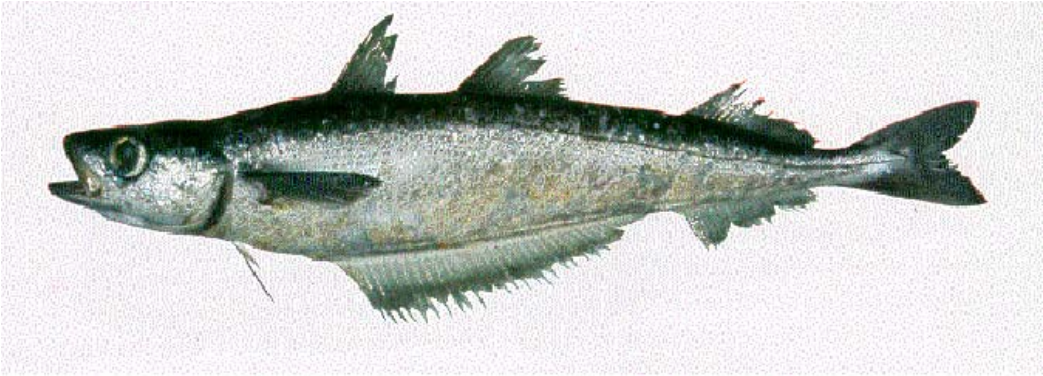
# Scientific Report

# Fisheries Research Cruise ZDLH1-09-2004



Fisheries Department

Falkland Islands Government

# Scientific Report

# Fisheries Research Cruise

# ZDLH1-09-2004


***FPRV Dorada***

***30 August to 24 September 2004***

Fisheries Department

Falkland Islands Government

Stanley

Falkland Islands

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## 1. Introduction

In September 2004, another joint UK-Argentine survey of southern blue whiting was conducted on the shelf of the Southwest Atlantic. Two vessels participated in the survey, namely the Falkland Islands Research and Patrol Vessel *Dorada* and Argentine Research Vessel *Dr Eduardo L. Holmberg*. It was decided that this year the R/PV *Dorada* would do an extensive trawl survey outside the main spawning grounds of southern blue whiting, whereas the R/V *Dr Eduardo L. Holmberg* would do an acoustic survey of the spawning area of southern blue whiting to the south of the Falkland Islands (Islas Malvinas). The following report summarises the research activities carried out on the R/PV *Dorada.*

### 1.1 Region and Cruise objectives

The survey was conducted on the northern, eastern and southern shelf of the Falkland Islands (Islas Malvinas), the southwestern deep shelf region of these islands and on the continental slope north and south of Isla de Los Estados (Staten Island) (Fig. 1).

The four objectives of the research cruise were to:

1. conduct a trawl survey to identify the stock distribution of southern blue whiting and other commercial species during the peak spawning period of southern blue whiting;
2. study oceanographic conditions over the survey area;
3. collect routine biological samples of most commercial species;
4. collect additional ad hoc acoustic data along the track of the trawl survey, to supplement the acoustic survey carried out on the R/V *Dr Eduardo L. Holmberg*.

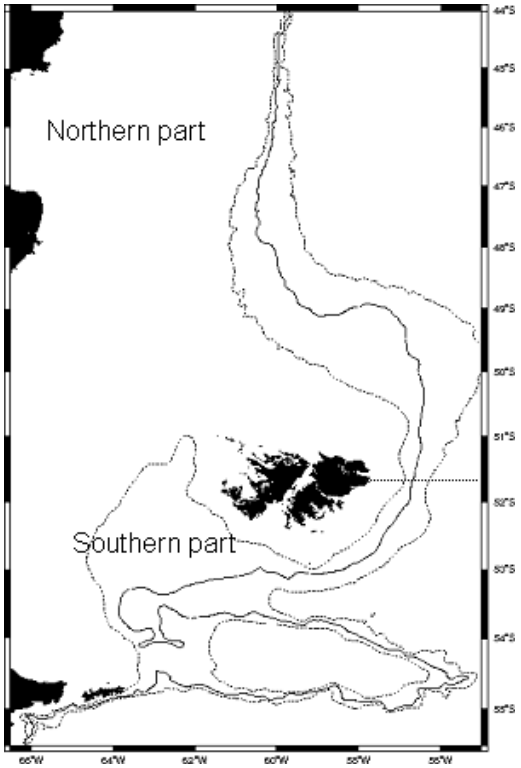



*Figure 1. Location of the research cruise ZDLH1-09-2004 undertaken between 30th Aug. and 24th Sept. 2004. The dotted line separates the southern and northern parts the cruise.*

## 1.2 Cruise plan and key dates

The primary aim of the first objective was to identify the distribution and abundance of southern blue whiting over the wider shelf and slope area outside its main spawning areas south of the Falkland Islands. The survey coincided with a single snapshot acoustic survey of the main spawning grounds by the Argentine R/V *Dr. Eduardo L. Holmberg*.

The survey area covered the entire slope area from Isla de Los Estados (Staten Island) in the south to 45°S in the north, between the depths of 200 and 700 metres. On the rare occasion, trawl depth was decreased to 120 m to allow for placement of some trawls in the main spawning area south of the Falkland Islands. For the purposes of this report, the survey area was split into two regions, north and south of 51.7°S (Fig. 1).

The cruise departed from Stanley for the northern part of the survey on the 30th August 2004 and the first trawl began at approximately 06:00 am the next morning. When this part of the survey (which included the High Seas region of 45-47°S) was completed, there was a port call to Stanley on the afternoon of September 10th. The second (southern) part of the survey began on the 11th September and ended on 24th September, 2004 with a total of 26 days spent at sea. Two UK scientists were transferred from the R/PV *Dorada* to the R/V *Dr. Eduardo L. Holmberg* on the 13th September.

Due to inclement weather, the scheduled survey plan was uncompleted. Four days were lost during the first part of the survey with a further five days lost during the second part. This resulted in some southern transects of the northern part not being surveyed. It also resulted in the cancellation of most transects in the west, except for the ones near Isla de los Estados. A further day was lost due to the failure of the hydraulic pump.

## 1.3 Vessel characteristics

The cruise was conducted on board the R/PV *Dorada*, which is registered in the Falkland Islands. The characteristics of this vessel are shown in Table 1.

*Table 1. Characteristics of the* Fisheries Protection and Research Vessel Dorada.

| *Callsign* | *ZDLH1* |
|---|---|
| Length | 76 m |
| GRT | 2360 t |
| NRT | 708 t |
| Crew | 16 people |

## 1.4 Personnel and responsibilities

The following UK and Argentine personnel participated in the cruise:

| | | |
|---|---|---|
| Dr. Alexander Arkhipkin | *C. Scientist (UK)* | |
| Dr. Vlad Laptikhovsky | *Oceanography(UK)* | |
| Joost Pompert | *Fisheries Biologist (UK)* | |
| Sandra Cordes | *Fisheries Biologist (UK)* | |
| Dr. Lianos Triantafillos | *Fisheries Biologist (UK)* | *(30 Aug – 13 Sept.)* |
| Michael Hattersley | *Fisheries Biologist (UK)* | *(30 Aug – 13 Sept.)* |
| Teresa Athayde | *Fisheries Biologist (UK)* | *(14 – 24 Sept.)* |
| Norberto Scarlato | *C. Scientist (AR)* | |
| Gustavo Macchi | *Reproductive Biology (AR)* | |

## 1.5 Equipment used

### *Acoustics*

The acoustic instrumentation was similar to that used in previous surveys. This included:

1. Scientific echosounder SIMRAD EK500 38/120 KHz;

2. Sonardata Echolog (data acquisition) and Echoview (post-processing) software.

The EK500 was triggered with a ping interval of approximately 2 seconds. Triggering was synchronised with the Furuno Doppler log to reduce acoustic interference. Data was logged with Sonardata Echolog and processed with Echoview.

### *Trawling*

All trawl stations used an ENGEL semi-pelagic trawl with a 40.2 m headline and a 38.7 m footrope equipped with rockhoppers. The mesh size at the cod-end was 95 mm and a 40 mm cod-end liner was used. The doors were Super-V style weighing 1200 kg and with an area of 6 $m^2$. The trawl was equipped with SIMRAD ITI sensors. The typical vertical opening of the trawl was between 10 and 15 m when fishing either semi-pelagically or near the bottom.

### *Oceanographic*

The oceanographic equipment was similar to that used in previous surveys. This included:

1. CTD SBE 25 with oxygen sensor and SeaTech fluorometer;

2. Thermosalinometer SBE45.

## 2. Sampling

### 2.1 Acoustic surveying

Acoustic data were logged along the entire track of the trawl survey. These data were archived (in Sonardata EK5 format) on a PC running Sonardata Echolog500 and then transferred to Ing. A. Madirolas on the R/V *Dr Eduardo L. Holmberg* for further post-processing and interpretation.

### 2.2 Trawl stations and biological sampling

A total of 52 trawl stations (of some 96 planned) were conducted with the Engel trawl between 31/08/04 and 23/09/04. Station numbers ranged from 1785 to 1907 (Table 2).

Catches at all stations were weighed using an electronic, marine adjusted balance (POLS, min 10g, and max 80kg). Commercial finfish species were measured (total or pre-anal length) to the nearest centimetre below and both sex and stage of maturity were recorded. Individual weight was measured to the nearest gram using the POLS balance (min. 1gram, max. 13kg) or, for larger specimens, to the nearest 20 grams using the Scanvaegt balances. The diet composition of some species was also recorded.

*Table 2. Dates, locations, modal depths and duration of oceanographic (CTD) and trawl (Semi-Pelagic) stations carried out during the research cruise ZDLH1-09-2004 undertaken from the 30th Aug to 24th September, 2004.*

| Station | Activity | *Date* | *Start Time* | *Start Latitude* | *Start Longitude* | *Modal Depth (m)* | *Duration (min)* |
|---|---|---|---|---|---|---|---|
| 1784 | CTD | 31/08/04 | 06:30 | 50° 0.3 S | 56° 44.5 W | 449 | 17 |
| 1785 | Semi-Pelagic | 31/08/04 | 07:22 | 49° 59.4 S | 56° 44.7 W | 420 | 65 |
| 1786 | CTD | 31/08/04 | 10:30 | 50° 7.7 S | 57° 1.9 W | 389 | 16 |
| 1787 | Semi-Pelagic | 31/08/04 | 10:57 | 50° 7.3 S | 57° 2 W | 383 | 78 |
| 1788 | CTD | 31/08/04 | 13:33 | 50° 16 S | 57° 20 W | 352 | 14 |
| 1789 | Semi-Pelagic | 31/08/04 | 13:57 | 50° 15.6 S | 57° 19.8 W | 347 | 83 |
| 1790 | Semi-Pelagic | 31/08/04 | 16:48 | 50° 26.2 S | 57° 41.6 W | 226 | 73 |
| 1791 | CTD | 31/08/04 | 18:35 | 50° 24.6 S | 57° 47.8 W | 214 | 11 |
| 1792 | CTD | 01/09/04 | 06:28 | 49° 13 S | 58° 44.6 W | 455 | 17 |
| 1793 | Semi-Pelagic | 01/09/04 | 06:49 | 49° 13.1 S | 58° 44.5 W | 468 | 90 |
| 1794 | CTD | 01/09/04 | 09:57 | 49° 23.8 S | 59° 3.8 W | 420 | 16 |
| 1795 | Semi-Pelagic | 01/09/04 | 10:21 | 49° 23.6 S | 59° 3.1 W | 431 | 83 |
| 1796 | CTD | 01/09/04 | 13:24 | 49° 33 S | 59° 19.4 W | 364 | 14 |
| 1797 | Semi-Pelagic | 01/09/04 | 13:43 | 49° 32.9 S | 59° 18.6 W | 370 | 87 |
| 1798 | Semi-Pelagic | 01/09/04 | 16:35 | 49° 42.6 S | 59° 37 W | 196 | 52 |
| 1799 | CTD | 01/09/04 | 19:05 | 49° 41.2 S | 59° 41.4 W | 195 | 9 |
| 1800 | CTD | 02/09/04 | 06:33 | 48° 31.9 S | 60° 40.5 W | 260 | 11 |
| 1801 | Semi-Pelagic | 02/09/04 | 06:51 | 48° 31.6 S | 60° 40.2 W | 263 | 69 |
| 1802 | CTD | 02/09/04 | 09:30 | 48° 25.4 S | 60° 21.6 W | 372 | 16 |
| 1803 | Semi-Pelagic | 02/09/04 | 09:53 | 48° 25.2 S | 60° 21.8 W | 385 | 79 |
| 1804 | CTD | 02/09/04 | 12:26 | 48° 19.9 S | 60° 4.4 W | 473 | 18 |
| 1805 | Semi-Pelagic | 02/09/04 | 12:51 | 48° 19.3 S | 60° 4.2 W | 472 | 87 |
| 1806 | Semi-Pelagic | 02/09/04 | 15:48 | 48° 12.8 S | 59° 40.7 W | 630 | 124 |
| 1807 | CTD | 02/09/04 | 18:29 | 48° 3.9 S | 59° 43.3 W | 665 | 25 |
| 1808 | CTD | 03/09/04 | 06:43 | 46° 58.1 S | 60° 48.2 W | 213 | 10 |
| 1809 | Semi-Pelagic | 03/09/04 | 09:52 | 46° 58.2 S | 60° 47.6 W | 232 | 66 |
| 1810 | CTD | 03/09/04 | 12:29 | 46° 56.4 S | 60° 34.3 W | 374 | 14 |
| 1811 | Semi-Pelagic | 03/09/04 | 12:50 | 46° 56.5 S | 60° 33.8 W | 383 | 76 |
| 1812 | CTD | 03/09/04 | 15:52 | 47° 2 S | 60° 10.6 W | 635 | 24 |

| Station | Activity | *Date* | *Start Time* | *Start Latitude* | *Start Longitude* | *Modal Depth (m)* | *Duration (min)* |
|---|---|---|---|---|---|---|---|
| 1813 | Semi-Pelagic | 03/09/04 | 16:21 | 47° 2.5 S | 60° 10.5 W | 651 | 126 |
| 1814 | CTD | 05/09/04 | 06:39 | 45° 11.9 S | 60° 2.8 W | 152 | 7 |
| 1815 | Semi-Pelagic | 05/09/04 | 07:34 | 45° 12 S | 60° 3.1 W | 148 | 62 |
| 1816 | CTD | 05/09/04 | 09:17 | 45° 12 S | 60° 1.6 W | 214 | 10 |
| 1817 | Semi-Pelagic | 05/09/04 | 09:34 | 45° 12.1 S | 60° 1.3 W | 230 | 68 |
| 1818 | Semi-Pelagic | 05/09/04 | 17:53 | 45° 17 S | 59° 59.9 W | 322 | 70 |
| 1819 | CTD | 05/09/04 | 19:17 | 45° 20 S | 59° 59.8 W | 359 | 16 |
| 1820 | CTD | 05/09/04 | 20:00 | 45° 19.7 S | 59° 55.1 W | 644 | 24 |
| 1821 | CTD | 06/09/04 | 07:04 | 46° 18.4 S | 60° 17.8 W | 178 | 8 |
| 1822 | Semi-Pelagic | 06/09/04 | 07:25 | 46° 18 S | 60° 18.1 W | 150 | 58 |
| 1823 | CTD | 06/09/04 | 08:50 | 46° 14.4 S | 60° 15.1 W | 230 | 9 |
| 1824 | Semi-Pelagic | 06/09/04 | 09:17 | 46° 15.1 S | 60° 14.7 W | 237 | 71 |
| 1825 | CTD | 06/09/04 | 11:03 | 46° 18.7 S | 60° 12.4 W | 363 | 13 |
| 1826 | Semi-Pelagic | 06/09/04 | 11:30 | 46° 19.3 S | 60° 12.3 W | 356 | 97 |
| 1827 | CTD | 06/09/04 | 14:00 | 46° 23.8 S | 60° 6.1 W | 610 | 21 |
| 1828 | Semi-Pelagic | 06/09/04 | 14:29 | 46° 22.9 S | 60° 6.2 W | 589 | 122 |
| 1829 | Semi-Pelagic | 06/09/04 | 18:22 | 46° 8.1 S | 60° 13 W | 223 | 82 |
| 1830 | CTD | 07/09/04 | 07:00 | 47° 43 S | 60° 6.6 W | 608 | 19 |
| 1831 | CTD | 09/09/04 | 06:41 | 50° 48.6 S | 56° 49.2 W | 359 | 14 |
| 1832 | Semi-Pelagic | 09/09/04 | 07:18 | 50° 48.3 S | 56° 50.7 W | 319 | 81 |
| 1833 | CTD | 09/09/04 | 09:50 | 50° 51.9 S | 56° 56.1 W | 233 | 10 |
| 1834 | CTD | 09/09/04 | 11:46 | 50° 46.8 S | 56° 32.3 W | 451 | 11 |
| 1835 | Semi-Pelagic | 09/09/04 | 12:06 | 50° 46.6 S | 56° 32.3 W | 447 | 96 |
| 1836 | CTD | 09/09/04 | 15:02 | 50° 46.2 S | 56° 14.6 W | 621 | 23 |
| 1837 | CTD | 11/09/04 | 09:59 | 51° 39.5 S | 57° 45.4 W | 18 | 3 |
| 1838 | CTD | 11/09/04 | 10:56 | 51° 42 S | 57° 33 W | 98 | 5 |
| 1839 | CTD | 11/09/04 | 11:49 | 51° 44 S | 57° 22.2 W | 188 | 8 |
| 1840 | Semi-Pelagic | 11/09/04 | 12:07 | 51° 43.1 S | 57° 20.6 W | 209 | 67 |
| 1841 | CTD | 11/09/04 | 14:03 | 51° 43.8 S | 57° 8.5 W | 294 | 11 |
| 1842 | Semi-Pelagic | 11/09/04 | 14:29 | 51° 44 S | 57° 5.6 W | 351 | 85 |
| 1843 | Semi-Pelagic | 11/09/04 | 16:18 | 51° 49 S | 57° 2 W | 439 | 115 |
| 1844 | CTD | 11/09/04 | 19:44 | 51° 44 S | 56° 41 W | 529 | 17 |
| 1845 | CTD | 11/09/04 | 21:51 | 51° 46 S | 56° 10 W | 1004 | 36 |
| 1846 | CTD | 12/09/04 | 00:19 | 51° 45 S | 55° 36.8 W | 1147 | 43 |
| 1847 | CTD | 12/09/04 | 07:34 | 52° 31.3 S | 57° 2.9 W | 678 | 24 |
| 1848 | Semi-Pelagic | 12/09/04 | 08:13 | 52° 29.7 S | 57° 4.7 W | 595 | 108 |
| 1849 | CTD | 12/09/04 | 11:43 | 52° 25.6 S | 57° 19.2 W | 397 | 15 |
| 1850 | Semi-Pelagic | 12/09/04 | 12:11 | 52° 26.3 S | 57° 16.7 W | 439 | 87 |
| 1851 | CTD | 12/09/04 | 15:10 | 52° 20 S | 57° 33.3 W | 349 | 16 |
| 1852 | CTD | 12/09/04 | 20:52 | 52° 15.4 S | 57° 45.9 W | 244 | 9 |
| 1853 | CTD | 13/09/04 | 06:34 | 52° 58.3 S | 57° 53.4 W | 606 | 23 |
| 1854 | CTD | 13/09/04 | 08:00 | 52° 50.4 S | 58° 2.4 W | 453 | 18 |
| 1855 | Semi-Pelagic | 13/09/04 | 09:21 | 52° 42.3 S | 58° 13.3 W | 406 | 109 |
| 1856 | CTD | 13/09/04 | 11:59 | 52° 40.5 S | 58° 13.7 W | 418 | 16 |
| 1857 | Semi-Pelagic | 13/09/04 | 13:32 | 52° 36.7 S | 58° 18.2 W | 322 | 89 |
| 1858 | Semi-Pelagic | 13/09/04 | 15:51 | 52° 35.9 S | 58° 26.1 W | 243 | 71 |
| 1859 | CTD | 13/09/04 | 18:36 | 52° 31.4 S | 58° 23.3 W | 199 | 9 |
| 1860 | CTD | 13/09/04 | 20:52 | 52° 18.9 S | 58° 56.3 W | 67 | 6 |
| 1861 | CTD | 13/09/04 | 22:45 | 52° 31.2 S | 59° 12.4 W | 62 | 3 |
| 1862 | CTD | 14/09/04 | 00:27 | 52° 47.4 S | 59° 8.4 W | 105 | 5 |
| 1863 | CTD | 14/09/04 | 06:37 | 52° 58.6 S | 59° 4.9 W | 197 | 10 |
| 1864 | Semi-Pelagic | 14/09/04 | 07:09 | 52° 58.7 S | 59° 4.2 W | 219 | 73 |

| Station | Activity | *Date* | *Start Time* | *Start Latitude* | *Start Longitude* | *Modal Depth (m)* | *Duration (min)* |
|---|---|---|---|---|---|---|---|
| 1865 | CTD | 14/09/04 | 08:51 | 52° 59.8 S | 59° 5 W | 304 | 12 |
| 1866 | Semi-Pelagic | 14/09/04 | 09:12 | 52° 59.9 S | 59° 5.3 W | 315 | 75 |
| 1867 | Semi-Pelagic | 14/09/04 | 14:11 | 53° 1.5 S | 59° 3.6 W | 415 | 92 |
| 1868 | CTD | 14/09/04 | 16:11 | 53° 6.1 S | 59° 4 W | 510 | 20 |
| 1869 | Semi-Pelagic | 14/09/04 | 17:35 | 53° 13.2 S | 59° 4.6 W | 605 | 118 |
| 1870 | CTD | 14/09/04 | 20:25 | 53° 15.2 S | 59° 1.8 W | 674 | 25 |
| 1871 | CTD | 14/09/04 | 21:37 | 53° 20.8 S | 59° 0.3 W | 1170 | 42 |
| 1872 | CTD | 15/09/04 | 06:35 | 53° 11 S | 60° 27.1 W | 579 | 22 |
| 1873 | Semi-Pelagic | 15/09/04 | 07:24 | 53° 12.4 S | 60° 26.4 W | 585 | 122 |
| 1874 | CTD | 15/09/04 | 11:19 | 53° 0 S | 60° 20.9 W | 465 | 18 |
| 1875 | Semi-Pelagic | 15/09/04 | 18:38 | 52° 53.3 S | 60° 14.6 W | 320 | 80 |
| 1876 | CTD | 15/09/04 | 20:30 | 52° 52.4 S | 60° 17.1 W | 287 | 13 |
| 1877 | CTD | 15/09/04 | 21:55 | 52° 45.8 S | 60° 12.1 W | 199 | 8 |
| 1878 | CTD | 16/09/04 | 06:29 | 52° 26.4 S | 60° 48.4 W | 197 | 11 |
| 1879 | Semi-Pelagic | 16/09/04 | 07:14 | 52° 25.6 S | 60° 48.4 W | 187 | 59 |
| 1880 | CTD | 16/09/04 | 09:23 | 52° 33.2 S | 60° 53.2 W | 290 | 11 |
| 1881 | Semi-Pelagic | 16/09/04 | 10:00 | 52° 32.6 S | 60° 52.2 W | 296 | 84 |
| 1882 | CTD | 16/09/04 | 12:32 | 52° 39.1 S | 60° 57.7 W | 365 | 15 |
| 1883 | Semi-Pelagic | 16/09/04 | 12:53 | 52° 38.8 S | 60° 56.8 W | 361 | 82 |
| 1884 | CTD | 16/09/04 | 16:47 | 52° 52.4 S | 61° 8.2 W | 371 | 16 |
| 1885 | Semi-Pelagic | 16/09/04 | 18:10 | 53° 3.8 S | 61° 8.5 W | 468 | 116 |
| 1886 | CTD | 16/09/04 | 21:20 | 53° 1.9 S | 61° 16.2 W | 447 | 16 |
| 1887 | CTD | 20/09/04 | 10:53 | 54° 54.3 S | 65° 11.9 W | 103 | 5 |
| 1888 | CTD | 20/09/04 | 14:20 | 54° 55.9 S | 64° 22 W | 381 | 14 |
| 1889 | Semi-Pelagic | 20/09/04 | 14:43 | 54° 55.5 S | 64° 20.1 W | 351 | 87 |
| 1890 | CTD | 20/09/04 | 16:48 | 54° 50.6 S | 64° 0.6 W | 151 | 8 |
| 1891 | Semi-Pelagic | 20/09/04 | 17:18 | 54° 49.6 S | 63° 55.9 W | 173 | 71 |
| 1892 | Semi-Pelagic | 20/09/04 | 19:15 | 54° 49.3 S | 63° 47.2 W | 259 | 85 |
| 1893 | CTD | 22/09/04 | 06:26 | 52° 27.1 S | 62° 21.8 W | 291 | 13 |
| 1894 | Semi-Pelagic | 22/09/04 | 07:20 | 52° 28 S | 62° 20 W | 289 | 75 |
| 1895 | CTD | 22/09/04 | 09:38 | 52° 23 S | 62° 2.9 W | 299 | 13 |
| 1896 | Semi-Pelagic | 22/09/04 | 09:57 | 52° 22.9 S | 62° 2.3 W | 295 | 76 |
| 1897 | CTD | 22/09/04 | 12:17 | 52° 16.8 S | 61° 45.7 W | 317 | 13 |
| 1898 | Semi-Pelagic | 22/09/04 | 12:37 | 52° 16.6 S | 61° 44.4 W | 324 | 86 |
| 1899 | CTD | 22/09/04 | 14:38 | 52° 14.1 S | 61° 29.9 W | 241 | 11 |
| 1900 | Semi-Pelagic | 22/09/04 | 15:35 | 52° 14.7 S | 61° 19.8 W | 178 | 100 |
| 1901 | CTD | 22/09/04 | 17:42 | 52° 10.6 S | 61° 17.2 W | 159 | 8 |
| 1902 | CTD | 23/09/04 | 07:05 | 51° 38.6 S | 61° 8 W | 72 | 5 |
| 1903 | Semi-Pelagic | 23/09/04 | 07:50 | 51° 39.2 S | 61° 0.8 W | 72 | 64 |
| 1904 | CTD | 23/09/04 | 10:33 | 51° 43.7 S | 60° 45 W | 42 | 3 |
| 1905 | CTD | 23/09/04 | 11:44 | 51° 34.8 S | 60° 35.7 W | 61 | 4 |
| 1906 | CTD | 23/09/04 | 13:21 | 51° 26.6 S | 60° 51 W | 74 | 3 |
| 1907 | Semi-Pelagic | 23/09/04 | 13:41 | 51° 26.5 S | 60° 50.7 W | 76 | 57 |
| 1908 | CTD | 23/09/04 | 17:06 | 51° 22.3 S | 60° 27.6 W | 32 | 5 |

## 2.3 Length-frequency sampling

A minimum of 100 individuals (or the entire catch if the catch was less than 100 individuals) of *Micromesistius australis australis* were randomly sampled. Each individual was measured for the following: total length (cm), weight (g); sex, and maturity stage. Occasionally, gonad weight and liver weight were also recorded for this species.

## 2.4 Otolith sampling

Due to the small number of southern blue whiting caught, otoliths were only collected on two occasions. On both these occasions, the sagittae were removed with plastic forceps, cleaned of any traces of mucus and blood, and stored separately. One sagittae of each of the 72 fish sampled was given to the Argentine and UK scientists.

## 2.5 Muscle tissue sampling

Two muscles tissue samples were taken from all the fish that were sampled in detail, with both the UK scientists and Argentine scientists getting a piece each. The tissue was collected by making two parallel cuts with a scalpel blade on the left flank of the fish, several millimetres apart. A strip, no wider than 5mm and not longer than 20mm, was removed with a scalpel and plastic forceps and stored in a labelled vial filled with 96% ethanol. To ensure there was no contamination, both the scalpel and forceps were rinsed in a sea water bath prior to the removal of the next sample.

## 2.6 Gonad sampling

The ovaries of 52 adult females were removed within 2 hours of the catch arriving on the deck. Most of these ovaries (n = 45) were taken from station 1867, with the remainder taken from various stations. To preserve these ovaries, each one was placed in a labelled plastic bag that was perforated, and then dropped in a sealable drum containing 10% Buffered Formol Saline solution (around 40-50 gonads per 20 litres of solution).

## 3. Oceanographic methods

### 3.1 Oceanographic sampling

A logging CTD (SBE-25, Sea-Bird Electronics Inc., Bellevue, USA) was used to obtain profiles of temperature (ºC), salinity (PSU), and dissolved oxygen (ml $l^{-1}$) at 72 oceanographic stations (Table 2; Fig. 2). The CTD was deployed for one minute at each station to a depth of between 8-10 m, to allow the oxygen sensor to polarise. It was then winched up to a depth of one metre and deployed to either a depth about 10-20 m above the sea bottom (shelf and continental slope) or down to 1000 m in the open sea. The speed of deployment was approximately 1m/s and was monitored by wire counter. While temperature was measured directly, the other variables were calculated using the Seasoft v.4.326 software (Sea-Bird Electronics Inc.) and the following measured parameters: pressure (db), conductivity (S/m), oxygen current (µA) and oxygen temperature (ºC). This software was also used to construct vertical profiles of temperature, salinity and density of each station while the VG griding method in the Ocean Data View package v. 5.2-2000 (Schlitzer 2000) was used to construct profiles and iso-surfaces for each transect.

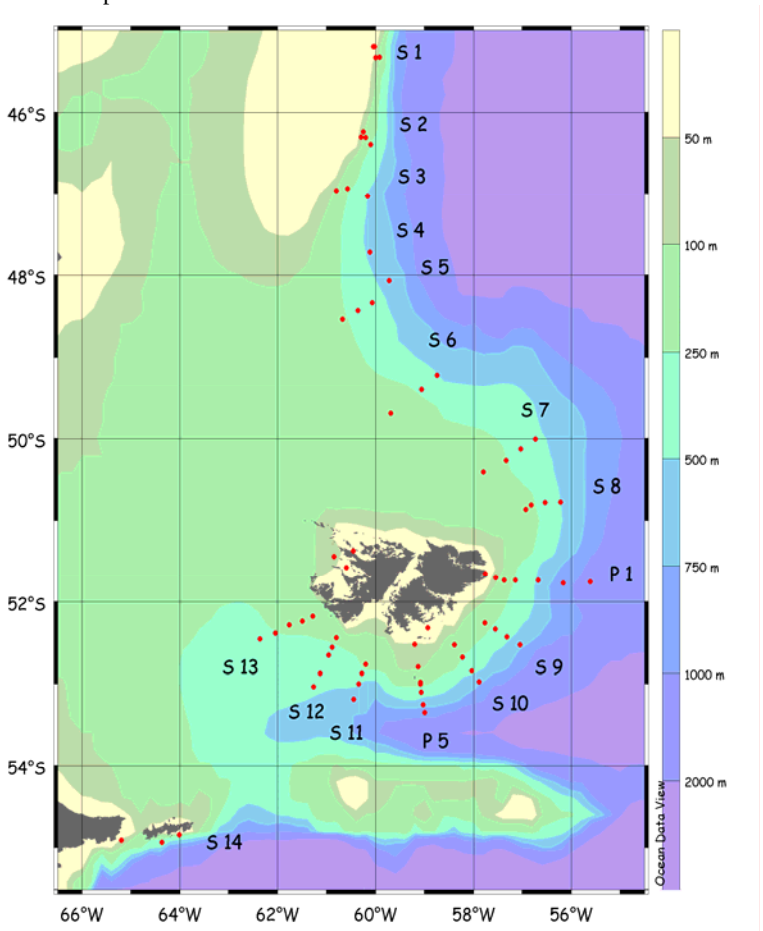



*Figure 2. Location of oceanographic transects conducted on the research cruise ZDLH1-09-2004.*

### 3.2 Results

CTD stations covered the offshore part of Patagonian shelf from of Isla de Los Estados (Staten Island) in the south to 45ºS in the north. Throughout this region, temperatures ranged from 3.2º to 6.7ºC, salinity from 32.2 to 34.3 psu, oxygen from 4.6 to 7.4 ml/l, and densities from 25.4 to 27.3 kg/$m^3$. A comparison of oceanographic features at regularly sampled transects P1 and P5 revealed that the hydroclimatic situation at this time of the year was similar to that in previous years. However, both 2003 and 2004 were much warmer than the previous 3 years. The spatial distribution of temperature, salinity, oxygen, and chlorophyll “a” at the different horizons are shown in Figs. 3-5, while the vertical profiles of temperature, salinity, oxygen and chlorophyll “a” for each oceanographic transect are shown in Figs 6-20.

The maximum abundance of chlorophyll “a” was found at the southern blue whiting spawning grounds south- and southeast of the Falkland Islands. High abundances were also discovered in shallow waters of King George Bay and Queen Charlotte Bay, and above the shelf edge at 45-46ºS (Fig 3). By contrast, the lowest abundances of chlorophyll “a” were found in an area east of the Falkland Islands. This low abundance was probably due to the impact of the Falkland Current.

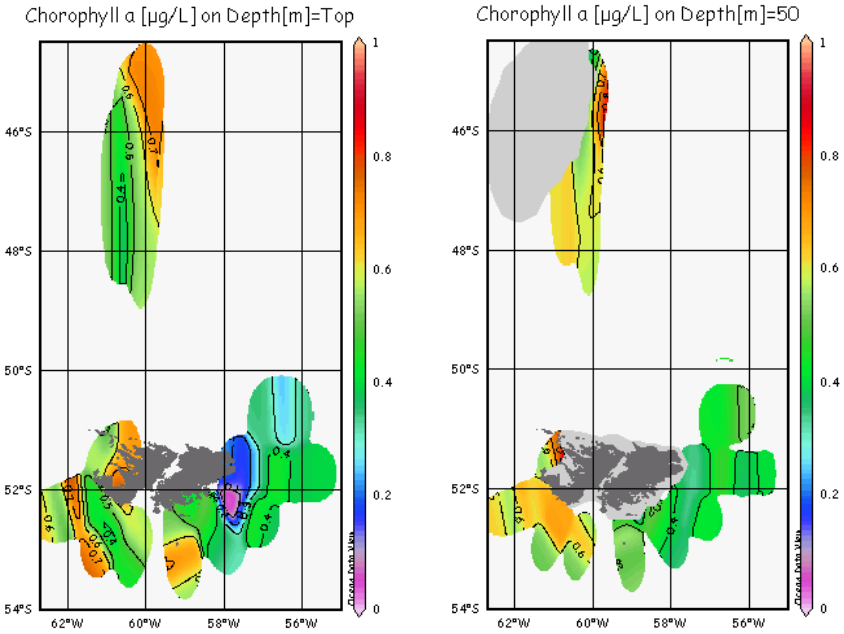



*Figure 3. Iso-surface of chlorophyll “a” found at the surface and at a depth of 50m depth during the research cruise ZDLH1-09-2004.*

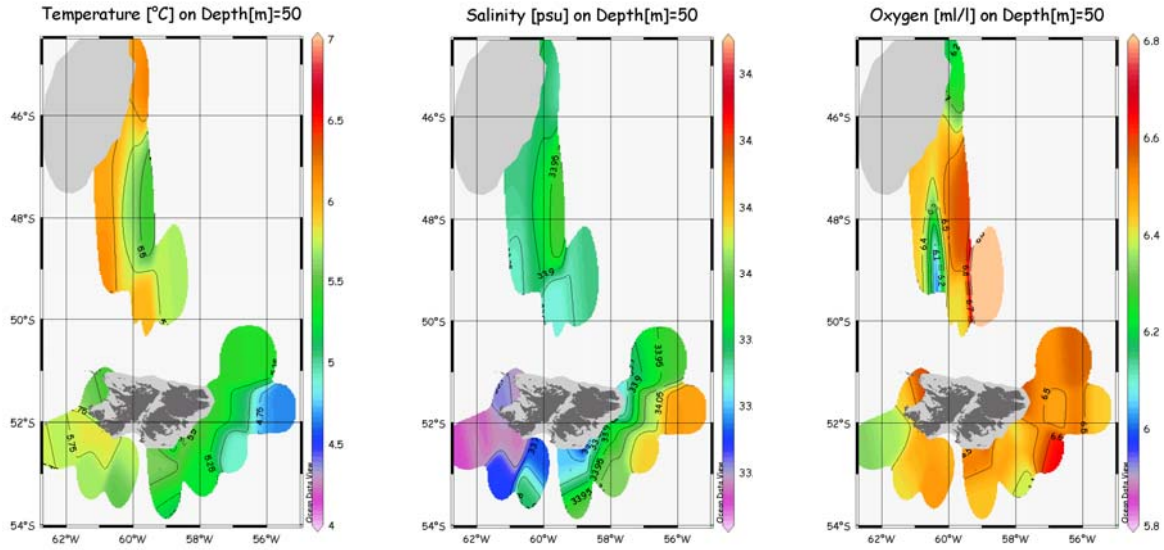



*Figure 4. Iso-surface of temperature, salinity and oxygen at the surface and at a depth of 50m during the research cruise ZDLH1-09-2004.*

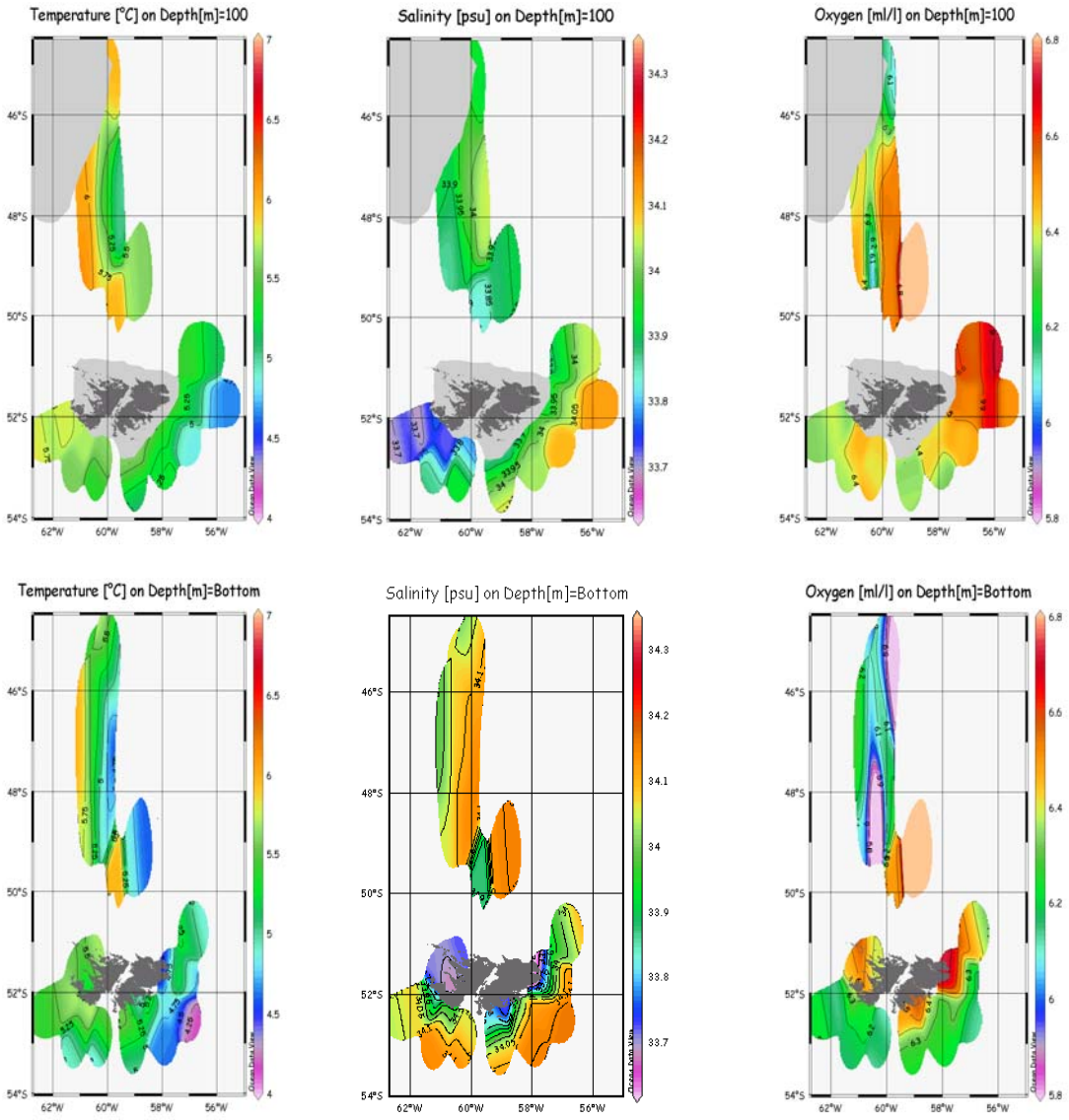



*Figure 5. Iso-surface of temperature, salinity and oxygen found at a depth of 100 m during research cruise ZDLH1-09-2004.*

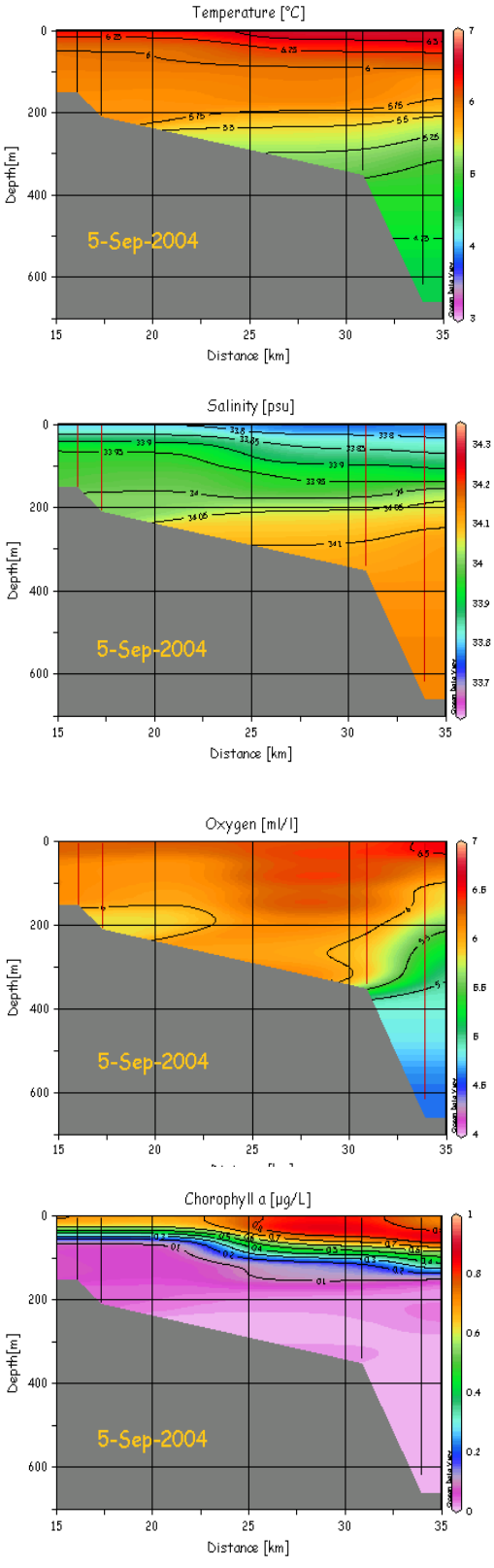



*Figure 6. Contoured vertical sections for transect S1*

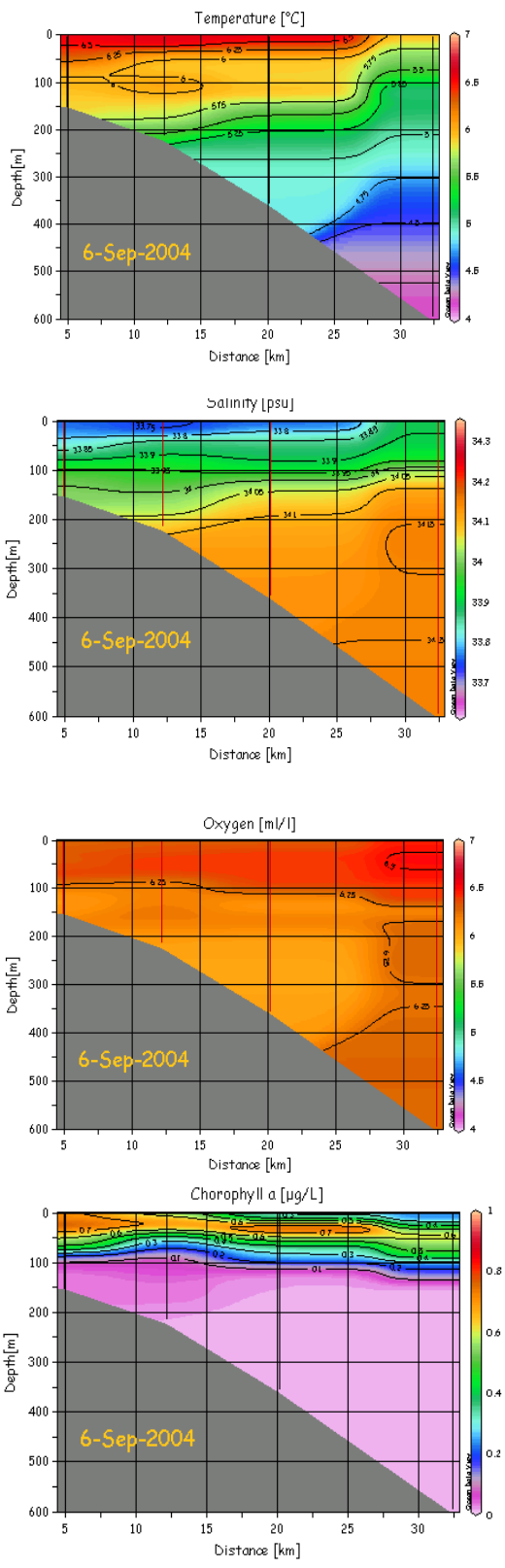



*Figure 7. Contoured vertical sections for transect S2*

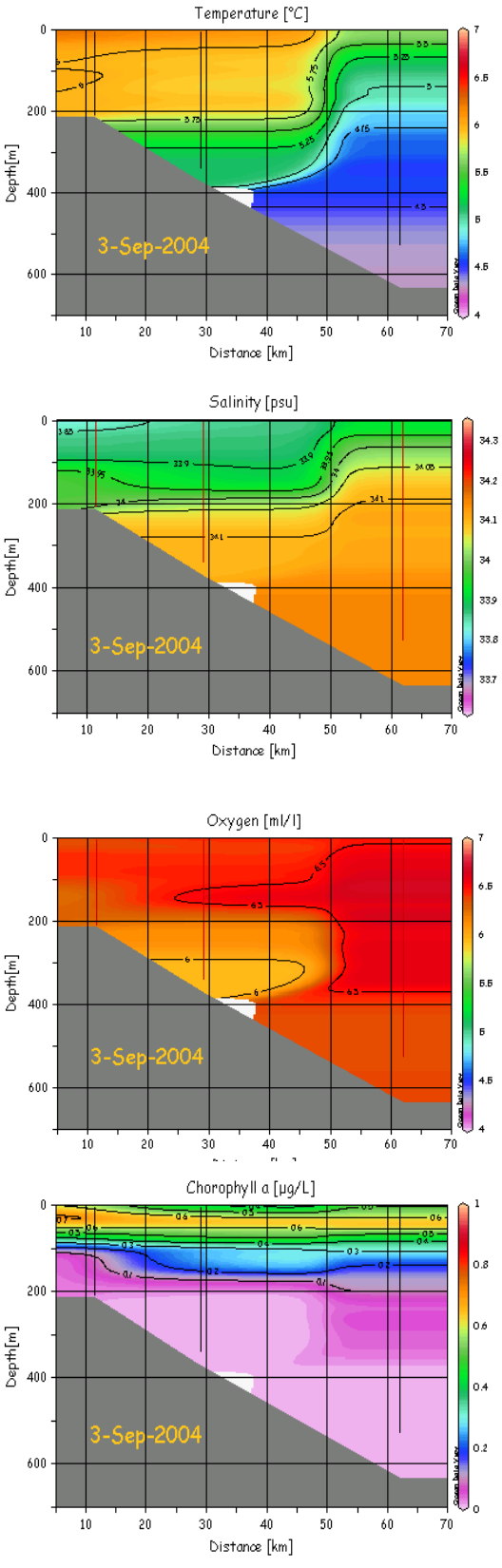



*Figure 8. Contoured vertical sections for transect S3*

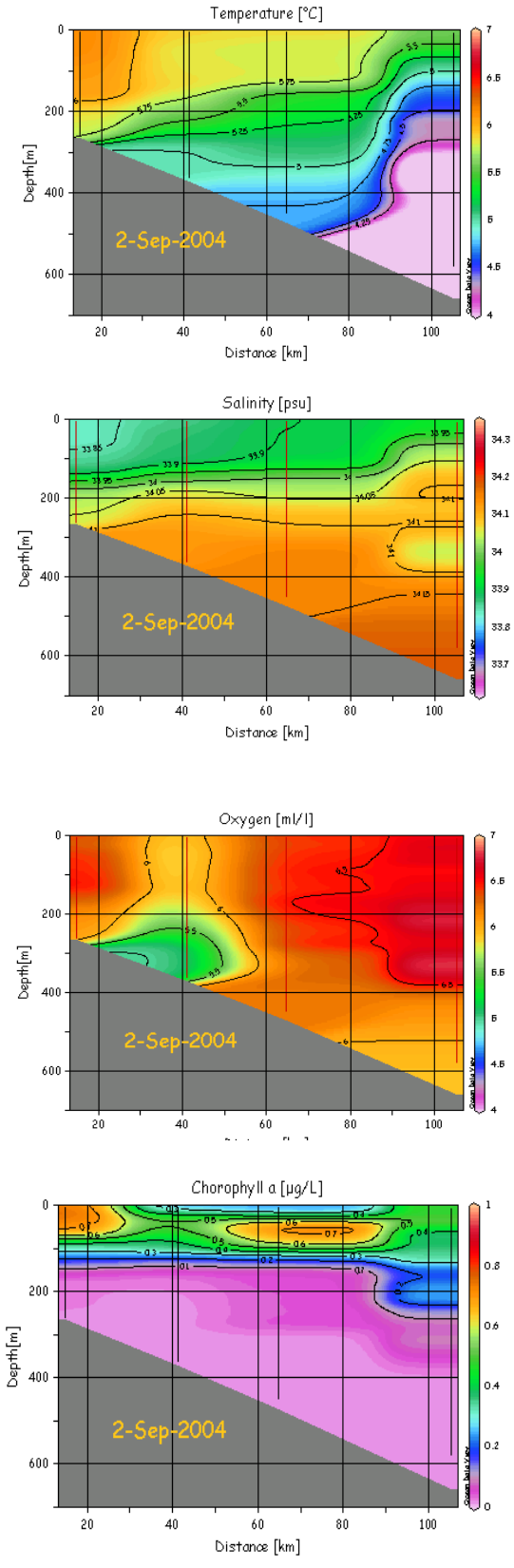



*Figure 9. Contoured vertical sections for transect S5*

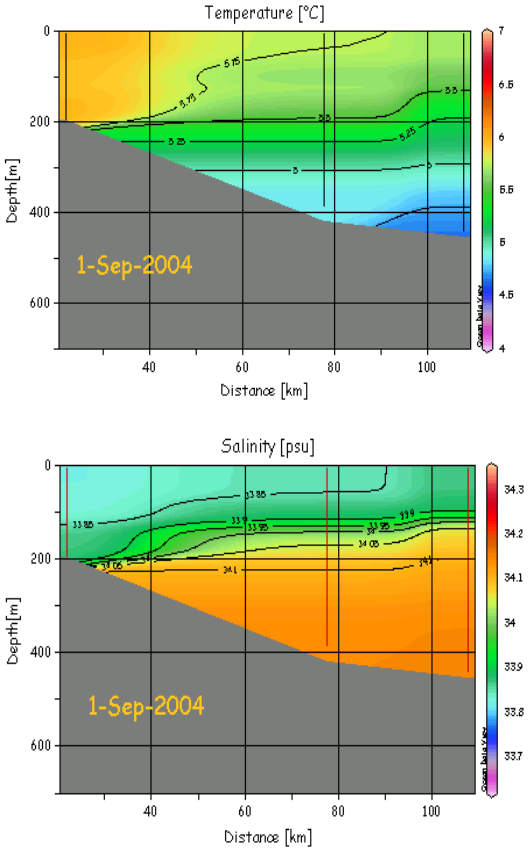



*Figure 10. Contoured vertical sections for transect S6*

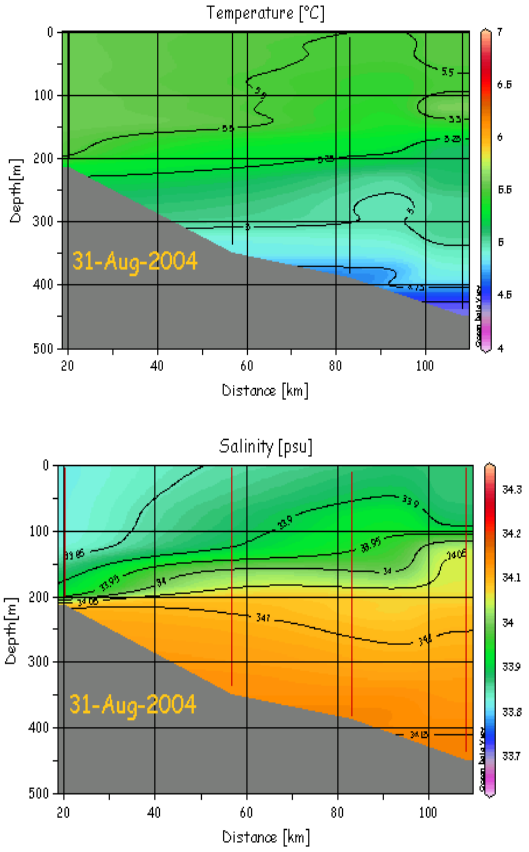
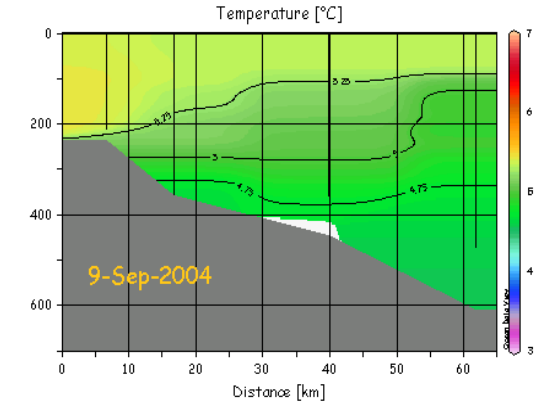
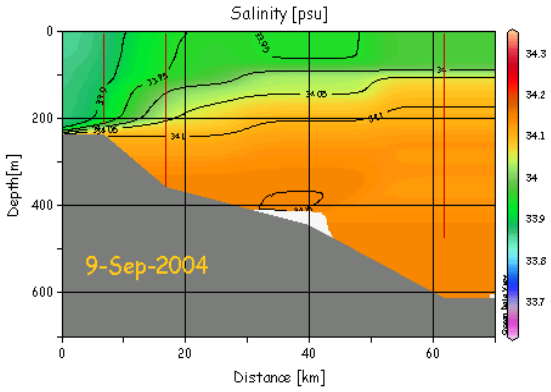
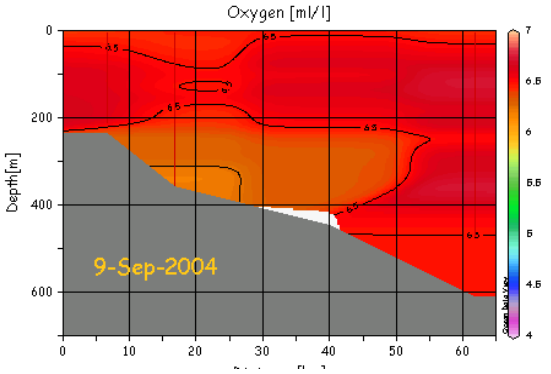



*Figure 11. Contoured vertical sections for transect S7*



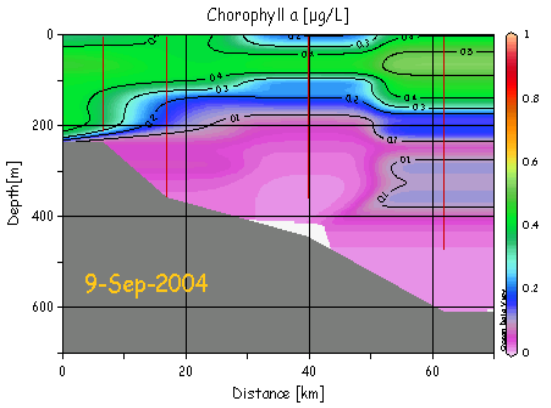
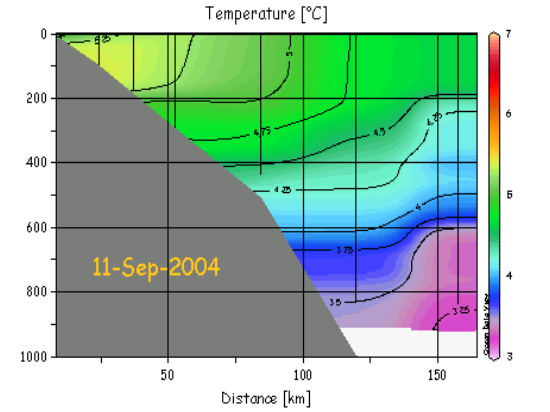
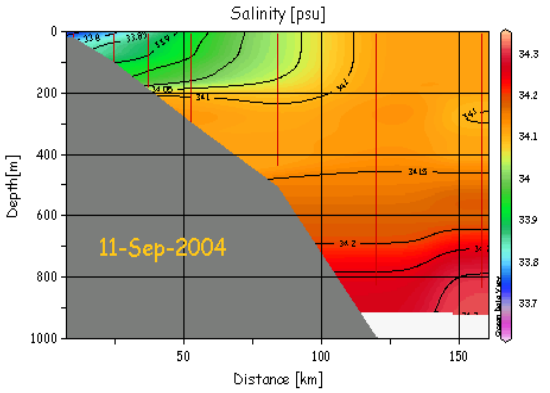
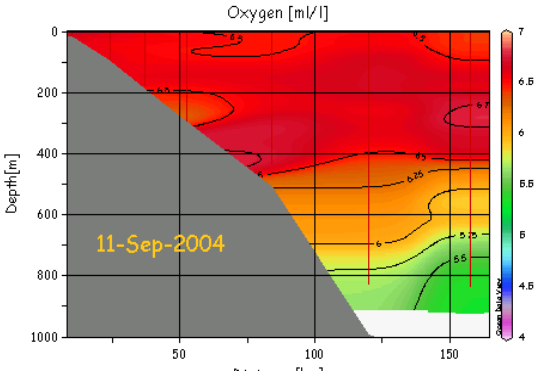




*Figure 12. Contoured vertical sections for transect S8*



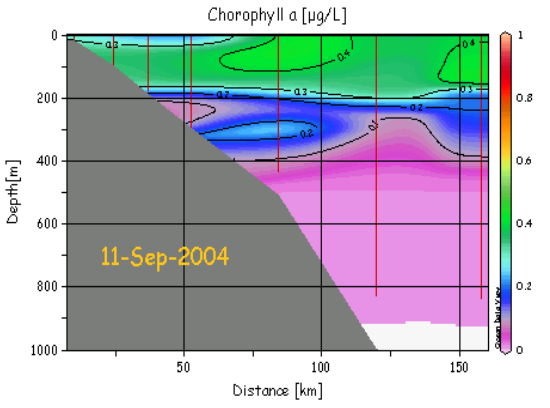
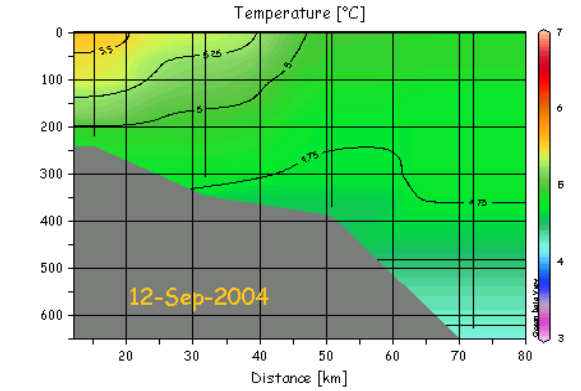
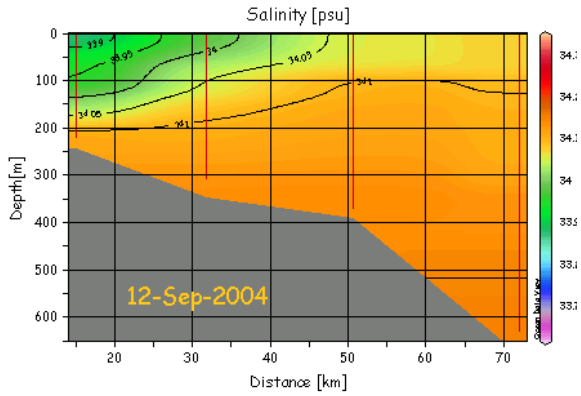
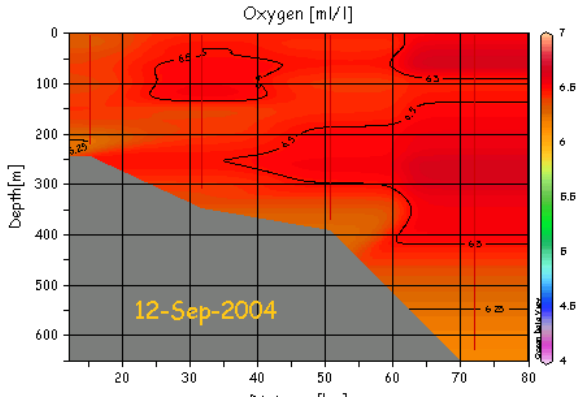




*Figure 13. Contoured vertical sections for transect P1*



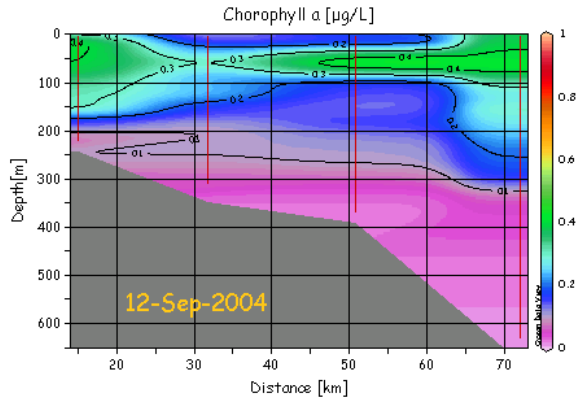
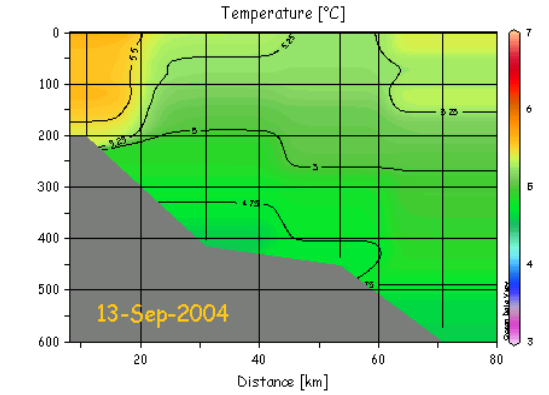
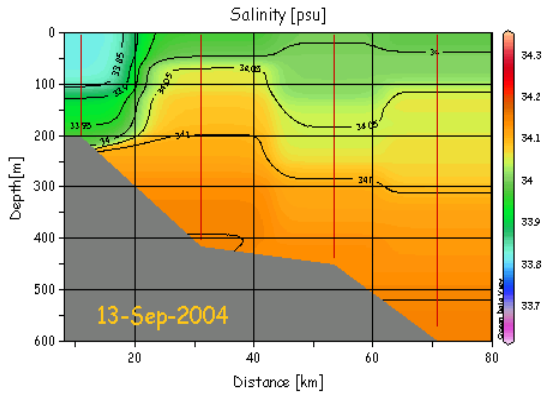
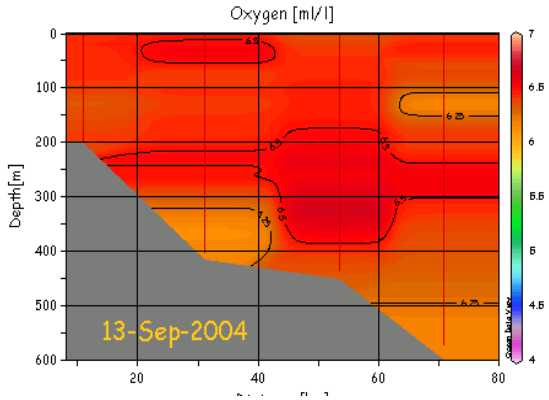




*Figure 14. Contoured vertical sections for transect S9*



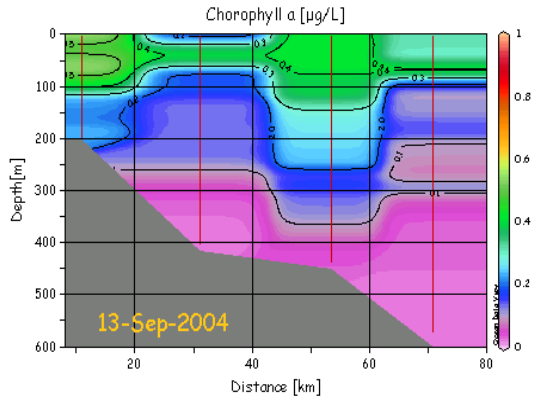
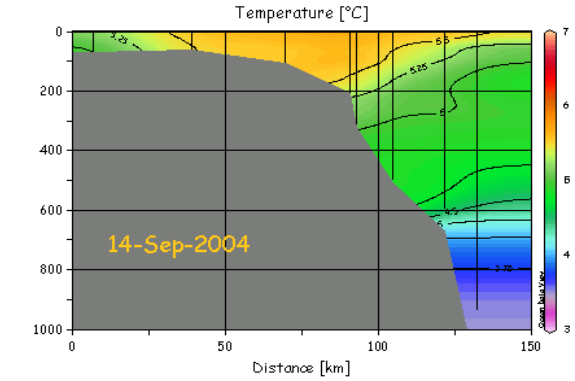
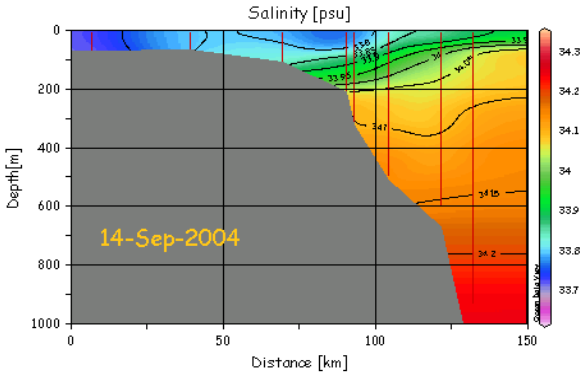
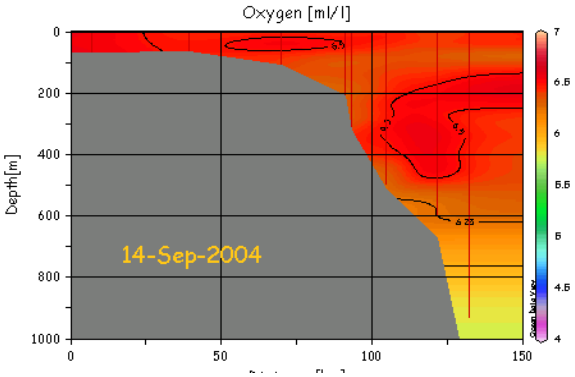




*Figure 15. Contoured vertical sections for transect S10*



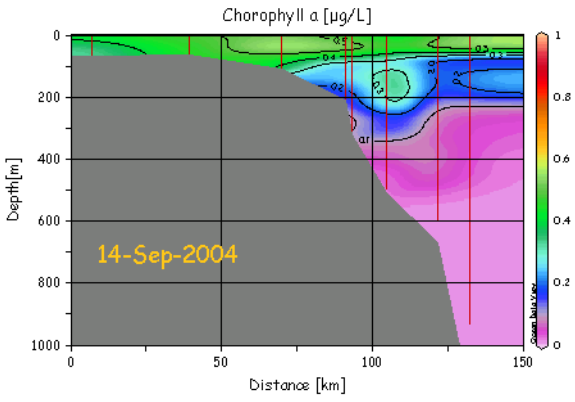
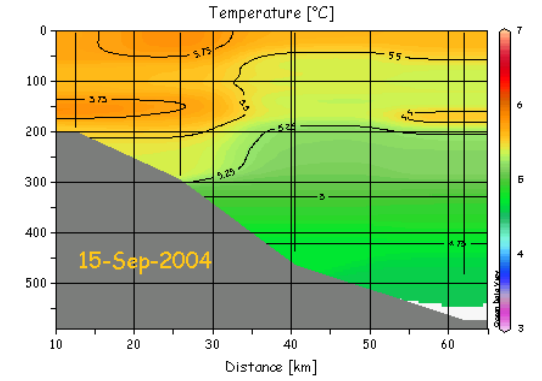
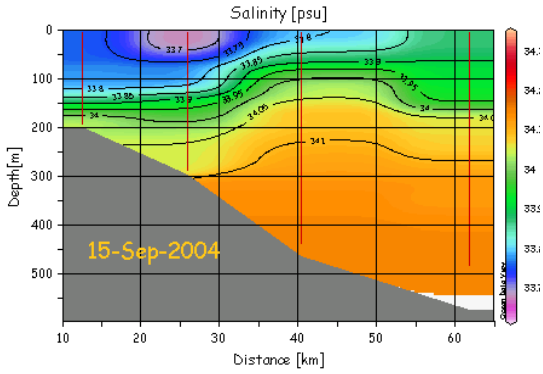
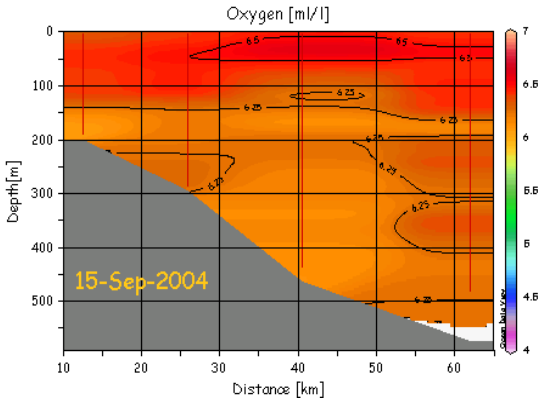




*Figure 16. Contoured vertical sections for transect P5*



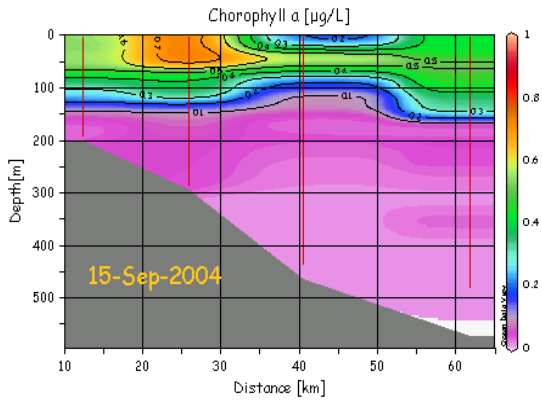




*Figure 17. Contoured vertical sections for transect S11*

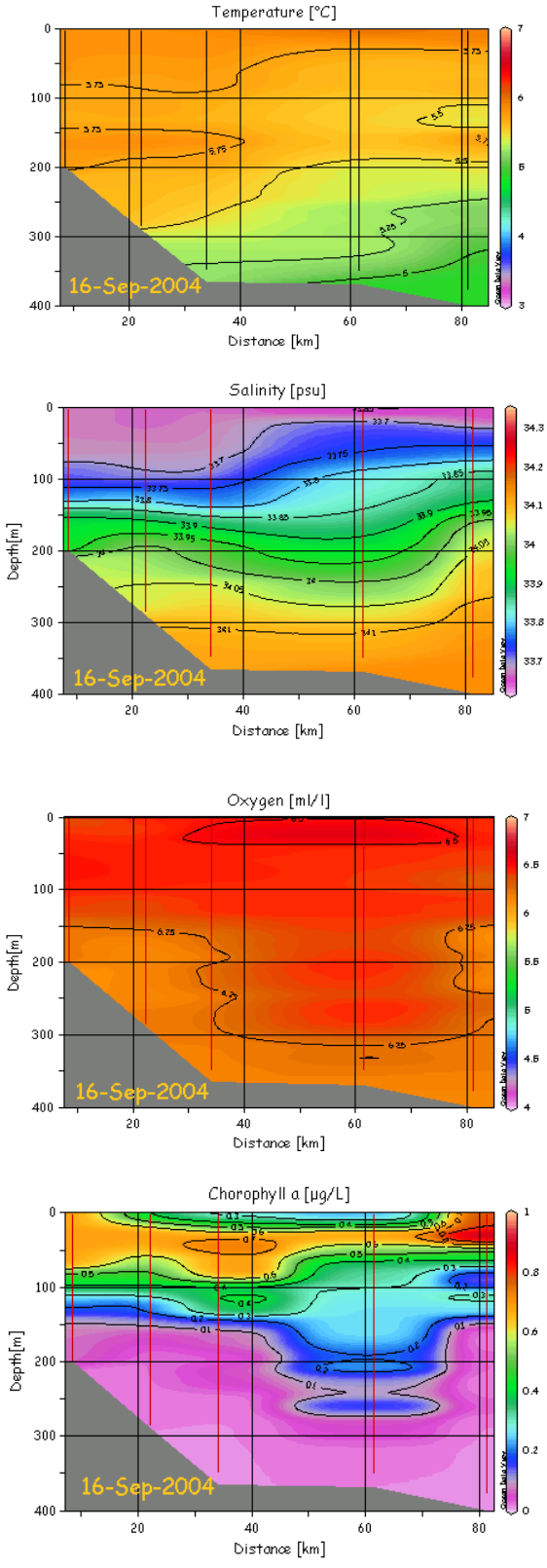



*Figure 18. Contoured vertical sections for transect S12*

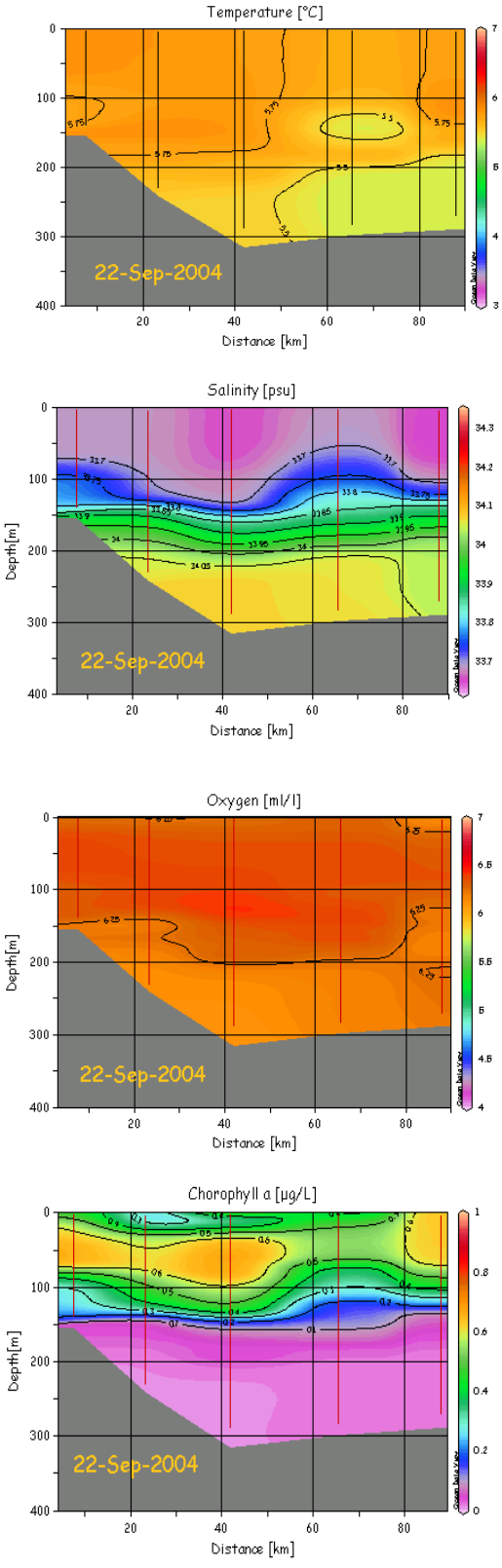



*Figure 19. Contoured vertical sections for transect S13*

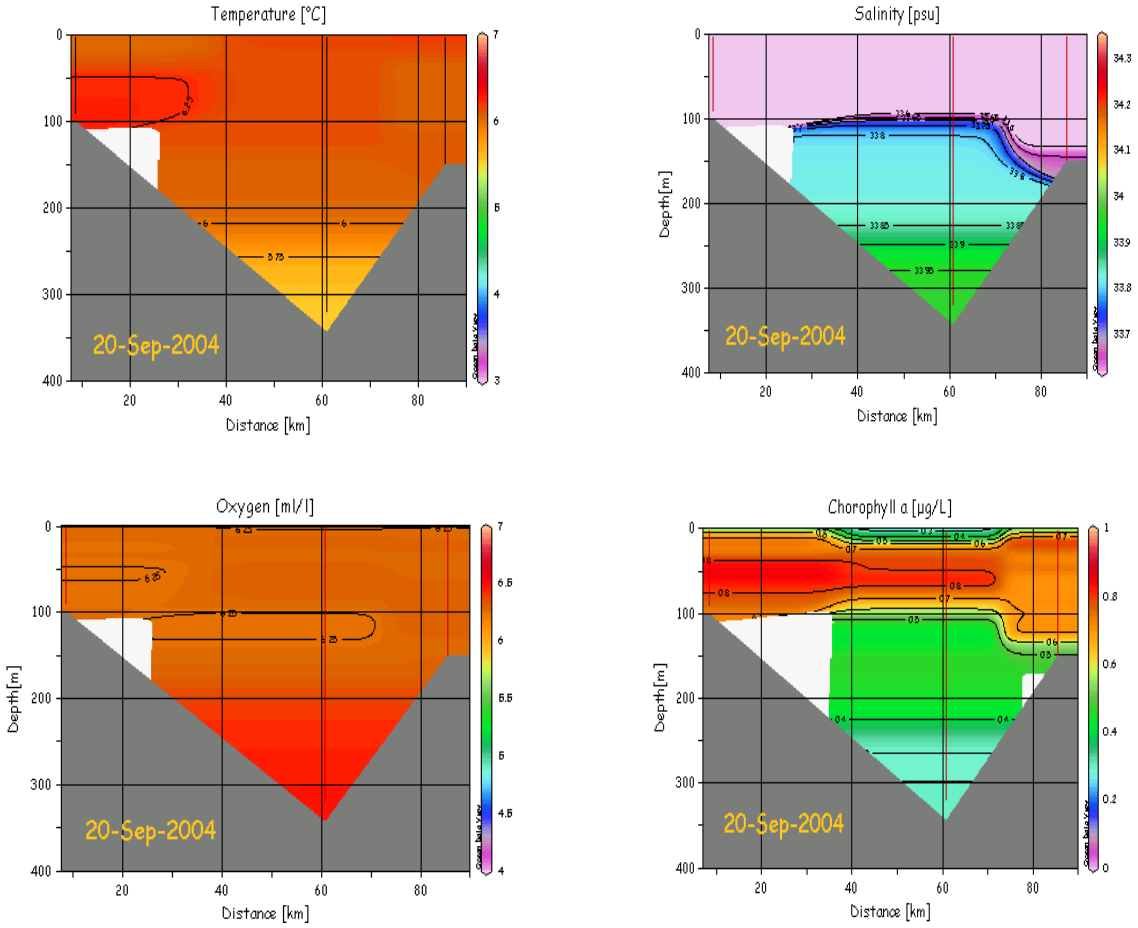



*Figure 20. Contoured vertical sections for transect S14*

## 4. Biological sampling

### 4.1 Catch and by-catch

The location of the 52 Semi-Pelagic trawls conducted with the Engel-Netze trawl during this cruise are shown in Fig. 21. In total, 5,976.56 kg was caught, with 1,929.045 kg of that sampled (Table 3). In terms of weight, the greatest overall catch was Hoki *Macruronus magellanicus*, followed by grenadier *Macrourus carinatus*, squid *Loligo gahi*, and southern blue whiting *Micromesistius australis australis*.

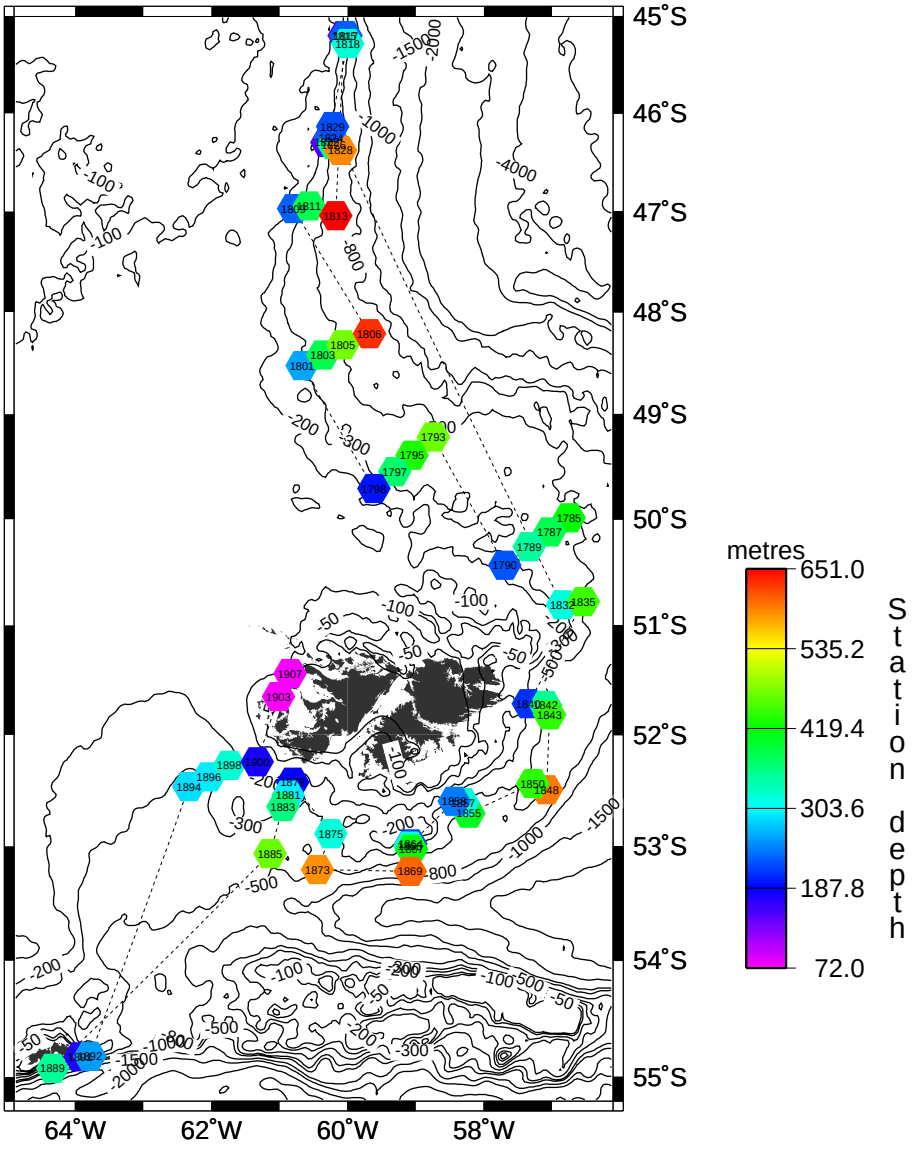



*Figure 21. Location and depth (m) of semi-pelagic trawl stations conducted during the research cruise ZDLH1-09-2004 during the 30th Aug. and 24th Sept. 2004.*

*Table 3. Total catch of semi-pelagic stations 1785-1907 undertaken on the research cruise ZDLH1-09-2004 during the 30th Aug. and 24th Sept. 2004.*

| Species Code | Species name | Catch (kg) | Sampled (kg) | Discarded (kg) | Proportion (%) |
|---|---|---|---|---|---|
| WHI | *Macruronus magellanicus* | 3070.225 | 223.346 | 2619.015 | 51.37% |
| GRC | *Macrourus carinatus* | 1110.313 | 561.205 | 1001.929 | 18.58% |
| LOL | *Loligo gahi* | 419.958 | 241.487 | 200.638 | 7.03% |
| BLU | *Micromesistius australis* | 165.824 | 78.721 | 165.824 | 2.77% |
| HAK | *Merluccius hubbsi* | 163.308 | 161.919 | 0.000 | 2.73% |
| GYN | *Gymnoscopelus nicholsi* | 149.291 | 0.000 | 148.093 | 2.50% |
| PAT | *Merluccius australis* | 103.088 | 103.088 | 0.000 | 1.72% |
| DGH | *Schroederichthys bivius* | 92.984 | 61.616 | 61.616 | 1.56% |
| POR | *Lamna nasus* | 90.130 | 90.130 | 0.000 | 1.51% |
| PAR | *Patagonotothen ramsayi* | 67.778 | 67.029 | 62.446 | 1.13% |
| MED | Medusae sp. | 62.089 | 0.000 | 62.089 | 1.04% |
| SPN | Sponges | 55.569 | 0.000 | 55.569 | 0.93% |
| RGR | *Bathyraja griseocauda* | 37.604 | 37.604 | 19.364 | 0.63% |
| TOO | *Dissostichus eleginoides* | 37.061 | 37.061 | 0.000 | 0.62% |
| ANT | Anthozoa | 30.409 | 0.000 | 30.409 | 0.51% |
| GRF | *Coelorhynchus fasciatus* | 29.285 | 26.393 | 29.285 | 0.49% |
| LAR | *Lampris immaculatus* | 25.850 | 25.850 | 0.000 | 0.43% |
| RAL | *Bathyraja albomaculata* | 24.882 | 22.447 | 22.447 | 0.42% |
| BAC | *Salilota australis* | 20.207 | 20.207 | 14.206 | 0.34% |
| RFL | *Raja flavirostris* | 18.580 | 18.580 | 18.580 | 0.31% |
| SEP | *Seriolella porosa* | 17.571 | 17.571 | 0.000 | 0.29% |
| KIN | *Genypterus blacodes* | 17.310 | 16.710 | 10.193 | 0.29% |
| RBZ | Unidentified ray #3 | 16.970 | 16.970 | 7.430 | 0.28% |
| ING | *Moroteuthis ingens* | 15.781 | 15.036 | 15.781 | 0.26% |
| DGS | *Squalus acanthias* | 14.814 | 14.814 | 14.814 | 0.25% |
| COT | *Cottunculus granulosus* | 13.554 | 13.554 | 0.000 | 0.23% |
| ALG | Algae | 10.490 | 0.000 | 10.490 | 0.18% |
| RBR | *Bathyraja brachyurops* | 9.646 | 9.646 | 9.646 | 0.16% |
| RDO | *Raja doellojuradoi* | 9.232 | 9.232 | 9.212 | 0.15% |
| ANM | Anemone | 8.156 | 0.500 | 7.656 | 0.14% |
| PYM | *Physiculus marginatus* | 7.964 | 4.136 | 3.919 | 0.13% |
| CGO | *Cottoperca gobio* | 7.846 | 7.846 | 7.846 | 0.13% |
| ROC | Rock | 7.763 | 0.000 | 7.763 | 0.13% |
| EEL | *Iluocoetes fimbriatus* | 5.514 | 0.000 | 5.514 | 0.09% |
| UCH | Sea urchin | 5.512 | 0.000 | 5.512 | 0.09% |
| RSC | *Bathyraja scaphiops* | 5.501 | 5.501 | 5.501 | 0.09% |
| GRH | *Macrourus holotrachys* | 4.713 | 4.713 | 4.713 | 0.08% |
| RMC | *Bathyraja macloviana* | 3.543 | 3.543 | 3.543 | 0.06% |
| GYB | *Gymnoscopelus bolini* | 3.296 | 0.000 | 3.296 | 0.06% |
| NEM | *Neophyrnichthys marmoratus* | 2.769 | 2.769 | 0.000 | 0.05% |
| MAM | *Mancopsetta milfordi* | 2.031 | 1.801 | 0.230 | 0.03% |
| BEE | *Benthoctopus eureka* | 1.773 | 1.773 | 0.000 | 0.03% |
| PAL | *Patagonotothen longipes* | 1.642 | 1.642 | 0.000 | 0.03% |
| BEJ | *Benthoctopus sp.cf.januarii* | 1.234 | 1.234 | 0.000 | 0.02% |
| MMA | *Mancopsetta maculata* | 0.877 | 0.607 | 0.877 | 0.01% |
| AST | Asteroidea | 0.788 | 0.000 | 0.788 | 0.01% |
| SQT | Ascidiacea | 0.706 | 0.000 | 0.706 | 0.01% |
| WLK | Whelks | 0.637 | 0.000 | 0.637 | 0.01% |

| Species Code | Species name | Catch (kg) | Sampled (kg) | Discarded (kg) | Proportion (%) |
|---|---|---|---|---|---|
| CAS | *Campylonotus semistriatus* | 0.578 | 0.377 | 0.201 | 0.01% |
| RED | *Sebastes oculatus* | 0.536 | 0.536 | 0.536 | 0.01% |
| THB | *Thymops birsteini* | 0.464 | 0.311 | 0.153 | 0.01% |
| ELE | Eledoninae-like octopod | 0.437 | 0.437 | 0.000 | 0.01% |
| PMX | *Protomictophum* spp. | 0.375 | 0.000 | 0.375 | 0.01% |
| MAT | *Achiropsetta tricholepis* | 0.350 | 0.350 | 0.350 | 0.01% |
| HIE | *Histioteuthis eltarinae* | 0.337 | 0.184 | 0.153 | 0.01% |
| PGR | *Paradiplospinus gracilis* | 0.270 | 0.225 | 0.270 | <0.00% |
| MUO | *Muraenolepis orangiensis* | 0.260 | 0.000 | 0.260 | <0.00% |
| OPH | Ophiuroidea | 0.212 | 0.000 | 0.212 | <0.00% |
| SAR | *Sprattus fuegensis* | 0.162 | 0.162 | 0.162 | <0.00% |
| PMC | *Protomictophum choriodon* | 0.125 | 0.000 | 0.125 | <0.00% |
| ILL | *Illex argentinus* | 0.113 | 0.113 | 0.113 | <0.00% |
| CAM | *Cataetyx messieri* | 0.097 | 0.028 | 0.069 | <0.00% |
| MXX | Myctophidae | 0.035 | 0.000 | 0.035 | <0.00% |
| HIX | *Histioteuthis* spp. | 0.033 | 0.000 | 0.033 | <0.00% |
| SYB | *Symbolophorus boops* | 0.028 | 0.000 | 0.028 | <0.00% |
| MUU | *Munida subrugosa* | 0.023 | 0.000 | 0.023 | <0.00% |
| MGP | *Magnisudis prionosa* | 0.021 | 0.021 | 0.021 | <0.00% |
| PAA | *Pandalopsis ampla* | 0.015 | 0.015 | 0.000 | <0.00% |
| CAV | *Campylonotus vagans* | 0.011 | 0.000 | 0.011 | <0.00% |
| MAU | *Maurolicus muelleri* | 0.005 | 0.005 | 0.000 | <0.00% |
| HYD | Hydrozoa | 0.004 | 0.000 | 0.004 | <0.00% |
| **Total** | | **5,976.560** | **1,929.045** | **4,650.712** | **100.00%** |

### *4.1.1 Micromesistius australis australis*

Southern blue whiting were taken from throughout the sampling area, except in the far south near Staten Island (Fig. 22). In total, 165.8 kg of southern blue whiting were caught in the survey, with 85% of the catch landed at station number 1867. This trawl station was located to the south of the Falkland Islands near the main spawning grounds in approximately 415 metres of water. When station 1867 was removed from the analysis, the mean weight of fish caught in the south (1.1 kg per trawl) was similar to that in the north (1.77 kg per trawl; Fig. 22). It is pertinent to note that due to inclement weather it was not possible to trawl on the principle spawning grounds of this species, which are located to the south of the west Falkland Islands. For this reason, our estimates of southern blue whiting abundance, particular in the south, are likely to be grossly underestimated. These findings do, however, clearly indicate that there are few southern blue whiting outside the main spawning grounds during the spawning season.

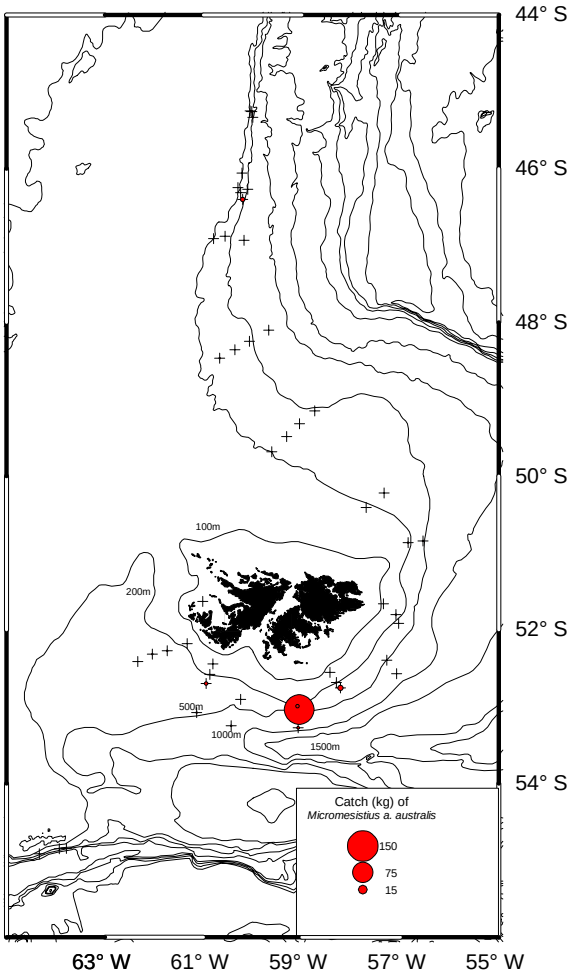



*Figure 22. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of southern blue whiting caught.*

Due to the low number of fish taken in the north, it was not possible to directly compare the size distribution and sexual maturity of fish from there with the south. Subsequently, the data from these two regions were pooled and the differences between depths compared. Although southern blue whiting were caught in depths ranging from 230 to 605 m, most were taken in waters between 350 and 450 metres deep (Fig. 23). Of the total number of fish landed within this depth range, 48% were female, 48% were male and the remaining 2% were classed as juvenile (unable to distinguish sex; Figure 23). Males caught at this depth ranged from 21-55 cm and had a unimodal size distribution around the mode of 40cm. In comparison, females were slightly larger, ranging from 23 to 64 cm and having a modal size of 48 cm.

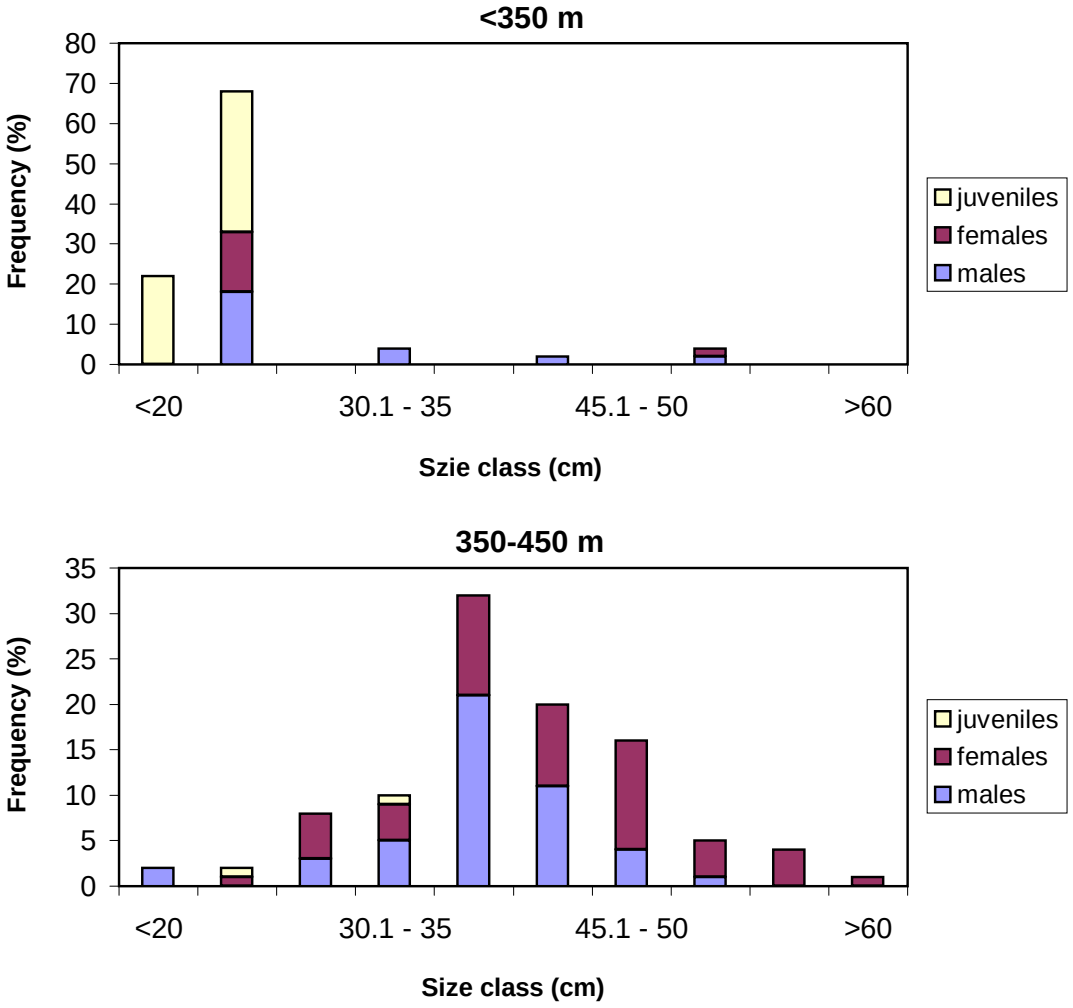



*Figure 23. Size structures of southern blue whiting caught during the research cruise ZDLH1-09-2004.*

The size structure of southern blue whiting taken from waters shallower than 350 metres was very different. Here, both males and females had a mode of less than 25 cm and only a couple of fish were greater than 30 cm in length (Fig. 23). Given these differences, and the strong relationship between size and sexual maturity in this species, it was not surprising to find that the sexual maturity of fish also seemed to be influenced by depth. Over half of the fish in 350-450 m depth range were sexually mature (i.e. stage IV or higher) and no significant differences in maturity were found between males and females. In contrast, approximately 95% of the fish found in shallow waters were either juveniles or stage I (Fig. 24). Such results indicate that large, sexually mature fish are spatially segregated from the smaller, less sexually mature fish, which are predominately found in the waters shallower than 350 metres (*Figure* 24).

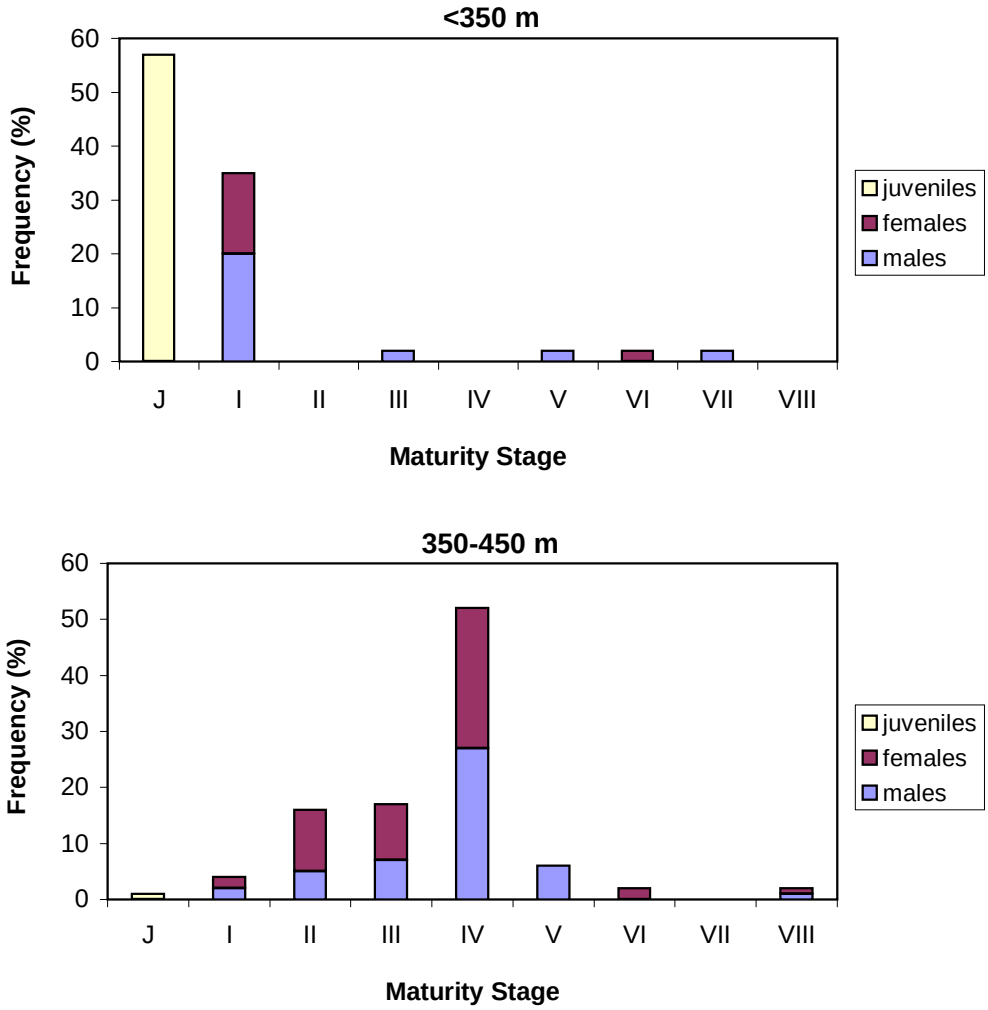



*Figure 24. Frequency of southern blue whiting maturity stages during the research cruise ZDLH1-09-2004.*

Only two stage VIII were caught in the entire survey, with both of these spent individuals taken at station 1867 (Fig. 24). The lack of spent southern blue whiting caught in this survey reinforces the notion that there is little spawning taking place outside the main spawning grounds of this species.

*4.1.2 Macruronus magellanicus*

Catches of *Macruronus magellanicus* ranged from 0.624kg at station 1894 to 2442.3kg at station 1826 (Fig. 25). The abundance of this species seemed to be greatest at the extremities of the survey area, particularly at latitude 45-46°S, and stations 1889, 1891, and 1892 south of Staten Island. A total of 432 *Macruronus magellanicus* were sampled, with size ranging from 9cm to 37cm pre-anal length (PAL). Mean length for females and males was 24.0cm and 19.9cm, respectively while the sex ratio of females to males was 1.5 to one. Of these 432 specimens, 98% were immature, i.e., stages I, II, or III and only a few were found to be in post spawning stages 7 and 8. However, some hydrated oocytes were recovered from a female at station 1891.

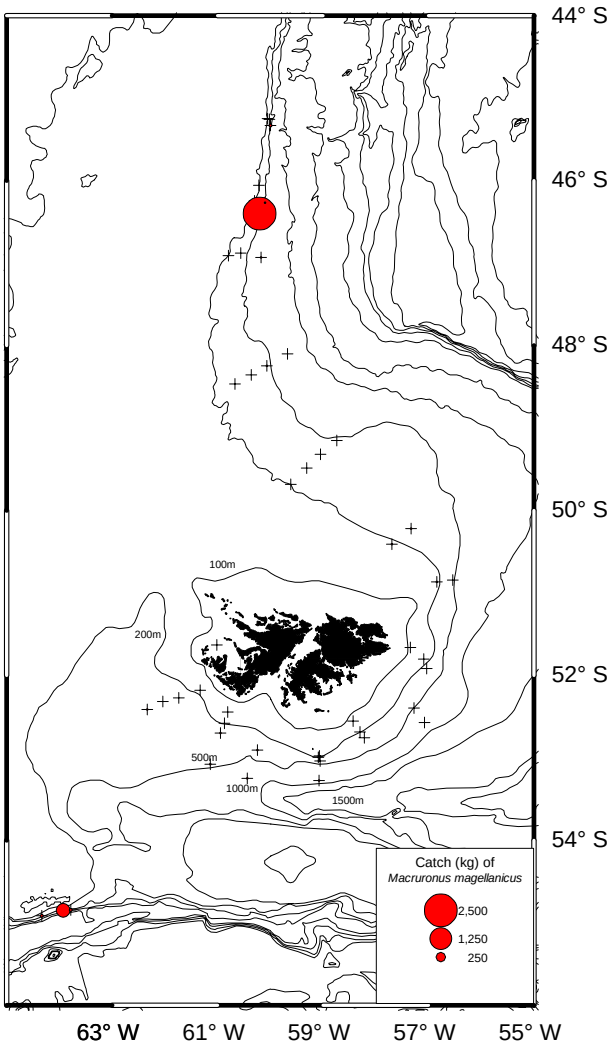



*Figure 25 Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Macruronus magellanicus *caught.*

*4.1.3 Macrourus carinatus*

A total of 1,110kg of *Macrouros carinatus* was caught at 18 stations. Although the catch was distributed over the entire survey area, all significant catches of this species occurred in depths greater than 450 m (Fig. 26). The shallowest depth at which this species was found was 289 m. The overall female to male sex ratio was 1.5 to one and the mean size of females (PAL = 20.0cm) was larger than that of males, who had a mean PAL of 16.9cm. Mean sizes for both males and females was considerably smaller than animals caught in previous surveys. Most of the large animals caught in this survey were taken to the south of the Falkland Islands (Islas Malvinas). While all maturity stages were found (aside from spawning stage VI), the majority of the sampled population was immature (88.6%). Of the remainder, 10.5% of the sample population was in post-spawning stages VII and VIII, and only four specimens (0.7%) were stage IV or V. One of these, a female V, was found north of the Islands at station 1789, whereas the other three were found in the stations south of the Falklands. Post-spawning animals were only encountered at stations to the east and south of the islands, as well as south of Staten Island.

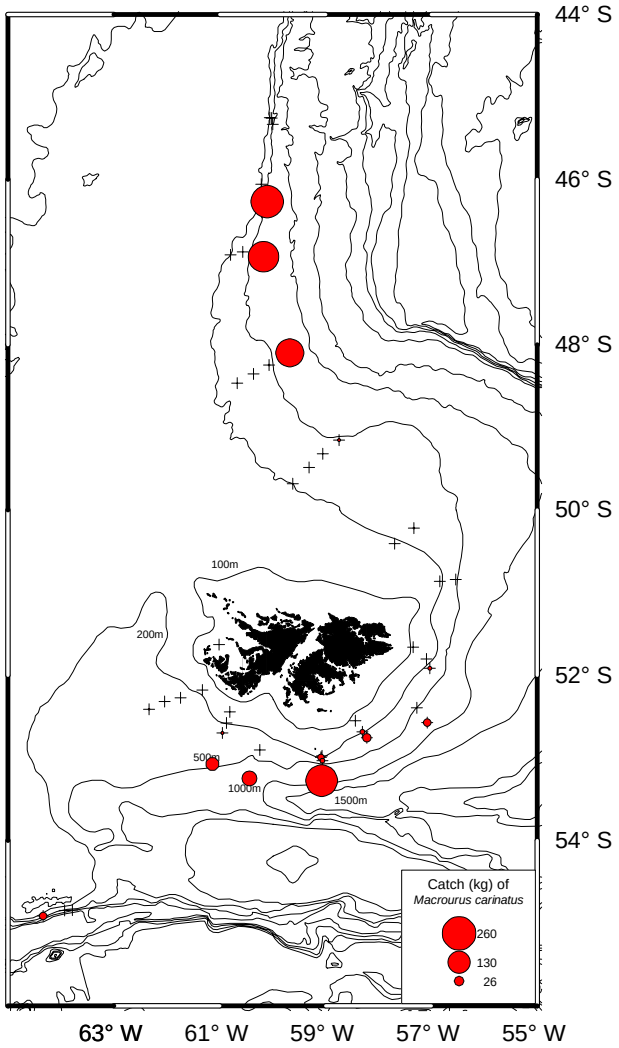



*Figure 26. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Macrourus carinatus *caught.*

*4.1.4 Merluccius hubbsi and M. australis*

Both species of hake were caught throughout the survey area, with *M. hubbsi* mostly confined to stations north of the Islands, and *M. australis* mostly to the south of the Islands. Catches of the former were as high as 70.9kg at station 1790, while the latter peaked at 82.4kg at station 1866 (Fig. 27). Of the 85 *M. hubbsi* caught, 84 were females. Their size ranged from 43cm to 86cm TL, with a mean 61.7cm. The single male of this species was only 43cm in length. Eighty percent of the sampled specimens were in early maturity stages II and II, with the remaining 20% mostly in stage VIII (16 specimens). One individual was stage VII. Of the 32 *M. australis* caught, over 90% were females with lengths ranging from 57cm to 83cm (mean 73.5cm). The size of the three males caught ranged from 66cm to 79cm, with a mean of 73.3cm. Most of the specimens were in maturity stages II and II, with only one female and one male in stage IV.

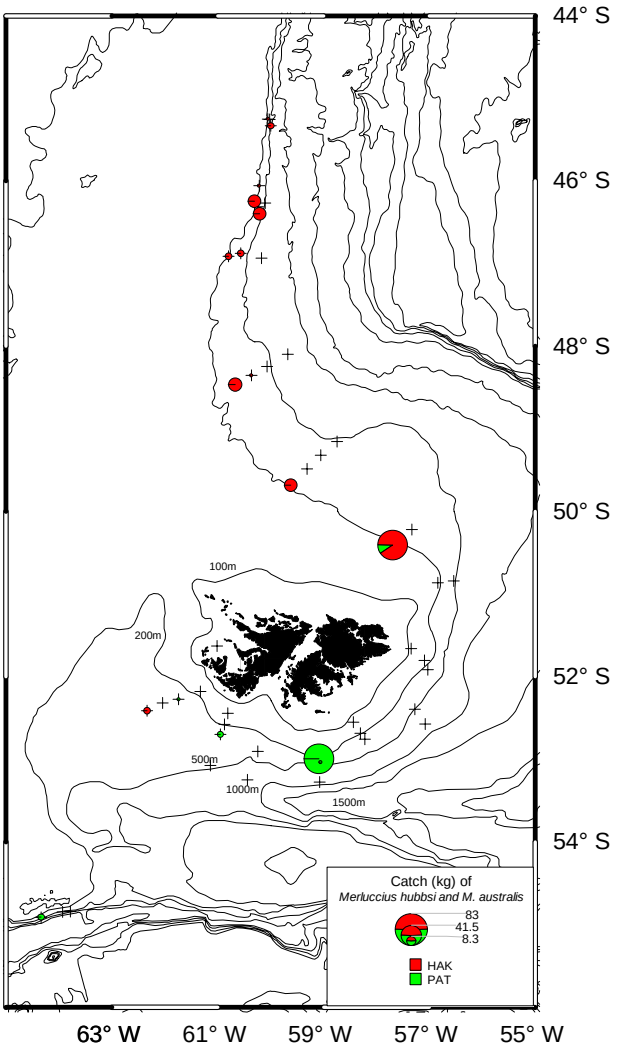



*Figure 27. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Merluccius hubbsi *and* M. australis *caught.*

### *4.1.5 Gymnoscopelus nicholsi*

*Gymnoscopelus nicholsi* was caught at a total of 23 stations, but only at depths greater than 315m. Catches ranging from 10.9 to 21.6 kg were taken on the shelf break to the east and north of the Falklands, while smaller amounts were caught elsewhere (Fig. 28). No other information is available for this species.

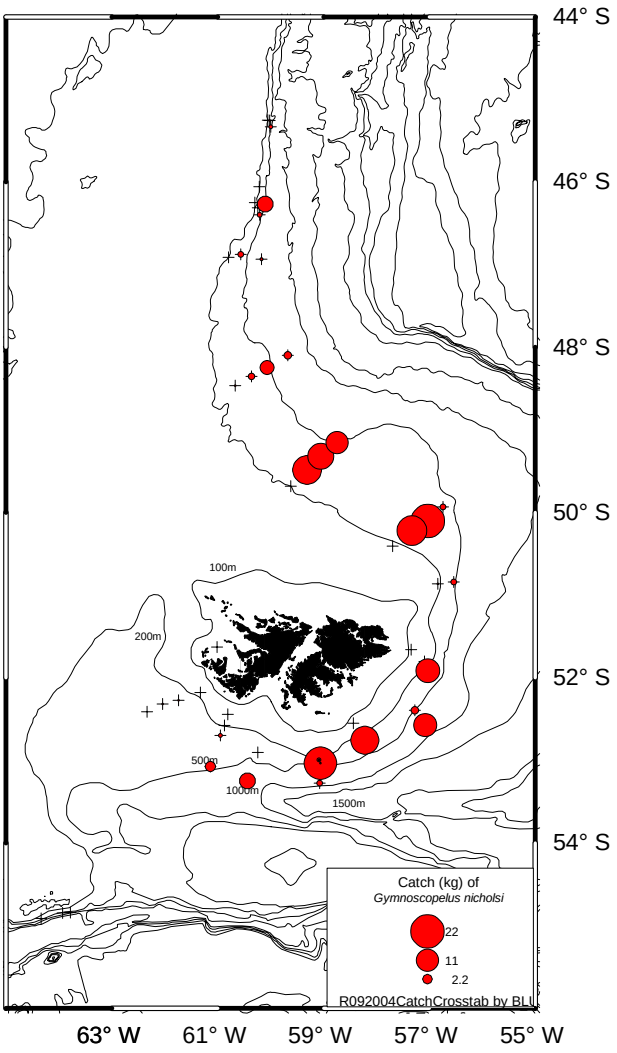



*Figure 28. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Gymnoscopelus nicholsi *caught.*

*4.1.6 Patagonotothen ramsayi*

Rockcod was caught at 30 stations, with the highest catch of 11.6 kg taken in the northeast of the Falklands at station 1789 (Fig. 29). Individuals ranged from 7cm to 35cm TL, with means of 23.1cm, 22.2cm, and 10.9cm for females, males and juveniles respectively. Sex and maturity were only determined for individuals larger than 13cm TL. Of these, 93.3% was in early developing stages I, II, and III, another 1.1% were stages IV and V, with the remaining 5.7% consisting of stages VII and VIII. Over two thirds of the catch was female. Three of the five pre-spawning specimens were caught south of Cape Meredith at stations 1881 and 1883, with the remaining 2 specimens taken at station 1798, which is north of the Falklands. Post-spawning specimens were only found in stations south of the Falklands, at stations 1869, 1883, 1885, and 1892.

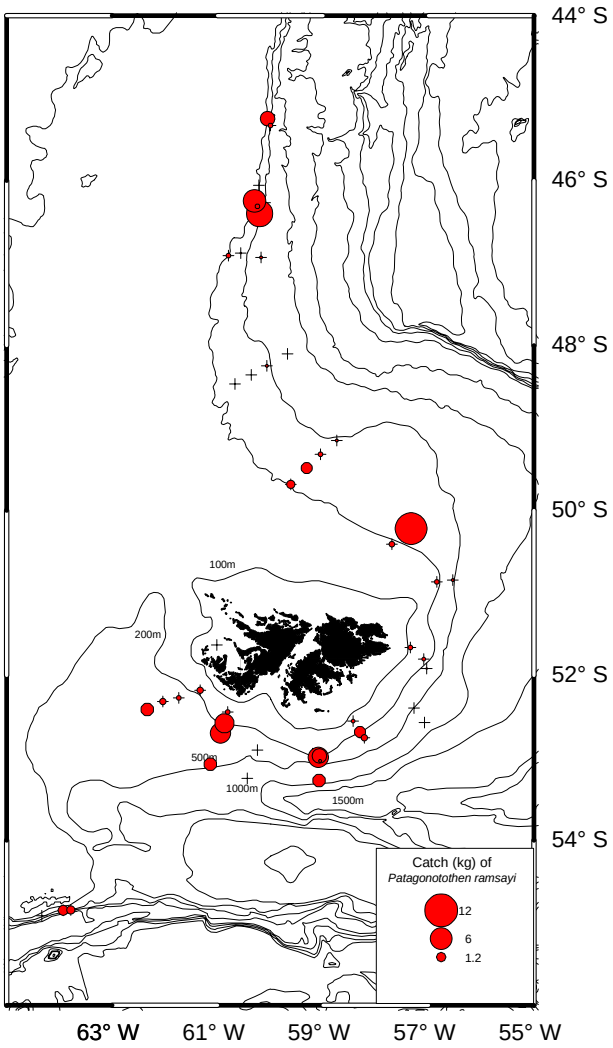



*Figure 29. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Patagonotothen ramsayi *caught.*

*4.1.7 Loligo gahi*

Patagonian squid *Loligo gahi* was relatively abundant throughout the survey area, with the highest catches taken to the east of Stanley and near Weddel Island in waters 200 m deep (Fig. 30). Some *Loligo* were taken from waters as deep as 600 m, which is uncommon for this squid. This may be due to the abnormally high temperatures at these depths (see section 3). The lowest catches of *Loligo* were taken to the south of Isla de los Estados (Fig. 30).

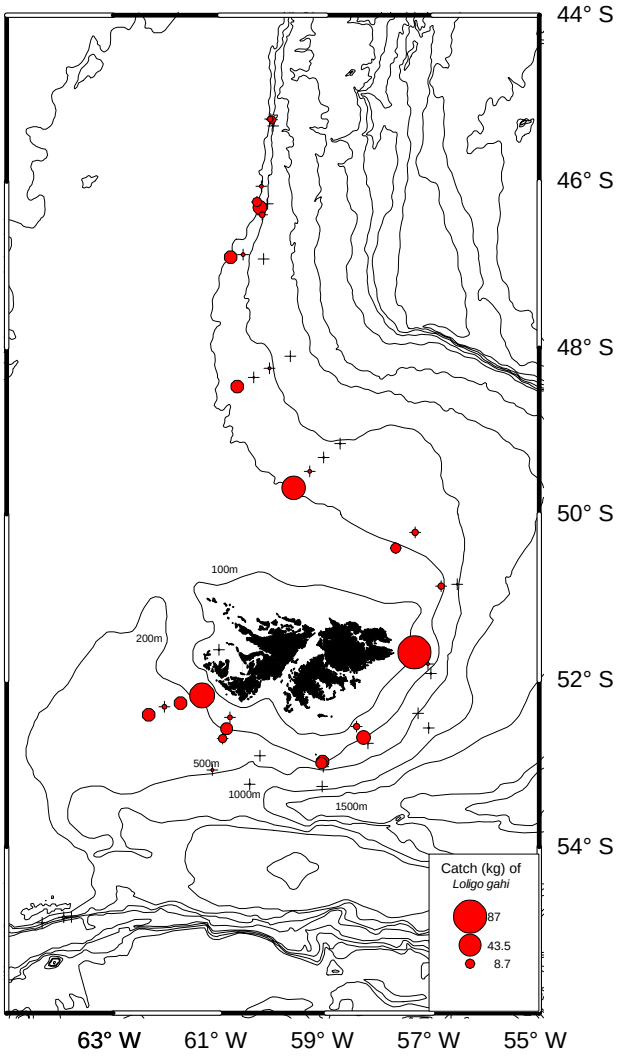



*Figure 30. Results from the trawl survey done on the research cruise ZDLH1-09-2004, showing the weight of* Loligo gahi *caught.*

All squid caught were thought to belong to the spring-spawning cohort because most were in pre-spawning condition (females at maturity stages III-V and males at stages IV-V).

Length-frequency distributions and maturities of males and females varied at different depths and different regions. They were analysed separately for depth ranges less than and more than 300 m, and for the following regions: High Seas, Northern, eastern and Southern part of the Falkland Shelf, and Isla de los Estados (Figs 31-35).

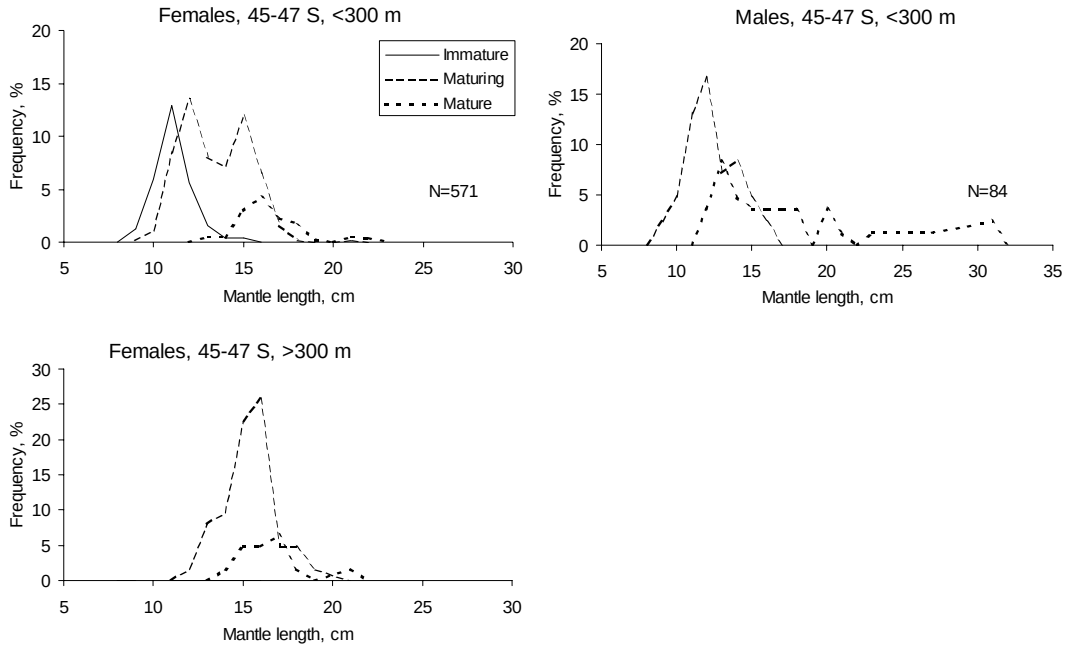



*Figure 31. Length frequency distributions of females and males of* Loligo gahi *caught at different depths on the High Seas during the research cruise ZDLH1-09-2004.*

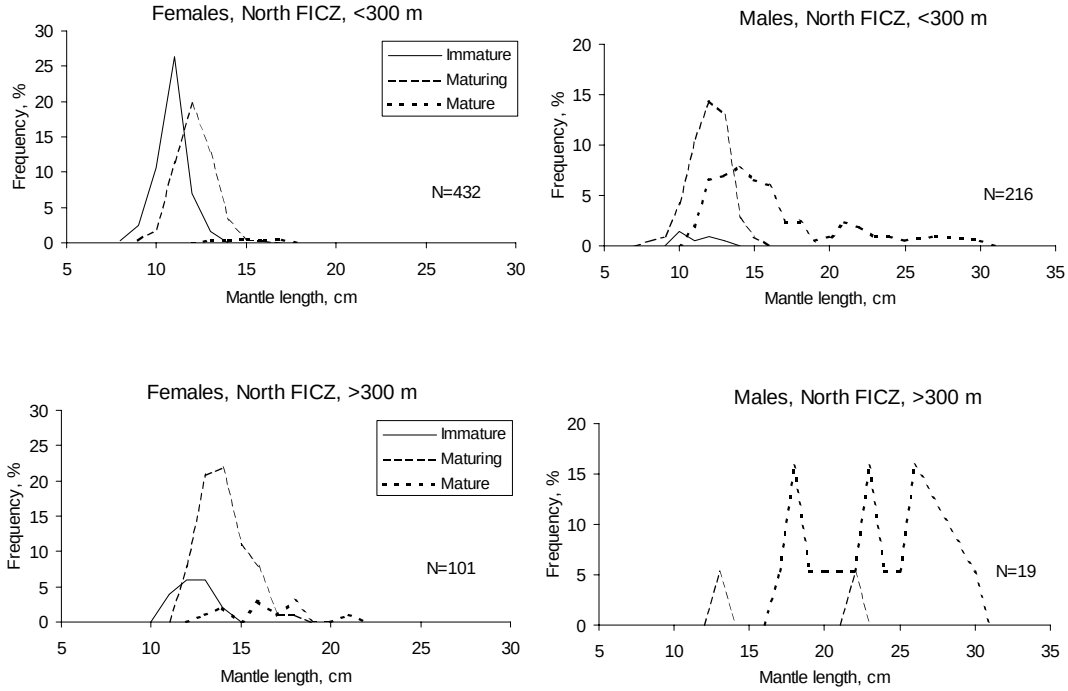



*Figure 32. Length frequency distributions of females and males of* Loligo gahi *caught at different depths in the northern part of the Falkland Shelf during the research cruise ZDLH1-09-2004.*

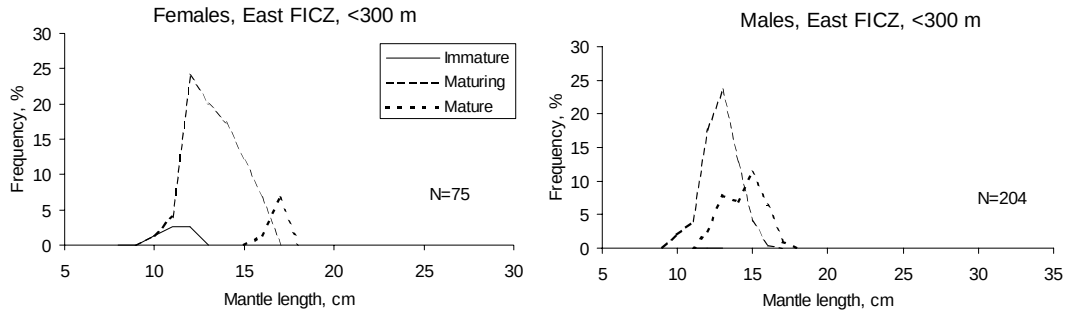



*Figure 33. Length frequency distributions of females and males of* Loligo gahi *caught at different depths in the eastern part of the Falkland Shelf during the research cruise ZDLH1-09-2004.*

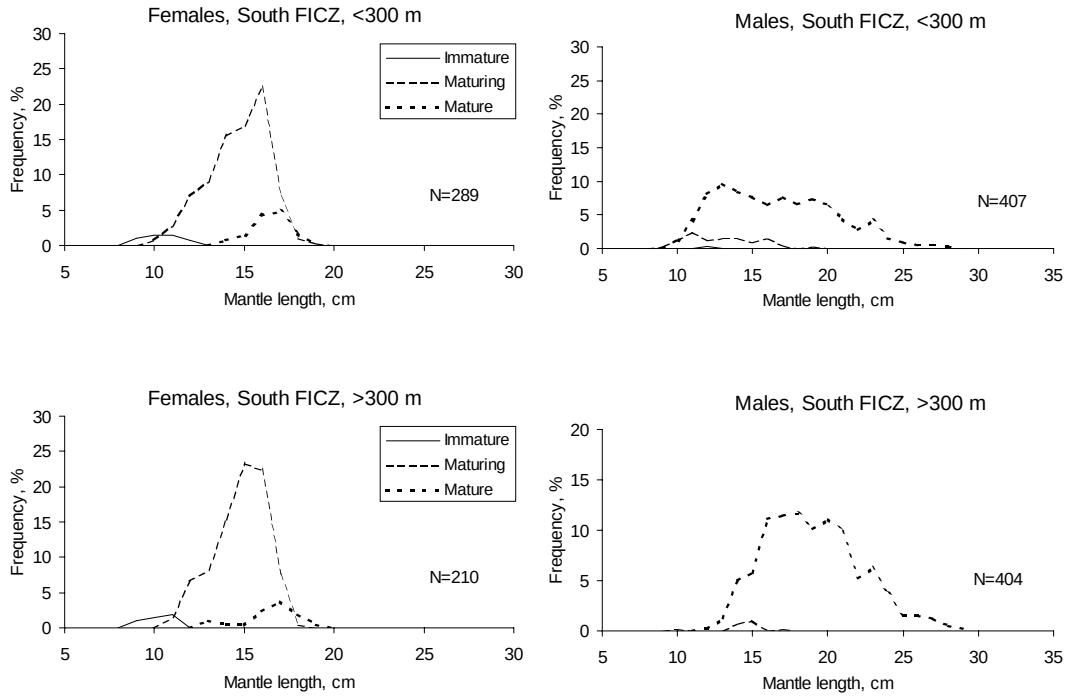



*Figure 34. Length frequency distributions of females and males of* Loligo gahi *caught at different depths in the southern part of the Falkland Shelf during the research cruise ZDLH1-09-2004.*

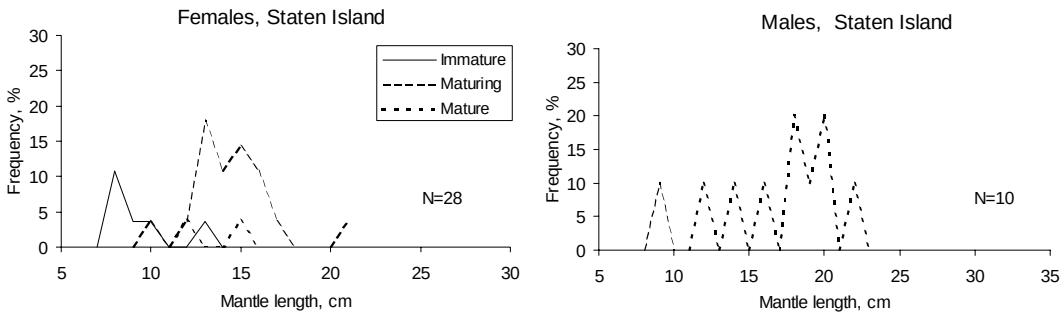



Figure 35. Length frequency distributions of females and males of *Loligo gahi* caught at different depths in the southern part of the Isla de los Estados during the research cruise ZDLH1-09-2004.