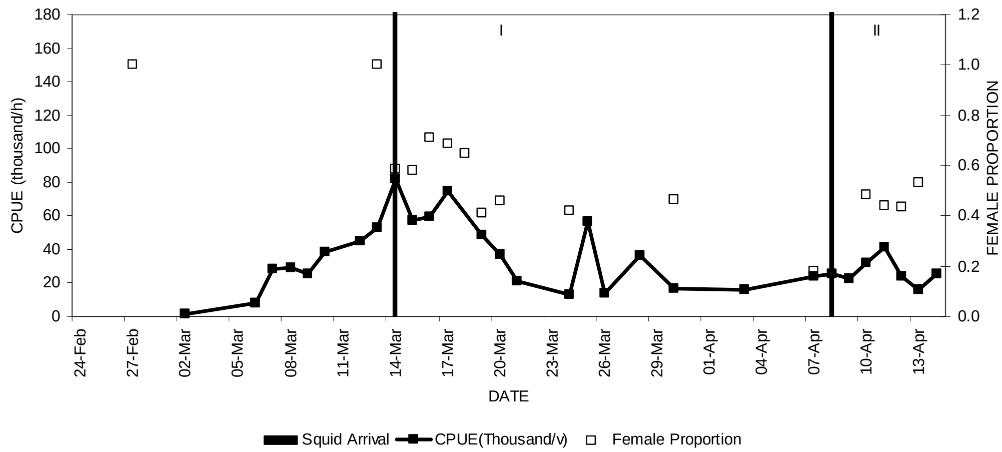


Fig. 19.- The arrivals of three different groups of squid to the southern area was identified based on the behaviour of the CPUE (Thousands/h), the female proportion (upper plot) and the mean weight (down plot). The arrival date is represented by the vertical bar.



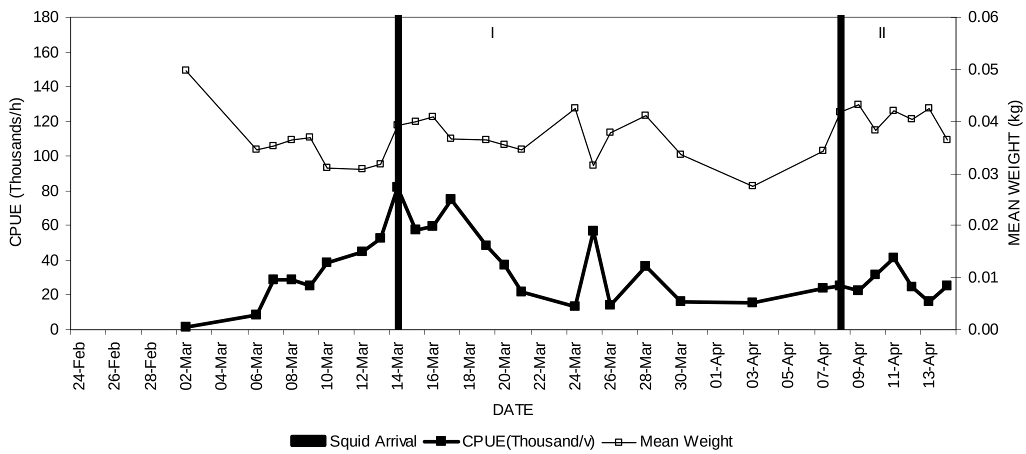


Fig. 20.- The arrival of two groups of squids to the Centre-North area was identified based on the behaviour of the CPUE (Thousands/h), the female proportion (upper plot) and the mean weight (down plot).

V. STOCK ASSESSMENT

1. In-Season Stock Assessment

In-season stock assessment was used to apply the decision rule to close the fishery if the projected spawning biomass is below 10000 tonnes, under the restriction to warn the industry with two weeks in advance of the expected closing date. A flowchart of the *Loligo* management procedure is presented in **Figure 21**.

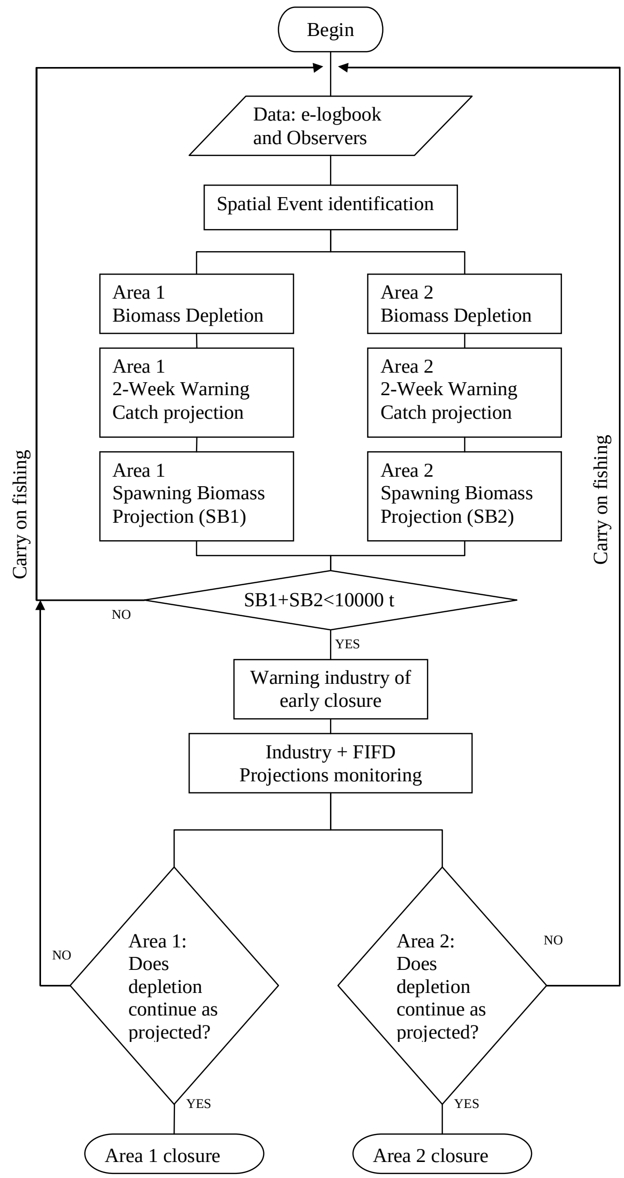


Fig. 21.- Flowchart of spatial management procedure for the early fishery closure decision. For simplicity only two depletion events are shown.

The fishery data was collected by daily catch reports and e-logbook and biological data by scientific observers onboard. Depletion events were located spatially and temporally by means of the graphical interface. Current biomass in each area was estimated by depletion models, then the catches and biomass during the 2-week warning period were projected and finally the surviving spawning biomass was estimated. If the projected spawning biomass is lower than 10000 tonnes then a warning of an early fishery closure is sent to the industry. During the warning period the FIFD daily updates the stock assessment and biomass projections, which are shown to the fishery entrepreneurs for discussion. Real time fleet movements and possible new areas of good catches are also discussed. If the biomass depletion follows the projection and no other new squid appear then the area will be closed.

The stock assessment was done using the depletion model with several recruitment pulses and vessel catchability coefficients estimations by area. The equations for the stock assessment and risk analysis have been previously described in the 2007 second fishery report (Payá 2007), and therefore are not presented here.

The first depletion in the southern area was estimated under the constraint that the initial biomass was at least equal to the biomass estimated during the *Loligo* pre-recruit survey. To estimate the *Loligo* biomass during the survey in the southern area, the whole geostatistic analysis was done using the data from the southern area only. The geostatistic method was improved including a trend of the density in the spatial model. The trend model included the bottom temperature recorded by loggers attached to the net during the survey. The inclusion of the density trend in the spatial model improved the density spatial distributions (**Figs 22 and 23**) but did not affect the biomass estimation (**Table 3**).

Table 3. Biomass in the southern area at the start of the fishing season, estimated using the pre-season *Loligo* survey.

	Without trend	With density-Temperature trend
Density (tonnes/km^2)	5.6	5.7
Area (Km^2)	3998	3998
Presence Proportion	0.852	0.852
Biomass (tonnes)	19230	19550
Fishing Power Correction factor	1.10	1.10
Standardised Biomass	21071	21421

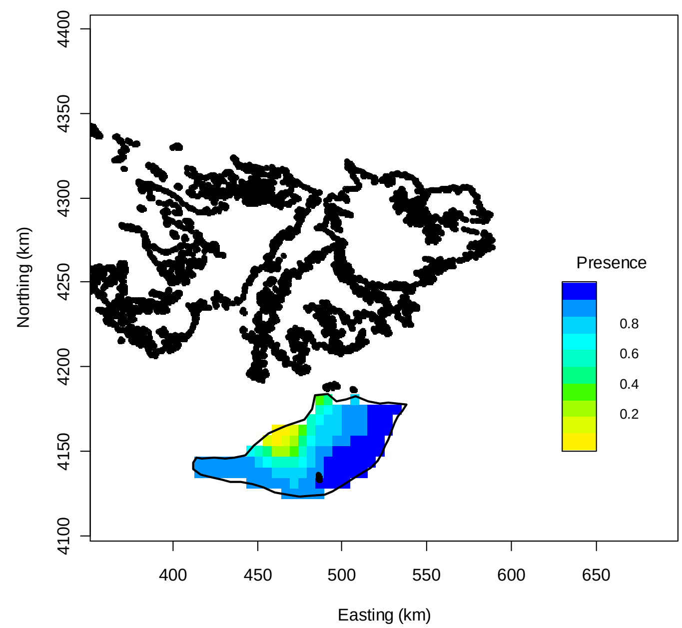


Fig. 22. *Loligo* presence (proportion of observations with *Loligo*) in the southern area during the survey. Estimation based on geostatistic analysis.

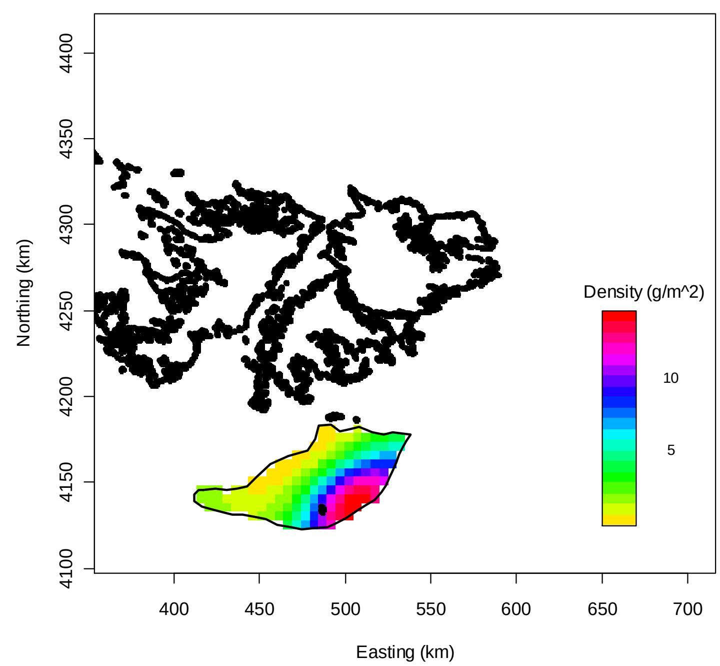


Fig. 23. *Loligo* density (g/m^2) in the southern area during the *Loligo* survey. Estimation based on geostatistic analysis.

The whole biomass, with data up to the 8th of April, was estimated at 11,237 tonnes and was composed mainly by the two squid groups from the southern area (**Fig. 24**). The projected escapement biomass (11,372 tonnes) was close to the 10,000 tonnes limit. The biomass was projected assuming that during the rest of the fishing season the whole fleet will fish in the southern area only.

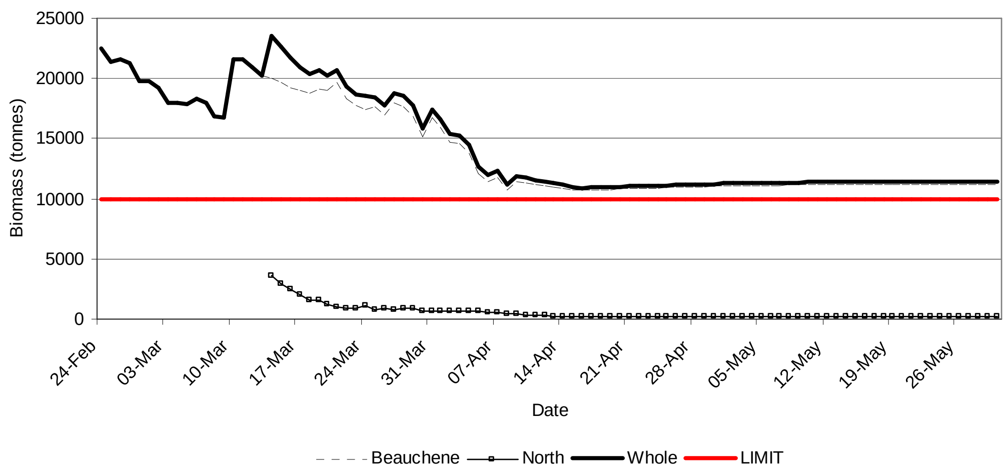


Fig. 24. Whole biomass and biomasses by area. From the 9th to the 14th of April the biomass was projected assuming that the whole fleet will fish in the southern area.

The historical probability of new squid arrivals after the 8th of April was estimated at 0.21 in the southern area (**Fig. 25**) and at 0.38 in the central-northern area (**Fig. 26**). Considering these probabilities of new arrivals and the escapement biomass projections, the fishing season had a normal end.

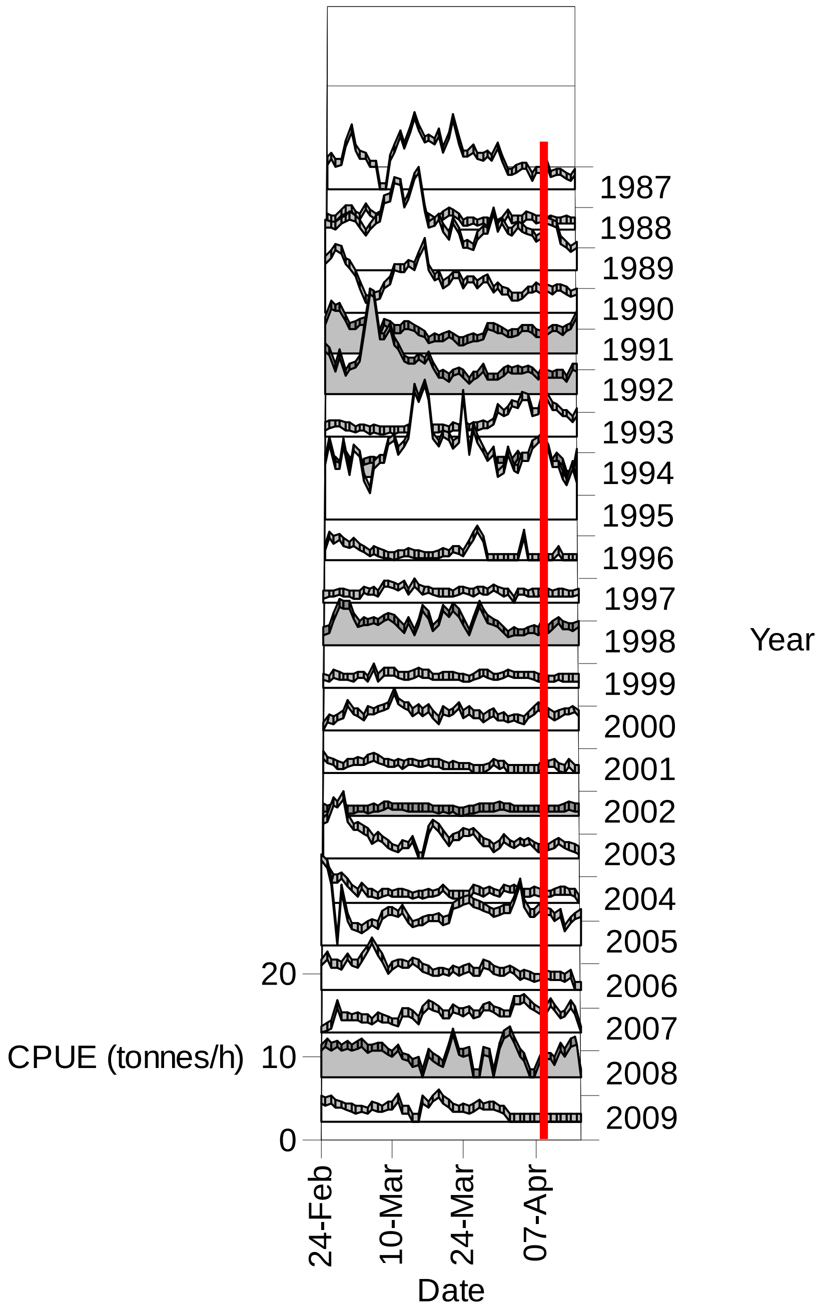


Fig. 25. Catch rates by day and year in the southern area. Grey series shows years with catch rates increase after the 8th of April (red line).

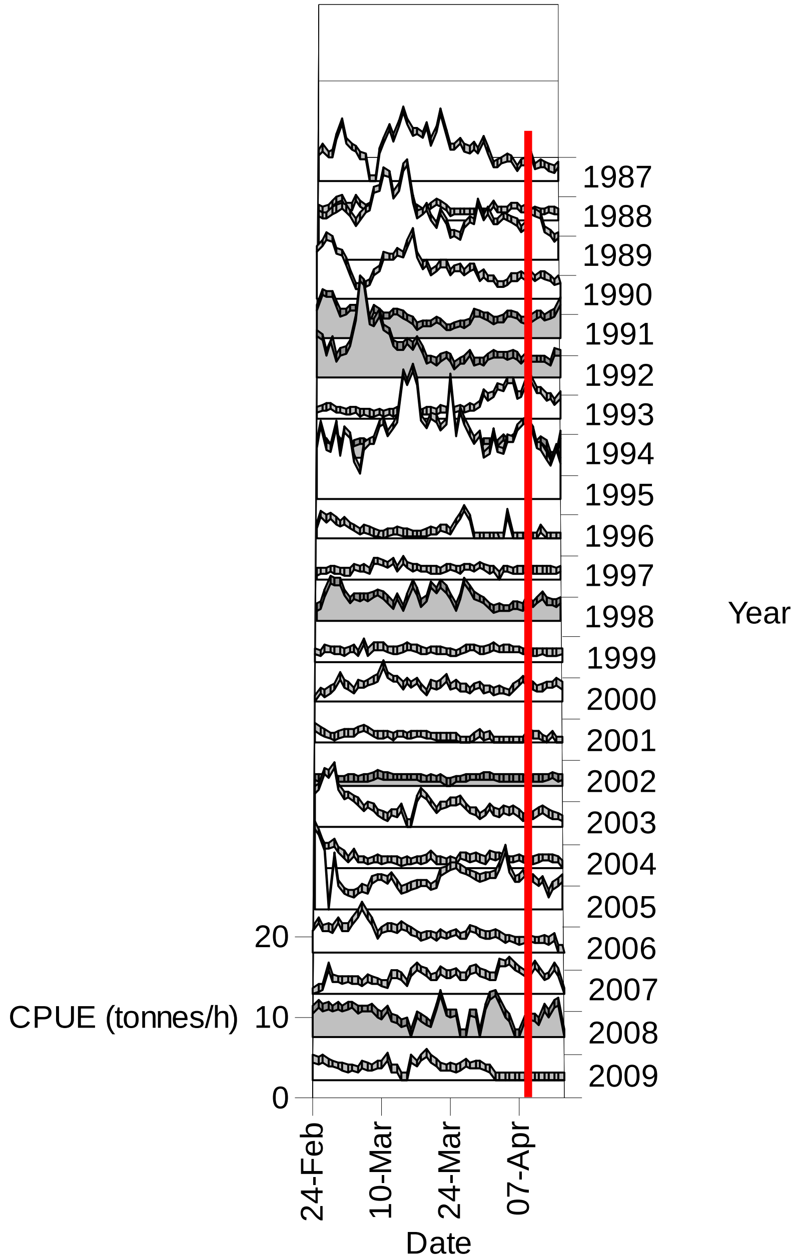


Fig. 26. Catch rates by day and year in the centre-north area. Grey series shows years with catch rates increase after the 8th of April (red line).

2. After-Season Stock Assessment and Risk Analysis

The integrated model had 2 depletion events in the southern area and 2 in the central-northern area. The squid group that arrived in the last 5 days of the season to the southern area was not taken into account because it did show any depletion. The catchability coefficients by vessel were estimated for each area, in the case of the southern area the catchability coefficients were estimated for each depletion event, but in the central-area were estimated for both depletion events together. This assumption was necessary because the last depletion lasted only 6 days, and therefore any catchability coefficient estimation was very uncertain.

2.1 Bayesian inference

In Bayesian inference, the posterior probability of the $\boldsymbol{\theta_i}$ parameters, $\boldsymbol{P(\theta_i|X)}$ is calculated as:

$$P(\theta_i \mid X) = \frac{P(X \mid \theta_i) * p(\theta_i)}{\sum_i P(X \mid \theta_i) * p(\theta_i)}$$

where $\boldsymbol{X}$ is the data; $\boldsymbol{P(X|\theta_i)}$ is the Likelihood and $\boldsymbol{p(\theta_i)}$ is the prior distribution of $\boldsymbol{\theta_i}$ parameter.

For the first squid group of the southern area the prior was set equal to the number of squids estimated in the pre-season *Loligo* survey 2009, normally distributed with mean and variance estimated by geostatistic methods. For the rest of parameters the priors were set according to historical values and a high coefficient of variation (1.5).

2.2 Model Fittings by Area

The fitting of the model was good and the errors were lognormal distributed in both areas (**Figures 27 to 31**). The residuals were evenly distributed and they did not show any trend in time or by vessel. Only two data points from the southern area were excluded as outliers (extremely high values).

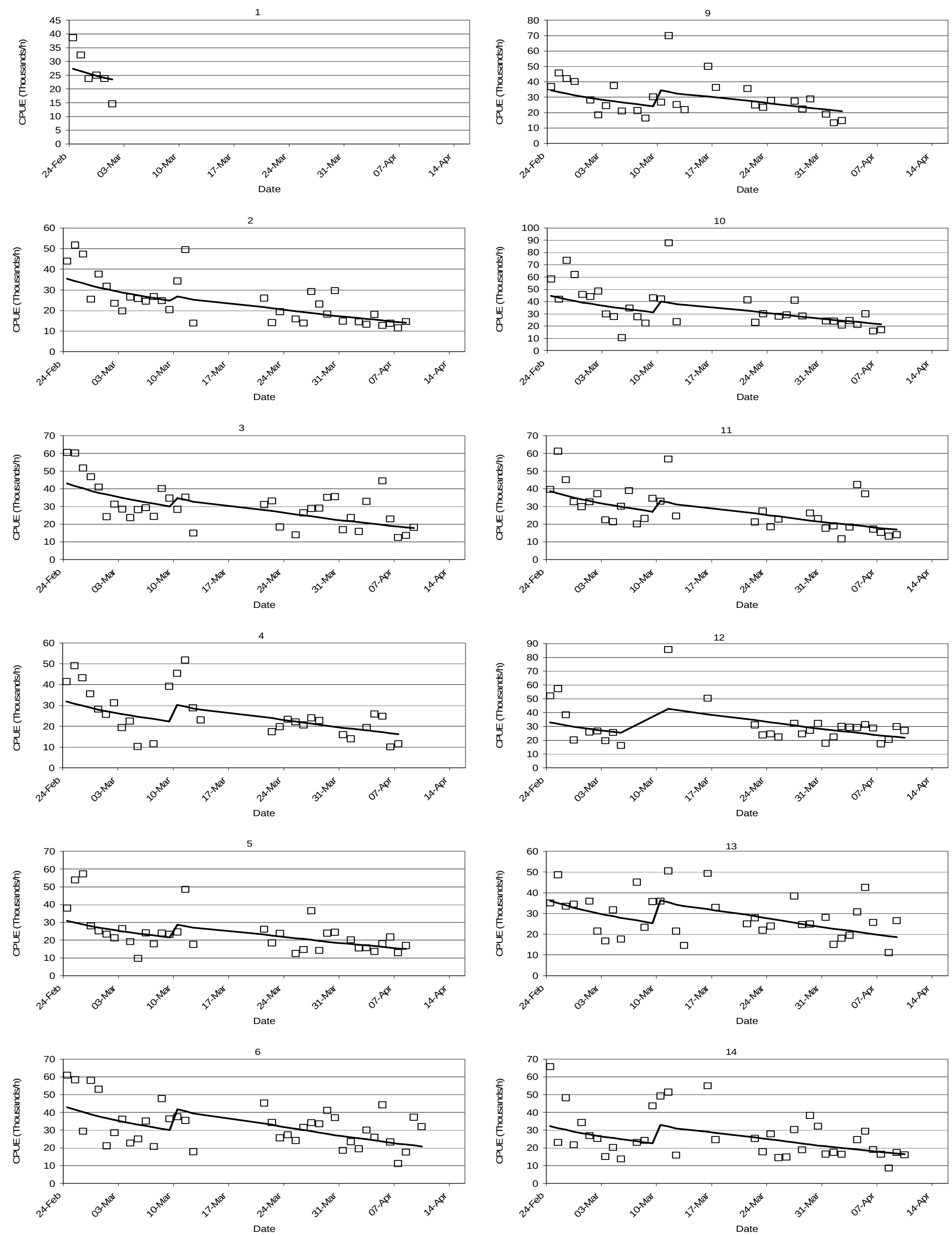


Fig. 27.- Fitting model (line) to CPUE (thousands/h) data (squares) by vessel in the Beauchene area.

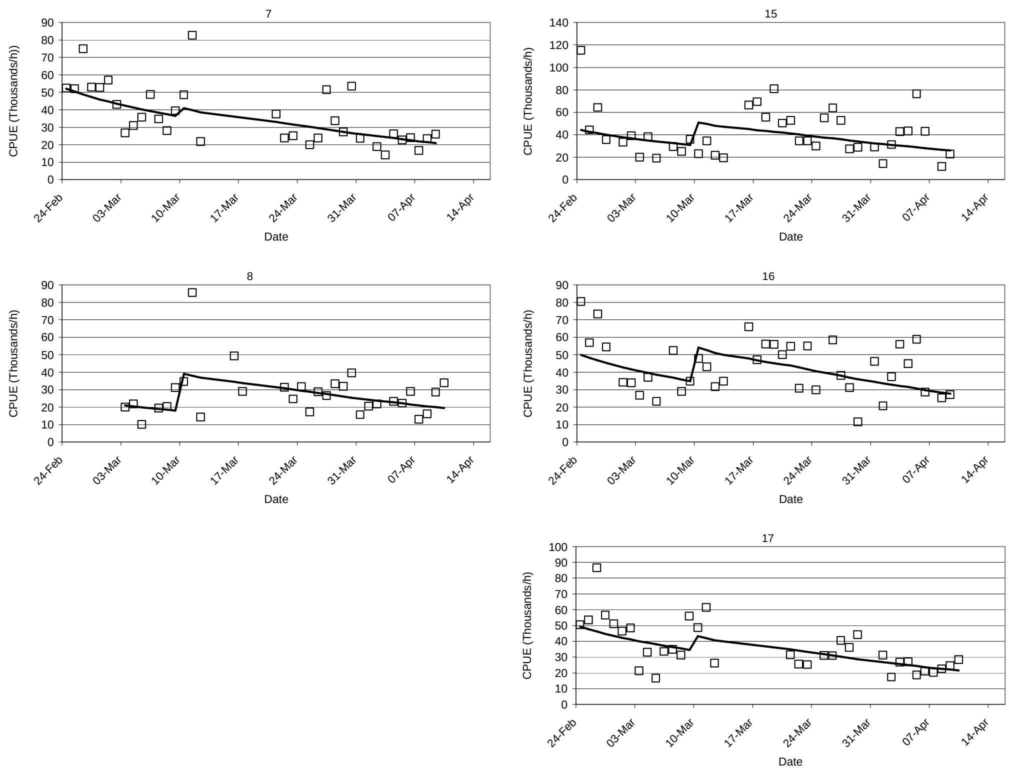


Fig. 27.- Continued.

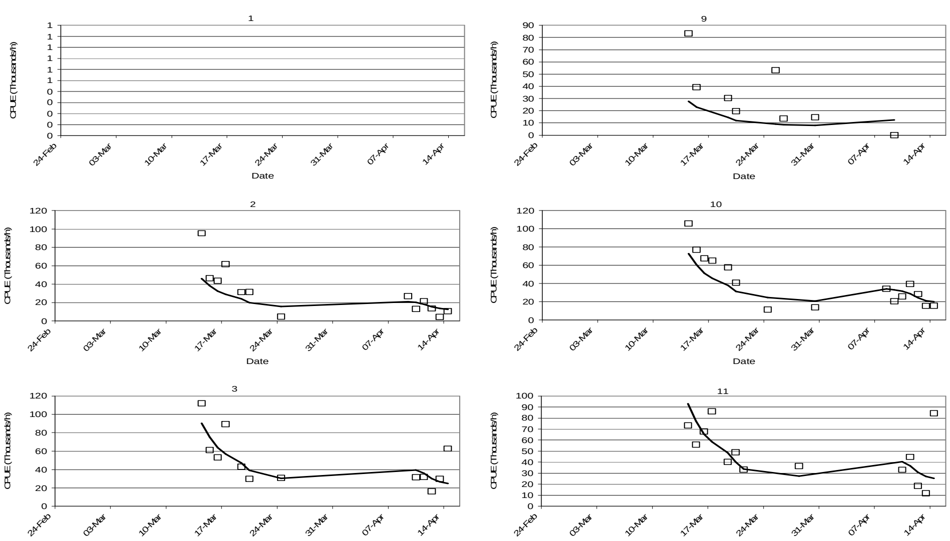


Fig. 28.- Fitting model (line) to CPUE (Thousands/h) data (squares) by vessel in central area.

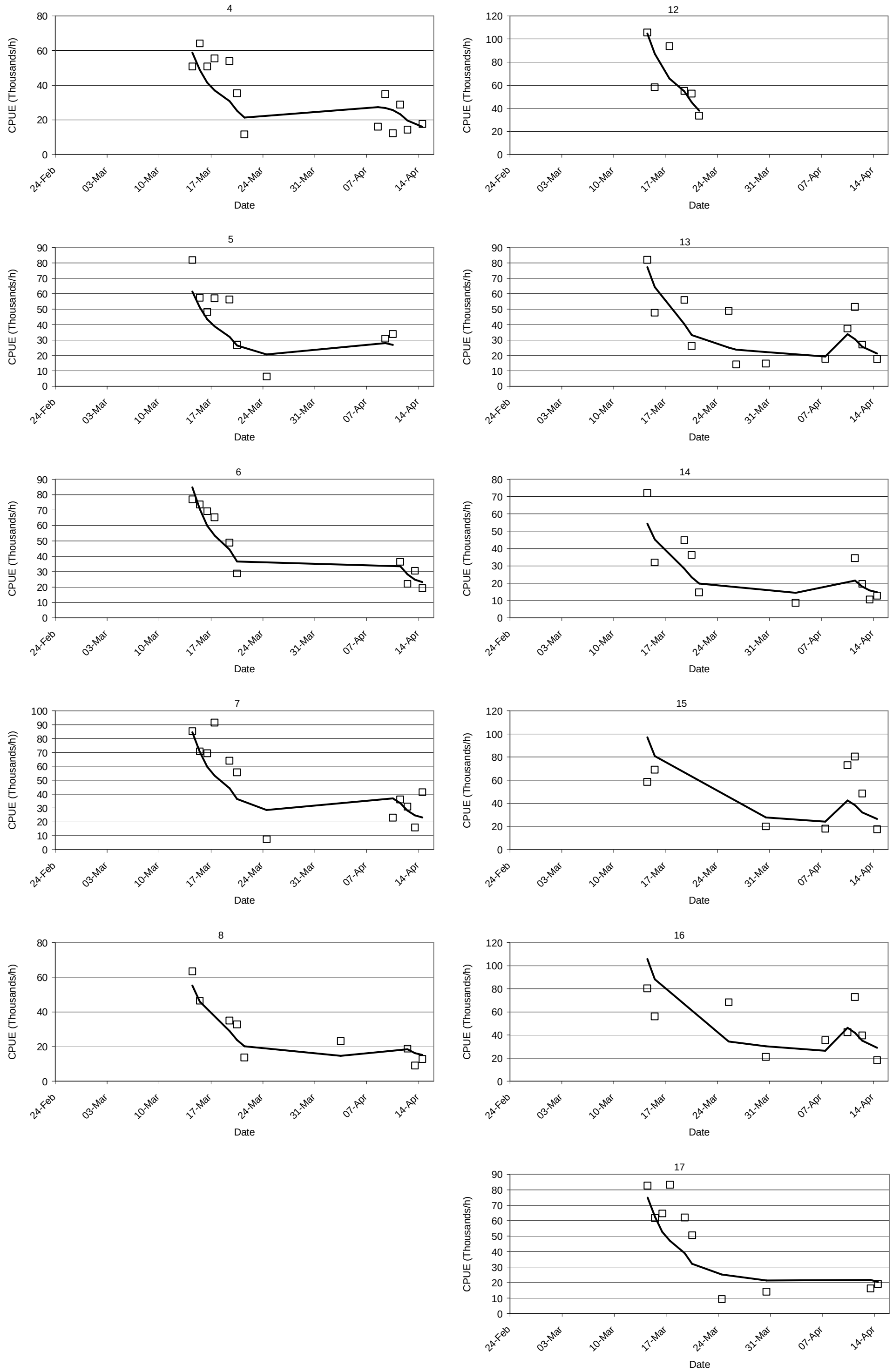


Fig. 28.- Continued.

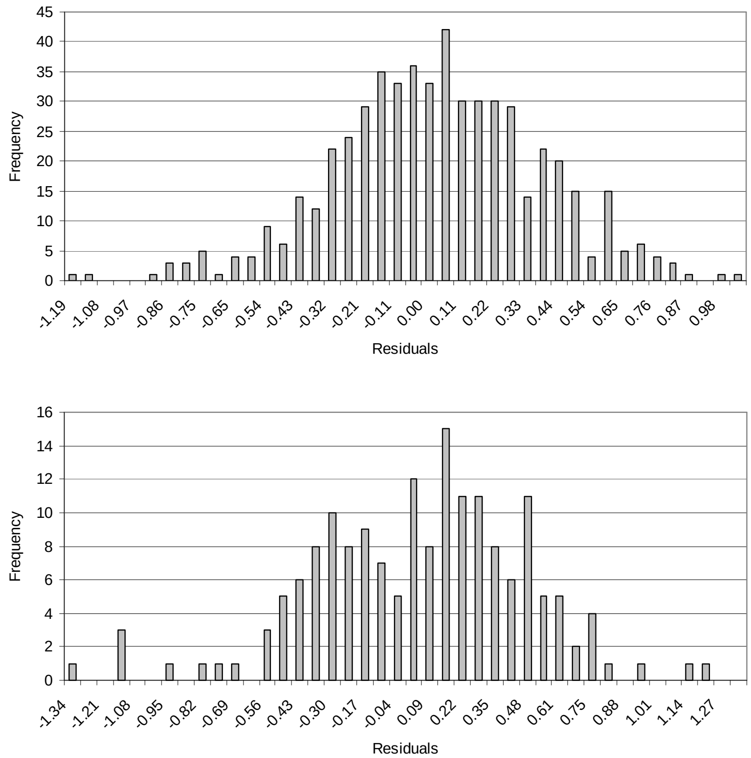
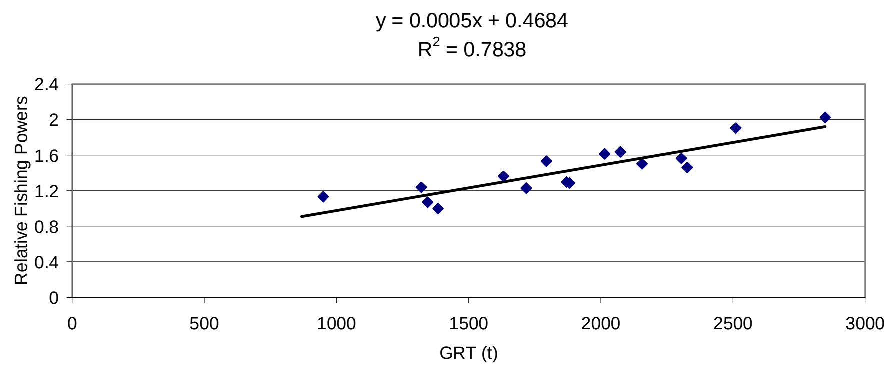


Fig. 29.- Residual distribution in Beauchene (upper plot) and central-northern (down plot) area.

2.3 Catchability Coefficients and Fishing Powers by Vessels

The relative fishing powers (vessel catchability / reference vessel catchability) had good relationships with the gross registered tonnage (R^2=0.78) and the main engine horse power (R^2=0.68) (**Fig. 30)**.



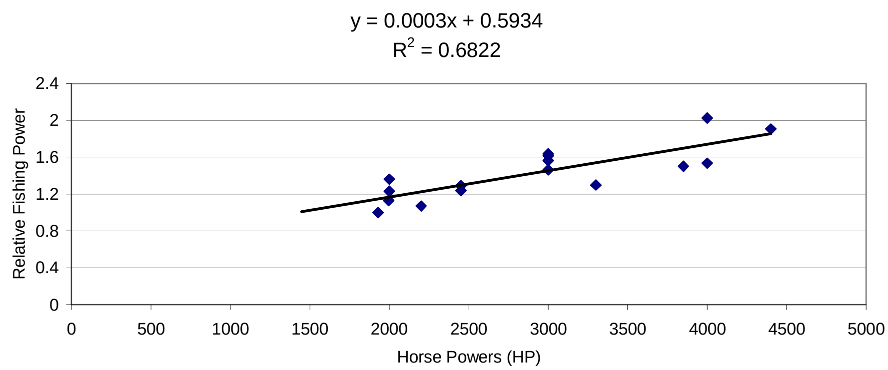


Fig. 30.- Relation between relative fishing powers and GRT (upper plot) and HP (down plot). Fishing powers of estimated using the catchability coefficient in the southern area during the second squid group depletion.

2.4 Biomass Estimations and Risk

The biomass in the whole *Loligo* box was estimated at 20984 tonnes on the 24th of February and at 29140 tonnes on the 14th of March (**Figs. 31 and 32, and Table 4)**. The whole biomass that arrived to fishing grounds during the season was estimated in 38179 tonnes and corresponds to the sum of the biomass at the start of the season and the biomasses of the squid groups that arrived during the season. The escapement spawning biomass on the 31rst of May was estimated at 15314 tonnes (**Table 5**).

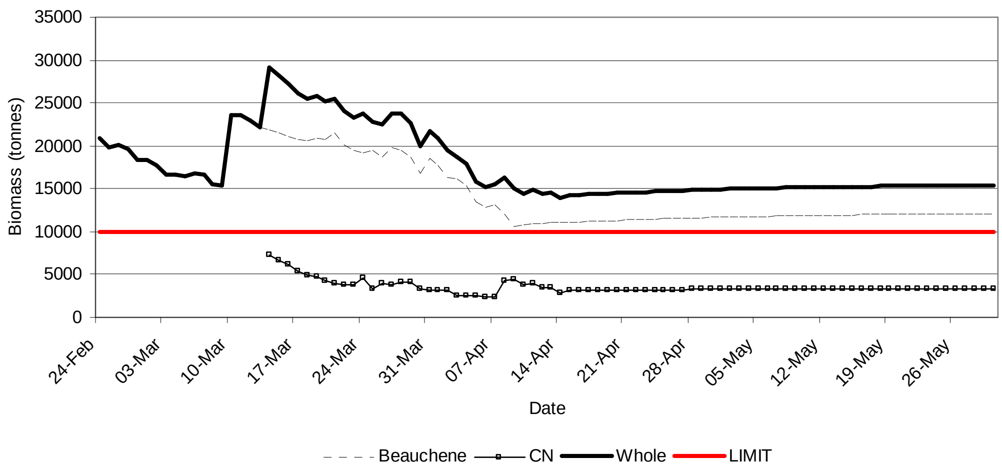


Fig. 31.- Depletion biomass and projected biomass in the whole *Loligo* box and by area (CN: Central-northern area). Two squid waves were observed in Beauchene area and two in central-northern area.

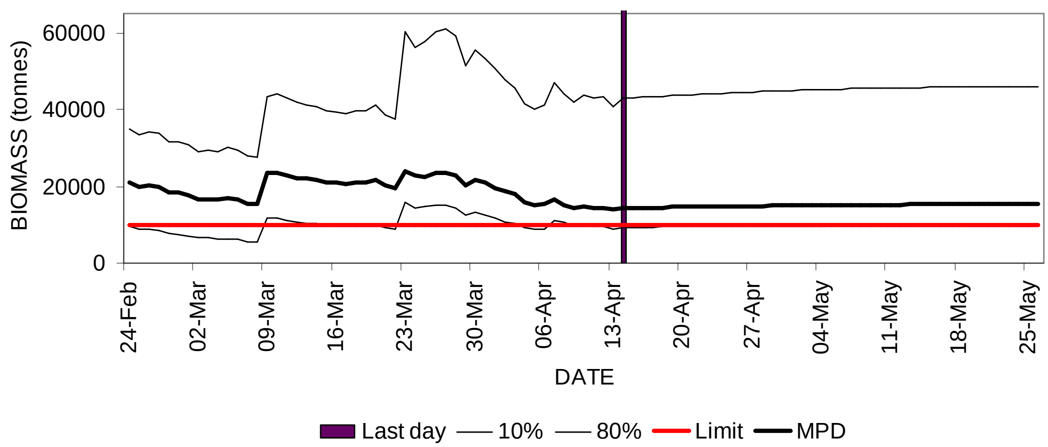


Fig. 32.- Biomass depletion and projection in the whole *Loligo* box (10% = 10th percentile; 80%= 80th percentile; MPD= Maximum Posterior Density).

Table 4.- 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). (*) Cumulative biomass is the sum of all squid group biomasses.

	1st Season 2005		1st Season 2006	1st Season 2007					
Parameter	Beauchene Inshore	Beauchene Offshore	Beauchene	Beauchene 1rst	Beauchene 2nd	Beauchene 3rd	Beauchene 4th	Beauchene 5th	North
Starting Date	10/03	22/03	8/3	27/02	12/03	17/03	28/03	3/04	6/03
Final Date	21/03	14/04	14/4	11/03	16/03	27/03	2/04	15/4	16/03
N° of days	12	24	32	12	5	11	6	13	11
Catchability	$1.7x10^{-3}$	$6.1x10^{-4}$	$9.8x10^{-4}$	$2.3x10^{-3}$	$2.3x10^{-3}$	$2.3x10^{-3}$	$2.3x10^{-3}$	$2.3x10^{-3}$	$3.6x10^{-3}$
(1/vessel-day)	(0.6)	(10.7)	(34.2)	(8.9)	(8.9)	(8.9)	(8.9)	(8.9)	(50.4)
Initial numbers	$8.5x10^{-1}$	2.3	1.47	$2.0x10^{-1}$	$3.2x10^{-2}$	$2.1x10^{-1}$	$1.4x10^{-1}$	$3.3x10^{-1}$	$4.4x10^{-2}$
(billions)	(12.9)	(5.7)	(5.5)	(11.0)	(98.0)	(16.0)	(3.9)	(10.9)	(23.3)
Initial biomass	21816	82247	38212	8250	1767	9500	6250	10000	1750
(tonnes)	(53.0)	(55.6)	(53.1)	(11.0)	(98.0)	(16.0)	(3.9)	(10.9)	(23.3)
Final Numbers NT	$5.4x10^{-1}$	1.4	$5.6x10^{-1}$	$1.3x10^{-1}$	$2.7x10^{-2}$	$1.4x10^{-1}$	$1.0x10^{-1}$	$2.1x10^{-1}$	$1.0x10^{-2}$
(billions)	(54.0)	(3.6)	(2.5)	(18.2)	(99.0)	(20.1)	(6.5)	(15.2)	(28.0)
Final Biomass (tonnes)	15594	52834	16282	7000	1225	6000	3250	5500	1250
	(55.7)	(56.2)	(54.0)	(18.0)	(99.0)	(20.2)	(6.5)	(15.2)	(27.0)
Cumulative Biomass at the start of the period (tonnes)*				8250	8750	15250	16250	18250	
				(11.0)	(14.1)	(8.5)	(30.6)	(8.5)	
Cumulative Biomass at the end of the period (tonnes)*				7250	8000	9500	8150	10250	
				(14.6)	(15.2)	(13.4)	(30.6)	(11.7)	

Table 5.- Continuing….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).. (*) This biomass is the sum of all squid group biomasses. (**) It is the average of catchability by vessel.

	1st Season 2008			1st Season 2009			
Parameter	1st Beauchene	2nd Beauchene	Centre	1st Beauchene	2nd Beauchene	1st CN	2nd CN
Starting Date	29/02	20/03	23/03	24/2	10/3	14/3	8/4
Final Date	19/03	14/04	14/04	9/3	10/4	7/4	14/4
N° of days	20	26	23	14	32	25	7
Catchability (1/h) **	9.13×10^{-5}	9.13×10^{-5}	9.8×10^{-5}	8.75×10^{-5}	6.89×10^{-5}	0.18×10^{-5}	0.18×10^{-5}
	(10.0)	(10.0)	(10.0)	(33.3)	(33.9)	(46.8)	(46.8)
Initial numbers	8.1×10^{-1}	3.9×10^{-1}	1.16	5.4×10^{-1}	23.4×10^{-1}	1.85×10^{-1}	0.85×10^{-1}
(billions)	(10.0)	(10.0)	(10.0)	(36.0)	(33.0)	(60.0)	(59.0)
Initial biomass (tonnes)	35590	17799	46061	20984	9168	7278	748
	(10.0)	(10.0)	(10)	(36.0)	(33.0)	(60.0)	(59.0)
Final Numbers NT (billions)	1.3×10^{-1}	3.9×10^{-1}	6.6×10^{-1}	3.6×10^{-1}	1.2×10^{-1}	0.8×10^{-1}	0.13×10^{-1}
	(10.0)	(10.0)	(10.0)	(36.0)	(37.0)	(58.0)	(59.0)
Final Biomass (tonnes)	17798	8572	19748	14371	4310	3550	503
	(10.0)	(10.0)	(10.0)	(46.0)	(37.0)	(58.0)	(59.0)
Cumulative Biomass at the start of	35590	32901			23539		4298
the period (tonnes)*	(10.0)	(10.0)			(37.0)		(59.0)
Cumulative Biomass at the end of the period (tonnes)*	7250	18674			10711		2892
	(10.0)	(10.0)			(37.0)		(59.0)

Table 5.- Spawning 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 (tonnes)
First Season 2005	21/03[1] and 14/04[2] to 30/05	70114 (9.9)
First Season 2006	14/4 to 30/5	16495 (9.1)
First Season 2007	16/4 to 31/5	12250 (14.4)
First Season 2008	15/4 to 31/5	43673 (10.0)
First Season 2009	15/4 to 31/5	15314 (60.0)

[1]Inshore Beauchene and [2]Offshore Beauchene

The spawning biomass projected by the 31[rst] of May had a mode at 15314 tonnes, a range from 2000 to 120000 tonnes, and an asymmetric distribution (**Fig. 37**). The risk of leaving an escapement biomass less than 10000 tonnes was estimated at 0.1.

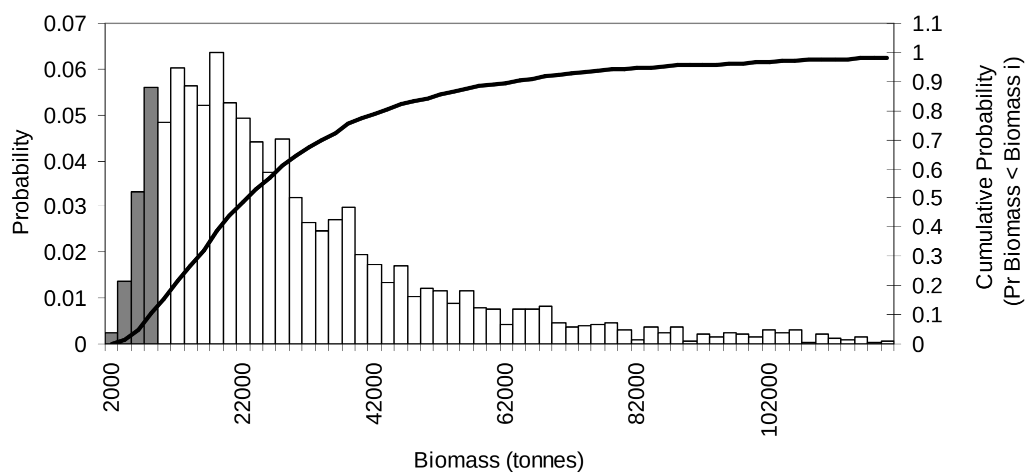


Fig. 33.- Probability distribution and cumulative probability of the spawning biomass projected to the 31[rst] of May. The grey bars show the biomass lower than 10000 tonnes. The risk (cumulative probability curve) of leaving an escapement biomass less than 10000 tonnes was estimated at 0.1.

VI. CONCLUSIONS

1) The whole catch in the first season was 12764 tonnes, which was 48% less than in first season 2008 and 43% less than the average of the last 5 years first seasons.

2) The 70% of the squid were caught in southern area, 2% in the central area and 28% in the northern area

3) The average mantle length was 12.1 cm, which was similar to ones in 2008 and 2007 and 2 cm larger than the one in 2006.

4) Two squid groups arrived sequentially to the southern area and two group to the central-northern area.

5) The *Loligo* surveys provided information that was used as parameter prior in the Bayesian depletion model.

6) The relative fishing powers were correlated with the gross registered tonnage (R^2=0.78) and the main engine horse power (R^2=0.68).

7) The whole *Loligo* biomass, the one that was present at the start of the season plus the ones that arrived during the season, was estimated at 38179 tonnes.

8) The fishing season ended at the scheduled date with a projected spawning biomass of 15315 tonnes.

9) The risk of leaving an escapement biomass less than 10000 tonnes was estimated at 0.1.

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