**Demersal Finfish Survey of the South Orkney Islands**

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**Abstract** A random, depth-stratified bottom trawl survey of the South Orkney Islands (CCAMLR Subarea 48.2) finfish populations was completed as part of Leg II of the 2008/09 AMLR Survey. Data collection included abundance, spatial distribution, species and size composition, demographic structure and diet composition of finfish species within the 500 m isobath of the South Orkney Islands. Additional slope stations were sampled off the shelf of the South Orkney Islands and in the northern Antarctic Peninsula region (Subarea 48.1). During the 2008/09 AMLR Survey:

- Seventy-five stations were completed on the South Orkney Island shelf and slope area (63-764 m);
- Three stations were completed on the northern Antarctic Peninsula slope (623-759 m);
- A total of 7,693 kg (31,844 individuals) was processed from 65 finfish species;
- Spatial distribution of standardized finfish densities demonstrated substantial contrast across the South Orkney Islands shelf area;
- The highest densities of pooled finfish biomass occurred on the northwest shelf of the South Orkney Islands, at stations north of Inaccessible and Coronation Islands, and the highest mean densities occurred within the 150-250 m depth stratum;
- The greatest species diversity of finfish occurred at deeper stations on the southern shelf region;
- Additional data collection of environmental and ecological features of the South Orkney Islands was conducted in order to further investigate Antarctic finfish in an ecosystem context.

## Introduction

Commercial exploitation of finfish in the South Orkney Islands (CCAMLR Statistical Subarea 48.2) occured between 1977/78 and 1989/90. The main reported species captured in the region during this time period were *Champsocephalus gunnari*, *Gobionotothen gibberifrons* and *Notothenia rossii* (CCAMLR, 1990a; 1990b). Other reported finfish species included *Lepidonotothen squamifrons*, *Pseudochaenichthys georgianus*, *Chaenocephalus aceratus*, *Dissostichus eleginoides* and unspecified finfish species. The first year of fishing yielded a reported catch of almost 140,000 metric tons of *C. gunnari*, supported mainly by 1973/74 and 1974/75 cohorts (Kock and Jones, 2005). Both cohorts were largely exhausted within two years, and overall catches declined by almost two orders of magnitude within a few years. Catches increased slightly in the mid-1980s, primarily as a result of the 1980/81 cohort, and decreased substantially once that cohort was exhausted (Jones et al. 2000). The rapid declines of catch size and catch rate led CCAMLR, in 1990/91, to impose a moratorium on all directed fishing for finfish in the South Orkney Islands (CCAMLR CM73/XVII). At present, this moratorium remains in effect (CCAMLR CM 32-03).

To characterize finfish stock biomass and biological characteristics and determine whether shelf areas can be re-opened to possible finfish exploitation, a random, depth-stratified bottom trawl survey of the South Orkney Islands was undertaken during Leg II of the 2008/09 AMLR Survey. This survey represents the first comprehensive scientific characterization of demersal fish along the fishable and accessible shelf regions of the South Orkney Islands since the 1998/99 AMLR Survey.

The survey objectives included data collection to be used for estimates of biomass, distribution, species and size composition, demographic structure, and diet composition of finfish species, primarily within the 500 m isobath of the South Orkney Islands. A number of additional hauls were taken on slope areas (600-800 m) of both the South Orkney Islands and northern Antarctic Peninsula regions. Several other sampling efforts and biological experiments were conducted during the course of this survey, including buoyancy measurements, DNA collections, otolith sampling for age and growth studies, and other specimen/tissue collections for biological, physiological, and phylogenetic studies. Other components of the South Orkney Island shelf ecosystem examined during Leg II included the physical oceanography (Chapter 1), krill density and distribution (Chapter 12), benthic invertebrate megafauna (Chapter 10), and underwater camera/video deployments (Chapter 11). The overall goals of Leg II were to collect information to be used toward an ecosystem-based assessment of the biomass and spatial distribution of demersal fish in the South Orkney Islands; to characterize feeding patterns; and to examine relationships between benthic and pelagic components of the Antarctic ecosystem and their influence on demersal finfish.

## Methods

*Bottom Trawling*

The at-sea protocols used to conduct the bottom trawl survey were based on those used during the 1998/99 AMLR Survey of the South Orkney Islands (Jones et al. 1999), with some modifications to include additional research activities. A hard-bottom snapper trawl with vented V-Doors (Net Systems, Inc. Bainbridge Island, WA) was used. The trawl was deployed using a 6’6” wide by 12’7” diameter net reel, an 11’9” long by 12” diameter stern roller, two trawl winches, instrumented trawl blocks, and a third wire slip ring winch. The headrope transducer platform of the trawl was instrumented with a Simrad FS25 trawl sonar system to monitor the geometry of the mouth of the trawl as it was deployed, record contact with the bottom, and measure the trawl mouth dimensions in real time while sampling the station.

Trawling operations were conducted aboard the R/V *Yuzhmorgeologiya* on 9 February 2009 through 9 March 2009 (Table 9.1). There were a total of 75 hauls completed on the South Orkney Island shelf and slope area, and three hauls taken off the northern Antarctic Peninsula slope area (Figure 9.1). The sampling strategy for the South Orkney Islands survey was based on a random, depth-stratified survey design, and stations were positioned to account for as wide a geographic range as time, sea, and ice conditions permitted. Estimates of seabed areas and bathymetric features were taken from Jones (2000). In all cases, a haul was taken only after initial acoustic reconnaissance verified that bottom conditions were suitable for trawling. All final decisions regarding sampling operations during the survey were made by the chief scientist in consultation with the fishing master and ship captain.

In the South Orkney Islands there were three targeted designated depth strata: 50-150 m, 150-250 m, and 250-500 m; a limited number of hauls were taken in an additional depth stratum (on the slope) between 600-800 m. These hauls were included on an exploratory basis to increase collections of rare deep sea notothenioid species for ecological, taxonomic and physiological studies, as well as characterize benthic invertebrate megafauna. The numbers of hauls within

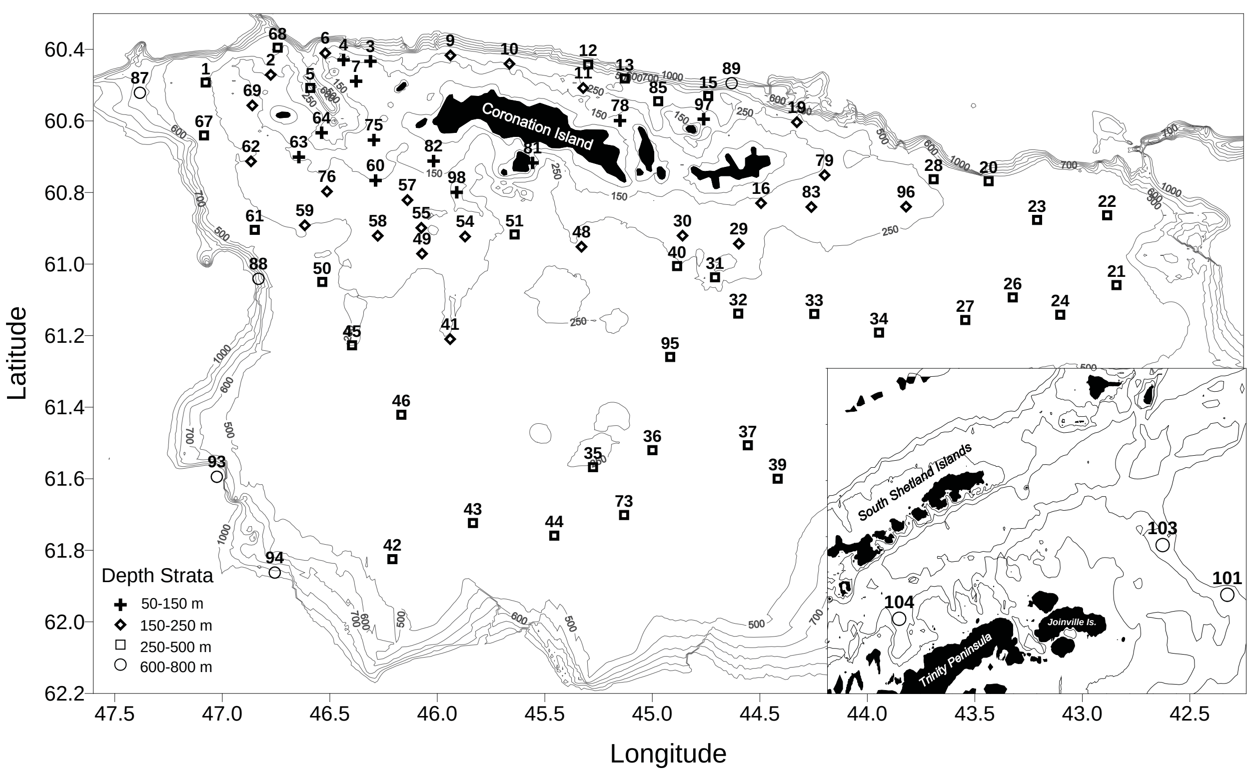


Figure 9.1. Station locations, by depth strata, from Leg II of the 2008/09 AMLR Survey, in the South Orkney Islands. Figure inset shows the three trawls taken on the slope of the northern Antarctic Peninsula.

Table 9.1. Station and finfish catch information for the 2008/09 AMLR Survey bottom trawl in the South Orkney Islands and along the northern Antarctic Peninsula slope.

| Station No. | Date | Latitude (S) | Longittude (W) | Avg. Depth | Number Finfish Species | Finfish Catch (Kg) | Total Number Finfish |
|---|---|---|---|---|---|---|---|
| 4 | 9-Feb-09 | 60°25.77 | 46°26.16 | 142 | 9 | 81.42 | 239 |
| 3 | 10-Feb-09 | 60°26.00 | 46°18.66 | 142 | 11 | 236.23 | 790 |
| 9 | 10-Feb-09 | 60°25.00 | 45°56.34 | 228 | 10 | 588.80 | 1433 |
| 10 | 10-Feb-09 | 60°26.41 | 45°39.87 | 237 | 9 | 378.66 | 830 |
| 11 | 11-Feb-09 | 60°30.48 | 45°19.29 | 240 | 10 | 222.91 | 659 |
| 13 | 11-Feb-09 | 60°28.89 | 45°07.68 | 350 | 13 | 149.62 | 442 |
| 12 | 11-Feb-09 | 60°26.52 | 45°17.91 | 497 | 11 | 33.59 | 225 |
| 78 | 11-Feb-09 | 60°35.94 | 45°09.01 | 98 | 9 | 46.17 | 179 |
| 85 | 12-Feb-09 | 60°32.69 | 44°58.36 | 371 | 13 | 120.09 | 398 |
| 15 | 12-Feb-09 | 60°31.82 | 44°44.39 | 310 | 11 | 183.96 | 340 |
| 97 | 12-Feb-09 | 60°35.72 | 44°45.66 | 118 | 11 | 87.03 | 180 |
| 89 | 12-Feb-09 | 60°29.67 | 44°37.86 | 798 | 14 | 5.26 | 71 |
| 19 | 13-Feb-09 | 60°36.21 | 44°19.67 | 211 | 12 | 42.76 | 183 |
| 79 | 13-Feb-09 | 60°45.09 | 44°11.92 | 166 | 6 | 872.39 | 1098 |
| 83 | 13-Feb-09 | 60°50.43 | 44°15.62 | 182 | 11 | 52.66 | 187 |
| 96 | 13-Feb-09 | 60°50.37 | 43°49.18 | 221 | 8 | 16.20 | 55 |
| 28 | 14-Feb-09 | 60°45.77 | 43°41.50 | 262 | 8 | 61.15 | 142 |
| 20 | 14-Feb-09 | 60°46.10 | 43°26.14 | 309 | 7 | 14.44 | 41 |
| 23 | 14-Feb-09 | 60°52.59 | 43°12.63 | 336 | 12 | 80.94 | 232 |
| 22 | 14-Feb-09 | 60°58.51 | 42°53.07 | 359 | 6 | 56.43 | 99 |
| 21 | 15-Feb-09 | 61°03.53 | 42°50.48 | 425 | 11 | 25.33 | 293 |
| 24 | 15-Feb-09 | 61°08.49 | 43°06.16 | 469 | 14 | 55.51 | 335 |
| 26 | 15-Feb-09 | 61°05.59 | 43°19.41 | 439 | 13 | 21.10 | 167 |
| 27 | 16-Feb-09 | 61°09.38 | 43°32.66 | 455 | 12 | 13.90 | 226 |
| 34 | 16-Feb-09 | 61°11.49 | 43°56.74 | 426 | 15 | 111.87 | 3766 |
| 33 | 16-Feb-09 | 61°08.37 | 44°14.80 | 337 | 13 | 77.85 | 271 |
| 32 | 16-Feb-09 | 61°08.30 | 44°36.03 | 314 | 12 | 72.92 | 290 |
| 31 | 16-Feb-09 | 61°02.20 | 44°42.51 | 254 | 10 | 34.10 | 256 |
| 40 | 17-Feb-09 | 61°00.33 | 44°53.08 | 258 | 9 | 73.12 | 258 |
| 30 | 17-Feb-09 | 60°55.23 | 44°51.56 | 235 | 11 | 66.61 | 314 |
| 16 | 17-Feb-09 | 60°49.78 | 44°29.65 | 172 | 8 | 140.25 | 299 |
| 29 | 17-Feb-09 | 60°56.58 | 44°35.86 | 234 | 11 | 87.25 | 298 |
| 39 | 18-Feb-09 | 61°35.99 | 44°25.02 | 390 | 15 | 51.76 | 729 |
| 37 | 18-Feb-09 | 61°30.39 | 44°33.35 | 380 | 13 | 212.96 | 1551 |
| 95 | 18-Feb-09 | 61°15.57 | 44°55.01 | 322 | 10 | 74.28 | 228 |
| 36 | 20-Feb-09 | 61°31.20 | 44°59.96 | 321 | 12 | 39.02 | 305 |
| 35 | 20-Feb-09 | 61°34.05 | 45°16.55 | 259 | 10 | 36.05 | 105 |
| 73 | 20-Feb-09 | 61°42.08 | 45°07.88 | 375 | 18 | 106.84 | 906 |
| 44 | 20-Feb-09 | 61°45.54 | 45°27.36 | 375 | 13 | 39.59 | 229 |

| Station | Date | Latitude (S) | Longittude (W) | Avg. Depth | Number Finfish Species | Finfish Catch (Kg) | Total Number Finfish |
|---|---|---|---|---|---|---|---|
| 43 | 21-Feb-09 | 61°43.41 | 45°50.04 | 398 | 9 | 42.33 | 189 |
| 42 | 21-Feb-09 | 61°49.47 | 46°12.52 | 453 | 10 | 16.84 | 102 |
| 94 | 21-Feb-09 | 61°51.73 | 46°45.25 | 750 | 20 | 20.25 | 135 |
| 93 | 21-Feb-09 | 61°35.67 | 47°01.52 | 629 | 16 | 14.58 | 56 |
| 46 | 22-Feb-09 | 61°25.27 | 46°09.97 | 352 | 14 | 97.88 | 272 |
| 45 | 22-Feb-09 | 61°13.62 | 46°23.79 | 274 | 12 | 70.07 | 199 |
| 41 | 22-Feb-09 | 61°12.59 | 45°56.41 | 240 | 15 | 86.22 | 245 |
| 48 | 23-Feb-09 | 60°57.09 | 45°19.74 | 236 | 11 | 50.33 | 182 |
| 81 | 23-Feb-09 | 60°43.03 | 45°33.40 | 63 | 5 | 8.49 | 108 |
| 98 | 24-Feb-09 | 60°47.97 | 45°54.57 | 126 | 9 | 13.07 | 111 |
| 82 | 24-Feb-09 | 60°42.72 | 46°01.02 | 96 | 7 | 24.38 | 188 |
| 57 | 25-Feb-09 | 60°49.26 | 46°08.33 | 195 | 8 | 127.05 | 524 |
| 60 | 25-Feb-09 | 60°45.98 | 46°17.22 | 150 | 10 | 51.57 | 198 |
| 75 | 25-Feb-09 | 60°39.20 | 46°17.69 | 104 | 5 | 54.46 | 194 |
| 64 | 25-Feb-09 | 60°37.98 | 46°32.27 | 130 | 7 | 86.77 | 229 |
| 51 | 26-Feb-09 | 60°55.04 | 45°38.43 | 294 | 12 | 88.05 | 2569 |
| 54 | 26-Feb-09 | 60°55.38 | 45°52.24 | 208 | 13 | 120.71 | 303 |
| 55 | 26-Feb-09 | 60°53.92 | 46°04.44 | 187 | 6 | 16.94 | 62 |
| 58 | 26-Feb-09 | 60°55.24 | 46°16.62 | 227 | 10 | 55.76 | 138 |
| 50 | 26-Feb-09 | 61°03.00 | 46°32.10 | 287 | 8 | 25.94 | 84 |
| 76 | 27-Feb-09 | 60°47.82 | 46°30.78 | 210 | 15 | 64.65 | 249 |
| 59 | 27-Feb-09 | 60°53.49 | 46°36.98 | 231 | 8 | 25.20 | 70 |
| 61 | 27-Feb-09 | 60°54.25 | 46°50.94 | 308 | 7 | 8.88 | 42 |
| 88 | 27-Feb-09 | 61°02.47 | 46°49.91 | 764 | 18 | 17.60 | 83 |
| 1 | 28-Feb-09 | 60°29.55 | 47°04.62 | 259 | 10 | 116.29 | 379 |
| 67 | 28-Feb-09 | 60°38.43 | 47°05.08 | 299 | 7 | 44.28 | 177 |
| 2 | 28-Feb-09 | 60°28.26 | 46°46.48 | 162 | 7 | 146.40 | 378 |
| 5 | 28-Feb-09 | 60°30.47 | 46°35.45 | 457 | 19 | 108.70 | 454 |
| 68 | 1-Mar-09 | 60°23.71 | 46°44.54 | 282 | 10 | 419.29 | 878 |
| 6 | 1-Mar-09 | 60°24.63 | 46°31.26 | 220 | 13 | 410.72 | 1204 |
| 7 | 1-Mar-09 | 60°29.34 | 46°22.65 | 106 | 8 | 199.42 | 1481 |
| 63 | 1-Mar-09 | 60°42.06 | 46°38.62 | 142 | 11 | 46.01 | 173 |
| 49 | 3-Mar-09 | 60°58.26 | 46°04.26 | 236 | 9 | 22.10 | 125 |
| 62 | 3-Mar-09 | 60°42.77 | 46°51.98 | 242 | 8 | 15.53 | 59 |
| 69 | 3-Mar-09 | 60°33.39 | 46°51.62 | 176 | 10 | 105.25 | 370 |
| 87 | 3-Mar-09 | 60°31.28 | 47°22.98 | 657 | 0 | 0 | 0 |
| 101 | 4-Mar-09 | 63°01.08 | 52°24.34 | 623 | 13 | 60.15 | 210 |
| 103 | 5-Mar-09 | 62°34.51 | 53°47.78 | 731 | 9 | 76.30 | 218 |
| 104 | 9-Mar-09 | 63°13.92 | 59°27.47 | 759 | 33 | 63.87 | 557 |

the four depth strata were 12, 23, 35, and 8, respectively. All targeted strata were sampled and the survey design was completed successfully.

All hauls, with the exception of those taken in the fourth strata, were conducted during daylight hours with a targeted haul time of 30 minutes. Trawling time started as the footrope made contact with the bottom. Once contact with the bottom was made, time, geographic coordinates, ship speed, bearing, headrope depth, bottom depth, and net mouth geometry were recorded. Recordings were made every five minutes thereafter throughout the course of the haul. The area of seabed sampled during the haul was determined using the latitude and longitude coordinates taken with GPS from the start to the end of the trawl's bottom contact and the average of the trawl mouth width recorded while on the bottom. Supplementary data collected for each haul included ship course, air temperature, wind direction and speed, weather, cloud conditions, sea state, light and ice conditions.

*Haul Processing*

After a successful haul, the contents of the trawl were emptied onto the deck and transferred to a sorting table, where fish were identified, separated by species, and placed into baskets or trays. Organisms other than fish (benthic and pelagic invertebrates) were processed separately (Chapter 10). Baskets and trays were weighed to obtain total catch weights by species. Where catches of a single species were very large, a subsample of the catch was taken (see Sub-sampling Protocol).

There were two categories of haul processing. Category 1 included length (nearest cm below), sex, and gonad maturity stage. Length types were collected as total length (length from tip of snout to end of caudal fin) for all species except myctophid species and *Pleurogramma antarcticum*, where length was measured in mm as standard length (length from tip of snout to end of caudal peduncle). Maturity was classified on a scale of 1 to 5 (immature, maturing virgin or resting, developing, gravid, spent) according to the method of Kock and Kellermann (1991). The gonado-somatic index GSI (Kock, 1989) was collected from several species to describe the individual developmental stage of the gonads and to estimate the time of spawning. Category 2 processing included full biometric data including length, weight, sex, maturity, gonad (ovary or testis) weight, diet composition, eviscerated weight, and otolith and fin clip sampling. All weights were measured as total fresh weight to the nearest gram.

An examination of the diet composition of finfish was conducted across all regions of the shelf for most species. Stomach content information included content weight (to the nearest g); a measure of the filling degree according to a scale of 0-5 (empty, 25% full, 50% full, 75% full, 100% full, regurgitated); and a measure of the degree of digestion according to a scale of 1-3 (fresh, moderately digested, fully digested). Dietary items were identified to general common taxonomic groupings (with the exception of krill, *E. superba*), and to species whenever possible. The relative volume of each species present within a stomach was recorded by assigning each dietary component a proportion from 0-10, with the total score for each stomach equal to 10.

Otoliths and fin clips were taken from several species in order to estimate age and construct age-length keys, which will allow age-based models to be used in assessing the population biology and stock status of several species.

*Sub-sampling Protocol*

When species yield was too great to process in its entirety due to time constraints, sub-sampling was performed using randomized techniques for either Category 1 or Category 2 processing. When using a straightforward simple random sampling with each fish as an independent sampling unit was logistically impractical, we used full baskets of fish as primary sampling units (PSUs). Two forms of sampling strategies were then used: cluster sampling, where all fish within a basket were sampled, and multi-stage sampling, were only some of the fish within a basket were sampled at random. Sampling effort was adjusted for each haul to allow sampling to be completed before the next haul was on deck. Additional details on these methods and statistical rationale is provided in Ashford and Jones (2001).

## Results

*Total yield and patterns of distribution*

A total of 7,693 kg (31,844 individuals) from 65 finfish species were processed from all hauls (Table 9.2). The dominant element of the Antarctic fish fauna in terms of biomass and numbers was within the suborder Notothenioidei (Perciformes). The highest standardized densities of undifferentiated finfish biomass occurred at stations north of Inaccessible and Coronation Islands (Figure 9.2A), and the highest mean densities occurred within the 150-250 m depth stratum.

The ten most prominent finfish species encountered during the course of the survey (all with over 700 individuals) were *Chaenocephalus aceratus*, *Chionodraco rastrospinosus*, *Champsocephalus gunnari*, *Electrona Antarctica*, *Gobionotothen gibberifrons*, *Gymnoscopelus nicholsi*, *Lepidonotothen larseni*, *L. squamifrons*, *Pleuragramma antarcticum*, *Pseudochaenichthys georgianus* (Table 9.2).

The species with the greatest catch in numbers was *G. gibberifrons* (11,178 individuals, 2,628 kg,) followed by *P. antarcticum* (6,156 individuals, 94 kg.) and *C. rastrospinosus* (2,679 individuals, 618 kg). The species with greatest yield in kilograms was *G. gibberifrons* followed by *C. rastrospinosus*, C. aceratus (1,920 kg, 2447 individuals) and *P. georgianus* (656 kg, 769 individuals).

The mean density of undifferentiated finfish biomass for all stations, pooled, was 10.7 tonnes/nmii$^2$ ($\sigma$=14.5). The greatest standardized density of fish at a single station was 94 tonnes/nmi$^2$, found at Station 79, east of Laurie Island in the eastern shelf area, (Figures 9.1, 9.2A) at a depth of 166 m. This station was dominated (by weight) by *C. aceratus* (91%), followed by *G. gibberifrons* (8%); four other species made up the remaining percentage. Station 9 (228 m) was also dom-

Table 9.2. Total nominal weight (kg), numbers and biological information recorded for finfish by species from Leg II of the 2008/09 AMLR Survey bottom trawl of the South Orkney Islands and northern Antarctic Peninsula slope.

| Species | Total Catch (kg) | Total Number | Number Stations Species Occurred | Length, Sex, and Maturity Collected | Weights Col-lected | Evisc. Weights Col-lected | Gonad Weights Collected | Diet Col-lected | Otoliths Collected |
|---|---|---|---|---|---|---|---|---|---|
| *Aethotaxis mitopteryx* | 1.74 | 37 | 4 | 37 | 37 | - | - | 27 | - |
| *Antimora rostrata* | 1.13 | 11 | 1 | - | - | - | - | - | - |
| *Artedidraco skottsbergi* | 0.02 | 4 | 4 | 4 | 4 | - | - | 1 | - |
| *Bathydraco marri* | 0.33 | 4 | 3 | 4 | 4 | - | - | 2 | - |
| *Bathyraja eatonii* | 38.94 | 5 | 2 | 4 | 4 | - | - | - | - |
| *Bathyraja maccaini* | 64.38 | 27 | 10 | 19 | 18 | - | - | - | - |
| *Bathyraja species 2* | 16.94 | 46 | 15 | 34 | 34 | - | - | - | - |
| *Chaenocephalus aceratus* | 1919.7 | 2447 | 58 | 1915 | 1060 | 392 | 318 | 792 | 460 |
| *Chaenodraco wilsoni* | 6.12 | 67 | 2 | 67 | 34 | - | - | 1 | - |
| *Champsocephalus gunnari* | 575.42 | 2259 | 55 | 1835 | 1261 | 325 | 169 | 946 | 356 |
| *Chionodraco hamatus* | 0.28 | 2 | 1 | - | - | - | - | - | - |
| *Chionodraco myersi* | 1.12 | 3 | 3 | 3 | 3 | - | - | 2 | - |
| *Chionodraco rastrospinosus* | 617.85 | 2679 | 62 | 1809 | 580 | 280 | 164 | 547 | 262 |
| *Cryodraco antarcticus* | 25.34 | 122 | 19 | 122 | 117 | 23 | 17 | 106 | 21 |
| *Cyclothone microdon* | 0.02 | 2 | 1 | 2 | - | - | - | - | - |
| *Dacodraco hunteri* | 0.06 | 1 | 1 | 1 | 1 | - | - | 1 | - |
| *Dissostichus mawsoni* | 21.21 | 12 | 5 | 12 | 12 | 5 | 3 | 10 | 5 |
| *Electrona antarctica* | 8.69 | 700 | 27 | 558 | 123 | 5 | 1 | 2 | 69 |
| *Gobionotothen gibberifrons* | 2628.28 | 11178 | 72 | 6779 | 406 | 269 | 98 | 285 | 343 |
| *Gymnodraco acuticeps* | 2.7 | 22 | 6 | 23 | 23 | - | - | 6 | - |
| *Gymnoscopelus braueri* | 4.04 | 49 | 6 | 49 | 16 | - | - | - | 15 |
| *Gymnoscopelus nicholsi* | 76.68 | 2188 | 27 | 648 | 137 | 24 | 17 | 3 | 117 |
| *Gymnoscopelus opisthopterus* | 0.27 | 8 | 3 | 1 | - | - | - | - | - |
| *Krefftichthys anderssoni* | 0.02 | 4 | 3 | 4 | 4 | - | - | - | 1 |
| *Lepidonotothen larseni* | 37.68 | 888 | 61 | 907 | 245 | 119 | 37 | 167 | 142 |
| *Lepidonotothen nudifrons* | 0.84 | 30 | 15 | 30 | 26 | 11 | 11 | 18 | 10 |
| *Lepidonotothen squamifrons* | 505.48 | 892 | 44 | 1021 | 271 | 184 | 65 | 222 | 161 |
| *Lycenchelys species* | 0.02 | 1 | 1 | 1 | 1 | - | - | - | - |
| *Macrourus whitsoni* | 38.71 | 127 | 6 | 73 | 75 | 8 | - | 8 | 8 |
| *Magnisudis prionosa* | 0.61 | 6 | 3 | 5 | 5 | - | - | 4 | - |
| *Melanostigma species* | 0.62 | 42 | 2 | 57 | 57 | - | - | 1 | - |
| *Muraenolepis microps* | 4.87 | 16 | 11 | 7 | 6 | - | - | - | - |
| *Muraenolepis species* | 6.38 | 16 | 7 | 24 | 23 | - | - | 3 | - |
| *Myctophidae* | 0.22 | 19 | 1 | - | - | - | - | - | - |
| *Neopagetopsis ionah* | 6.46 | 17 | 5 | 13 | 13 | - | - | 13 | - |
| *Notolepis coatsi* | 0.39 | 14 | 4 | 11 | 11 | - | - | 2 | - |
| *Notothenia coriiceps* | 109.84 | 81 | 22 | 81 | 78 | 49 | 49 | 51 | 39 |
| *Notothenia rossii* | 48.57 | 23 | 17 | 22 | 22 | 19 | 18 | 21 | 16 |
| *Ophthalmolycus amberensis* | 0.94 | 15 | 2 | 15 | 15 | - | - | - | - |
| *Pachycara brachycephalum* | 0.25 | 2 | 1 | 2 | 2 | - | - | - | - |
| *Pagetopsis macropterus* | 0.14 | 1 | 1 | 1 | 1 | - | - | 1 | - |
| *Parachaenichthys charcoti* | 3.12 | 21 | 10 | 21 | 21 | 2 | 1 | 15 | 2 |
| *Paradiplospinus gracilis* | 1.03 | 11 | 4 | 14 | 13 | 1 | - | - | - |
| *Paraliparis gracilis* | 0.26 | 3 | 1 | - | - | - | - | - | - |
| *Paraliparis meganchus* | 1.15 | 11 | 4 | 7 | 7 | - | - | - | - |
| *Paraliparis species* | 1.23 | 38 | 4 | 38 | 38 | - | - | - | - |
| *Pleuragramma antarcticum* | 94.18 | 6156 | 22 | 637 | 231 | 16 | 8 | 18 | 136 |
| *Pogonophryne barsukovi* | 5.09 | 80 | 9 | 82 | 82 | - | - | 9 | - |
| *Pogonophryne macropogon* | 0.41 | 1 | 1 | 1 | 1 | - | - | - | - |
| *Pogonophryne scotti* | 12.84 | 52 | 18 | 53 | 51 | - | - | 39 | - |
| *Prionodraco evansii* | 0.03 | 3 | 3 | 3 | 3 | - | - | 2 | - |
| *Pseudochaenichthys georgianus* | 655.61 | 769 | 42 | 762 | 289 | 237 | 74 | 259 | 240 |
| *Racovitzia glacialis* | 0.15 | 1 | 1 | 1 | 1 | - | - | - | - |
| *Raja georgiana* | 10.75 | 7 | 2 | 7 | 7 | - | - | - | - |
| *Trematomus bernacchii* | 1.16 | 5 | 4 | 5 | 5 | - | 1 | 5 | - |
| *Trematomus eulepidotus* | 92.24 | 413 | 56 | 418 | 280 | 125 | 154 | 189 | 128 |
| *Trematomus hansoni* | 30.52 | 95 | 39 | 99 | 90 | 36 | 13 | 75 | 38 |
| *Trematomus loennbergii* | 0.49 | 6 | 3 | 6 | 6 | - | - | 1 | - |
| *Trematomus newnesi* | 7.55 | 75 | 17 | 75 | 56 | 36 | 13 | 43 | 40 |
| *Trematomus nicolai* | 0.6 | 7 | 4 | 7 | 7 | - | - | 6 | - |
| *Trematomus pennellii* | 0.12 | 1 | 1 | 1 | 1 | - | - | 1 | - |
| *Trematomus scotti* | 0.09 | 2 | 2 | 2 | 2 | - | - | | 1 |
| *Trematomus tokarevi* | 1.27 | 16 | 11 | 17 | 17 | - | - | 13 | - |
| *Vomeridens infuscipinnis* | 0.06 | 3 | 1 | 3 | 3 | - | - | 1 | - |
| *Zoarcidae species 1* | 0.07 | 1 | 1 | 1 | 1 | - | - | | - |
| Total | 7693.3 | 31844 | - | 18460 | 5941 | 2166 | 1231 | 3918 | 2610 |

Table 9.3. Standardized densities (kg/nmi$^2$) of finfish species for non-zero hauls by depth strata from the 2009 AMLR survey of the South Orkney Islands and northern Antarctic Peninsula slope.

| Species | Depth Strata | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| *A. mitopteryx* | | | 126 | 14 |
| *A. rostrata* | | | | 75 |
| *A. skottsbergi* | 1 | 1 | | |
| *B. marri* | | | 14 | 3 |
| *B. eatonii* | | | 1394 | 1740 |
| *B. maccaini* | | 1762 | 686 | 209 |
| *Bathyraja SP2* | | 49 | 115 | 120 |
| *C. aceratus* | 1941 | 7607 | 556 | |
| *C. wilsoni* | | 19 | | 350 |
| *C. gunnari* | 1349 | 1230 | 982 | |
| *C. hamatus* | | | | 16 |
| *C. myersi* | | | 46 | 11 |
| *C. rastrospinosus* | 128 | 428 | 1506 | 250 |
| *C. antarcticus* | | | 108 | 125 |
| *C. microdon* | | | | 1 |
| *D. hunteri* | | | | 4 |
| *D. mawsoni* | | 63 | 652 | 454 |
| *E. antarctica* | | 2 | 43 | 12 |
| *G. gibberifrons* | 5565 | 6207 | 2327 | 95 |
| *G. acuticeps* | | 4 | 13 | 65 |
| *G. braueri* | | | 83 | 1 |
| *G. nicholsi* | | 5 | 376 | 18 |
| *G. opisthopterus* | | | 1 | 17 |
| *K. anderssoni* | | 0.2 | 1 | 0.4 |
| *L. larseni* | 28 | 107 | 49 | |
| *L. nudifrons* | 6 | 7 | | |
| *L. squamifrons* | | 1441 | 1339 | 221 |
| *Lycenchelys sp.* | | | | 1 |
| *M. whitsoni* | | | | 428 |
| *M. prionosa* | | | | 13 |
| *Melanostigma sp.* | | | | 15 |
| *M. microps* | 5 | 55 | 51 | 27 |
| *Muraenolepis sp.* | 9 | 59 | 171 | 74 |

| Species | Depth Strata | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| *Myctophidae* | | | 20 | |
| *N. ionah* | | | 64 | 87 |
| *N. coatsi* | | | | 6 |
| *N. coriiceps* | 862 | 342 | | |
| *N. rossii* | 231 | 209 | 398 | |
| *O. amberensis* | | | | 28 |
| *P. brachycephalum* | | | | 15 |
| *P. macropterus* | | | | 8 |
| *P. charcoti* | 43 | 27 | | |
| *P. gracilis* | | | 11 | 24 |
| *Paraliparis gracilis* | | | | 15 |
| *P. meganchus* | | | | 17 |
| *Paraliparis sp.* | | | | 16 |
| *P. antarcticum* | | 1 | 612 | 85 |
| *P. barsukovi* | | | 12 | 85 |
| *P. macropogon* | | | | 26 |
| *P. scotti* | | 120 | 63 | 10 |
| *P. evansii* | | 1 | | |
| *P. georgianus* | 211 | 1629 | 1775 | |
| *R. glacialis* | | | 18 | |
| *R. georgiana* | | | | 273 |
| *T. bernacchii* | 45 | 25 | | |
| *T. eulepidotus* | 12 | 50 | 83 | 777 |
| *T. hansoni* | 46 | 39 | 92 | 75 |
| *T. loennbergii* | | | | 9 |
| *T. newnesi* | 63 | 39 | | 48 |
| *T. nicolai* | | 20 | 14 | |
| *T. pennellii* | | 13 | | |
| *T. scotti* | | 5 | | 3 |
| *T. tokarevi* | | 3 | 16 | 11 |
| *V. infuscipinnis* | | | 7 | |
| *Zoarcidae sp1* | | | | 4 |

inated by *G. gibberifrons*, (62%), *C. aceratus* (29%) and eight other species. Also on the northern shelf, Station 68 (282 m) had the third most abundant catch, dominated by *L. squamifrons* (51%), with nine other species making up the remaing percentage.

The spatial distribution of standardized finfish densities demonstrated substantial contrast across the shelf area. The number of species encountered at each station ranged from five to 33, with an average of 11 species per haul. The greatest species diversity of finfish species occurred on the southern shelf region within deeper strata (Figure 9.2B).

The zoogeographical position of the South Orkney Islands results in a region where two ichthyofaunal elements meet, the ichthyofauna of both the low-Antarctic and high-Antarctic fish communities. Low-

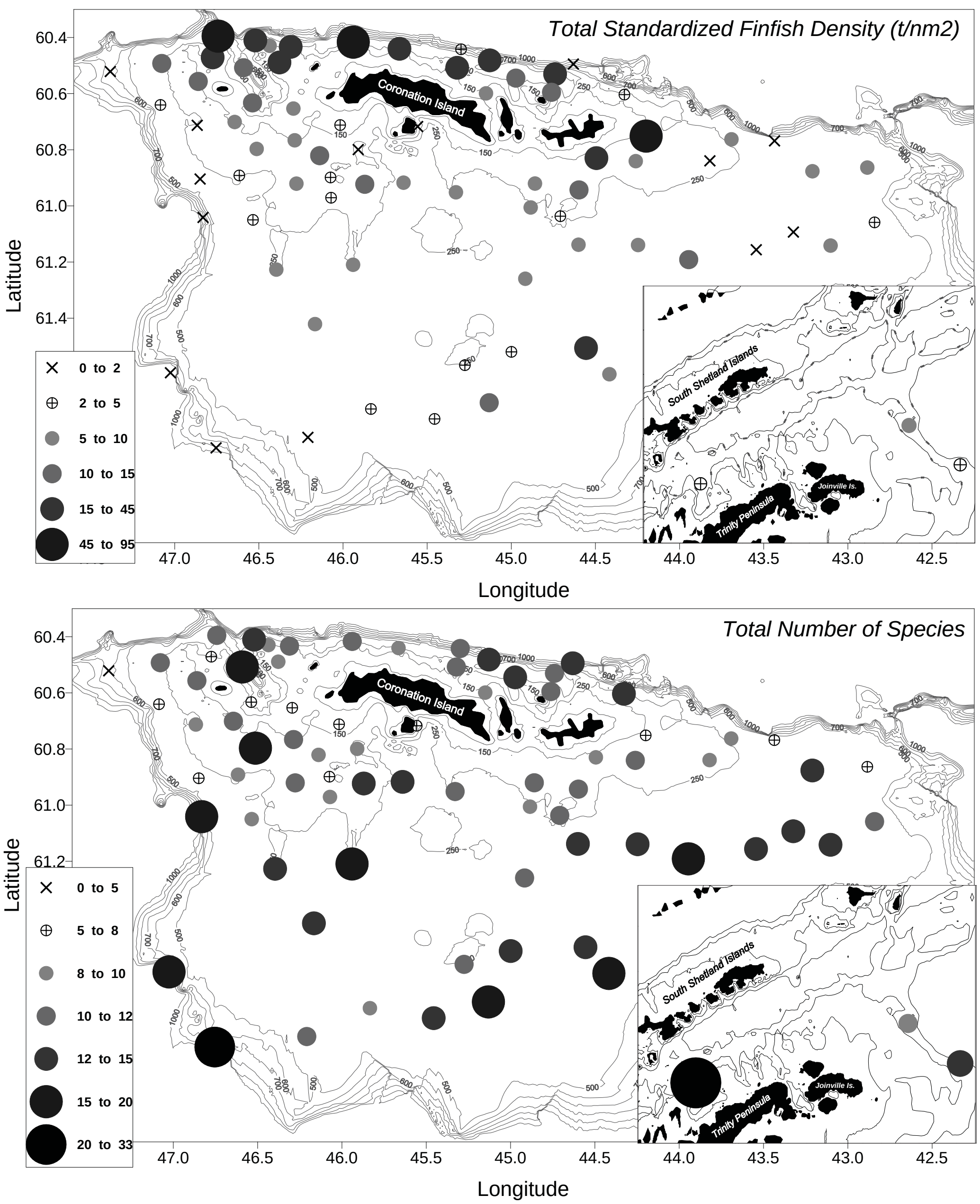


Figure 9.2. A) Total standardized finfish density in t/nmi$^2$, and B) total number of species from the 2008/09 AMLR finfish survey of the South Orkney Islands. Figure inset shows the three trawls taken on the slope of the northern Antarctic Peninsula.

Antarctic (or peri-Antarctic) species are those more common to the lower latitude regions of the Southern Ocean and archipelagos. High Antarctic species are those associated with Antarctic continent and high latitude regions. Low-Antarctic species dominate the ichthyofauna of the upper 300 m, with *G. gibberifrons*, *C. gunnari*, *C. aceratus* and *P. georgianus* as the most prominent finfish species. In waters deeper than 300 m, species such as *L. squamifrons*, a nototeniid without antifreeze glycoprotein in its blood, and *C. rastrospinosus* becomes more dominant. Mesopelagic myctophids such *E. antarctica* and *G. nicholsi* form another important element of the outer shelf ichthyofauna of the islands. High-Antarctic species dominate in terms of the number of species but are usually only represented by a small number of individuals. One of the few low-Antarctic species still found in small numbers below 500 m was G. gibberifrons.

The remainder of this report will focus on the catch, distribution, and characteristics of finfish in the South Orkney Islands region, where the primary effort of this research cruise was concentrated. The results include detailed information on the spatial distribution of densities and demographics of the eight most abundant demersal finfish species, as well as notes on other important and rare finfish taxa.

*Abundant demersal finfish*

*Chaenocephalus aceratus*: The channichthyid *C. aceratus* (Scotia Sea icefish), a relatively sluggish and sedentary demersal finfish, was a frequently encountered species during the survey. A total of 1,920 kg (2,447 individuals) was captured from 58 stations (Table 9.2), and the overall average standardized density for the area surveyed was 2,706 kg/nmii$^2$. The spatial distribution of standardized density (Figure 9.3) demonstrates *C. aceratus* occurring throughout the shallow shelf regions of the South Orkney Islands and mostly densely distributed on the northern shelf region. The largest catch was taken when a pre-spawning aggregation of *C. aceratus* northeast of Laurie Island (eastern South Orkney Islands) was encountered. Fish were encountered within all shelf strata, with the greatest average densities occurring in the 150-250 m depth strata Table 9.3).

As has been noted during previous AMLR finfish surveys in the Southern Scotia Arc region, the size distribution of *C. aceratus* was among the greatest of any species captured, ranging from 17 to 71 cm. The strongest length mode occurred around 45 cm, with weaker modes appearing around 27 cm, 37 cm, and 59 cm (Figure 9.4). Average lengths by sex were 39 cm and 47 cm for males and females, respectively. Maximum lengths of specimens were 62 cm in males and 71 cm in females. This difference provides further evidence of sexual dimorphism found in growth of males and females.

Fish were found at all stages of maturity. Most fish (40%) were maturing virgin/developing (maturity stage 2) with 25%, 32%, 3%, and 0.1% observed at maturity stages 1, 3, 4 and 5, respectively. The small number of spent females encountered toward the middle of the survey indicates that spawning likely starts in late February/early March. The maturation of gonads appears to be more synchronized than in channichthyids such as *C. gunnari*. Consequently, *C. aceratus* spawning time is likely to be shorter than that of a channichthyids species and is unlikely to extend 6 – 8 weeks. Eggs close to spawning were sticky, which is consistent with the observation of this species using a benthic nesting parental care strategy, as has been observed in other island groups in the Southern Ocean (Detrich et al. 2005).

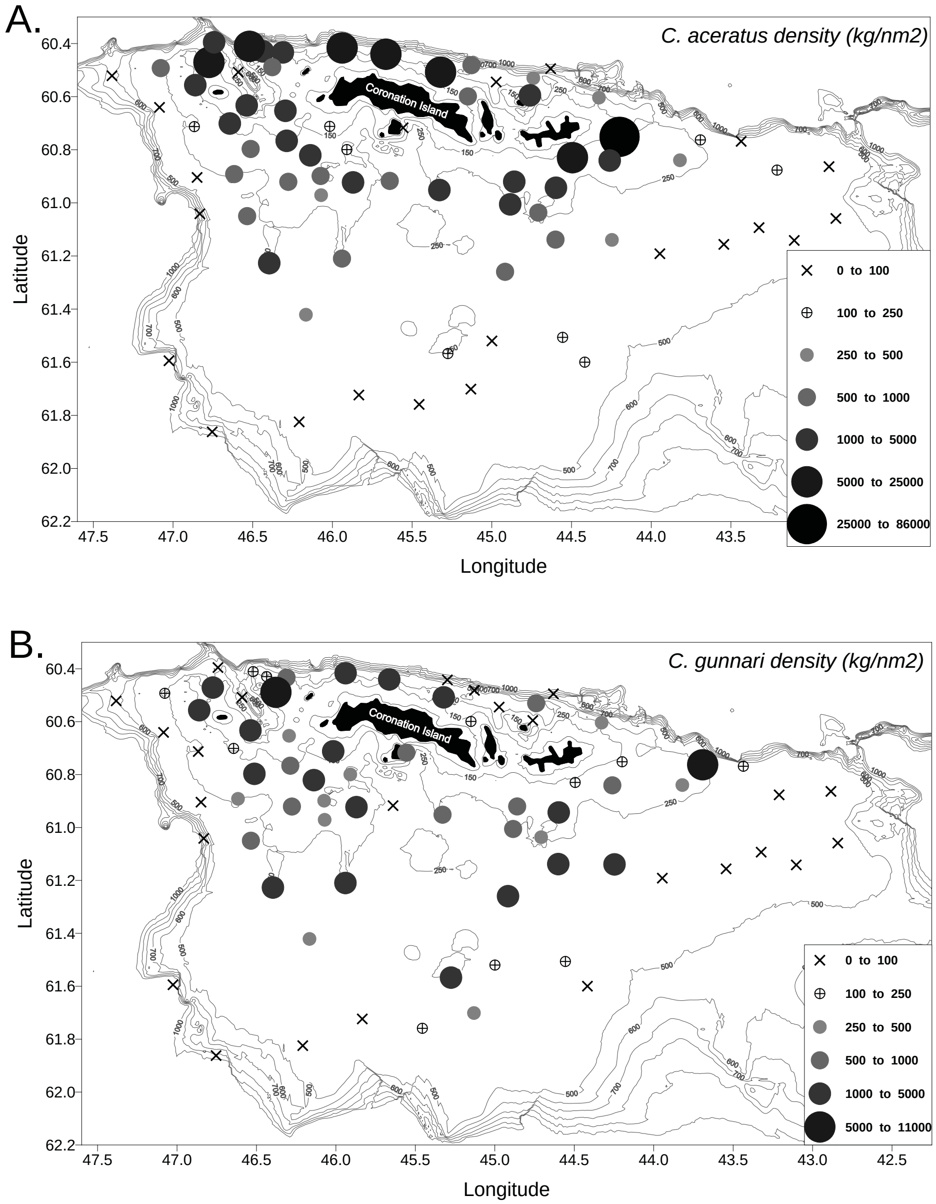


Figure 9.3. Standardized density (kg/nmi$^2$) for *C. aceratus* and *C. gunnari*.

Feeding intensity of *C. aceratus* was low, with 76% of the stomachs empty. However, it is likely that a significant proportion of the empty stomachs were regurgitated in the process of catching. Krill constituted about 44% of the overall average diet, and fish about 44%, for all individuals examined (Figure 9.11). *C. aceratus* fed primarily on krill and mysids (*Antarctomysis maxima*; 8%) when they were small (< 30cm). Mysids were likely taken close to the bottom. When *C. aceratus* change to a more sedentary life and sit and wait for prey on the bottom (ambush feeding) they alter their prey to fish (*C. gunnari*, *L. larseni*, etc.) with a smaller proportion of krill taken. This was also observed during the 2002/03 AMLR Survey of the South Shetland Islands (Flores et al., 2004).

*Champsocephalus gunnari*: The active bentho-pelag-

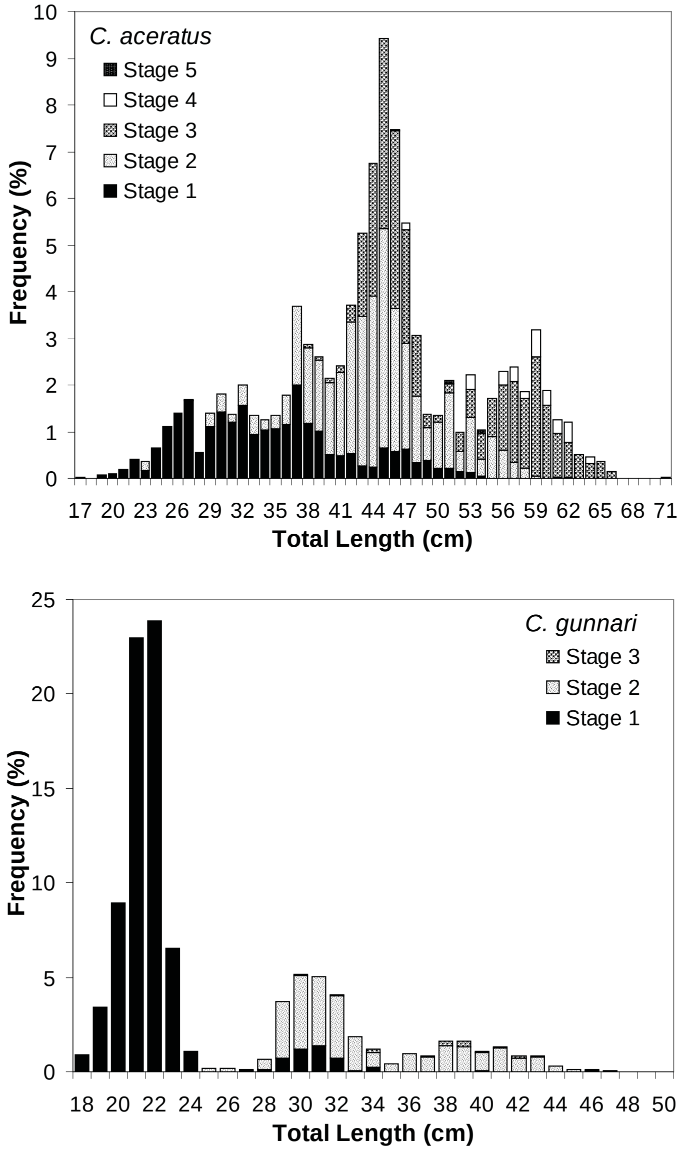


Figure 9.4. Catch-weighted length-frequency distribution for *C. aceratus* and *C. gunnari*.

ic channichthyid *C. gunnari* (mackerel icefish) was the most important commercially exploited finfish species in the South Orkney Islands (Jones et al., 2000), and the recovery of this species from depletion is of considerable interest to interest to CCAMLR.

We regularly encountered small numbers of *C. gunnari* across much of the surveyed area of the South Orkney Islands. A total of 575 kg (2,259 individuals) were encountered at 55 stations (Table 9.2), with an overall average standardized density of 833 kg/nmi$^2$. The highest densities of *C. gunnari* were observed in the western shelf regions (Figure 9.3), with the highest average densities occurring within the 50-150 m depth strata (Table 9.3). The spatial distribution of *C. gunnari* demonstrated relatively patchy concentrations across the shelf.

The size distribution ranged from 18 to 49 cm, with strong year-class modes at 22 cm, 30 cm, likely representing the age two and three year classes, respectively, and 38 cm, probably representing a mix of four-and-older year classes (Figure 9.4). Most fish (72%) were immature, from the large age two year class, with the remaining 26% and 1% at maturity stages two and three, respectively. C. gunnari is a winter spawner. Its egg diameter ranges from 2.0 – 3.5 mm

A total of 946 *C. gunnari* stomachs were sampled for dietary compostion. Of these, 754 (80%) had at least 25% full stomachs. Results from the diet analysis indicated that *C. gunnari* fed on about 99% krill (Figure 9.11). A few specimens had fish (primarily myctophids) in their stomachs. *C. gunnari* smaller than 25 cm also had a small proportion of *Thysanoessa macrura* and occasionally *Themisto gaudichaudii* and *Euphausia frigida* in their diet. The amount of food taken and the degree of digestion varied considerably between stations and even between individuals caught on one station. Stomach content weight varied from < 1 to 10% of the body weight.

*Chionodraco rastrospinosus*: The channichthyid *C. rastrospinosus* (Ocellated icefish) is a true high-Antarctic species that occurs regularly throughout the deeper shelf regions of Subarea 48.2 and other regions of the Southern Scotia Arc. A total of 618 kg (2,679 individuals) were captured, with an overall average standardized density of 783 kg/nmi$^2$. This species was among the most ubiquitous finfish species, occurring in all depth strata sampled (Table 9.3) at 62 stations (Table 9.2). The highest densities were encountered in the southernmost shelf deep stations (Figure 9.5) within 250-500 m depth strata (Table 9.3).

The size distribution of *C. rastrospinosus* ranged from 12 to 47 cm (Figure 9.6), with two strong year class modes appearing at 25 cm and 31 cm. Most fish (67%) were immature (maturity stage 1) with 30% and 2% observed at maturity stages 2 and 3, respectively (Figure 9.6). A very small percentage of post spawners were observed, which suggests the species was near the end of the spawning season.

Of the 547 stomachs examined for diet, only 173 (32%) contained material. The proximity of the spawning season likely prevented many *C. rastrospinosus* from feeding. The average diet composition consisted mainly of krill (76%) and both mesopelagic and benthic fish (21%; Figure 9.11).

*Gobionotothen gibberifrons*: The ubiquitous demersal nototheniid species *G. gibberifrons* (yellow notothenia) has been observed in relatively high abundance through the Southern Scotia Arc Islands, and was a substantial retained bycatch species when the South Orkney Islands were fished commercially for finfish (CCAMLR, 1990a; 1990b). As in the previous AMLR bottom trawl survey of Subarea 48.2 (Jones et. al, 2000), *G. gibberifrons* was the most abundant demersal finfish species, as well as the species most frequently encountered. A total of 2,628 kg (11,178 individuals) was captured from 72 stations (Table 9.2), and the overall average standardized density in the surveyed area was 3,733 kg/nmi$^2$. Fish were encountered in all depth strata, including slope stations (Table 9.3), with highest standardized densities occurring in the 150-250 m strata. The majority of catches occurred along an east-west band across the northern shelf areas of the islands, with highest concentration in the northwestern shelf sector (Figure 9.5).

The size distribution ranged from 9 to 44 cm, with an overall mode around 26-29 cm and no clearly defined year class modes (Figure 9.6). Most fish had immature or resting stage gonads, with 44% immature (stage 1), 48% maturing virgin or resting (stage 2) and 8% developing (Stage 3). Gonads of *G. gibberifrons* in resting stage confirm observations from other areas in the southern Scotia Arc that the species spawns in late austral winter. Egg diameters were less than 2 mm.

Of the 285 *G. gibberifrons* stomachs analyzed, 275 (96%) had at least 25% full stomachs. *G. gibberifrons* exhibits a high degree of variability in diet composition; it is primarily an opportunistic benthic browser (Figure 9.11). Most of the stomach contents (59%) were highly digested benthic invertebrates and not identifiable in the field. Polychaetes accounted for one of the most abundant identifiable prey items in their stomachs (14%), followed by salps (7), ophiuroids (7%), krill (4%), amphipods (4%), and isopods, echinoderms, pycnogonids, and fish equally making up the remainder (4%) of the average diet.

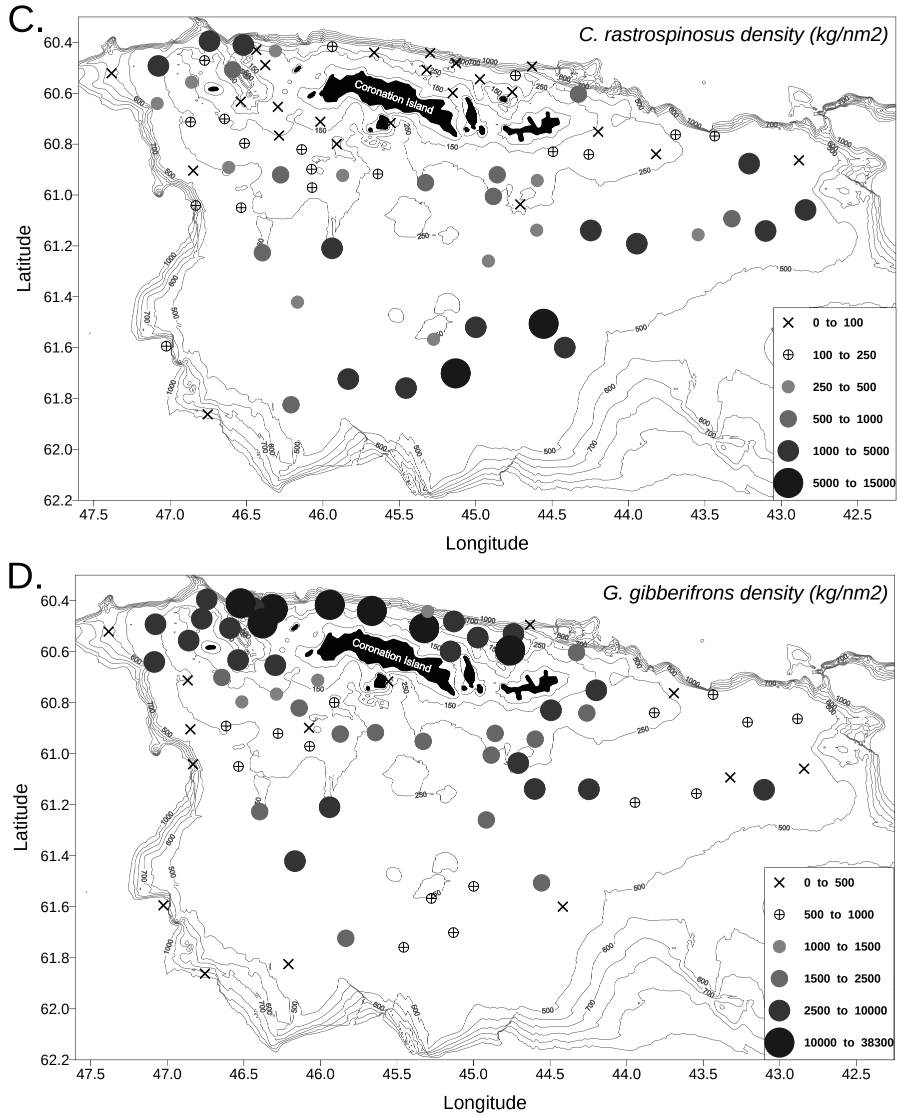


Figure 9.5. Standardized density (kg/nmi$^2$) for *C. rastrospinosus* and *G. gibberifrons*.

*Lepidonotothen squamifrons*: A relatively large number of the nototheniid *L. squamifrons* (grey rockcod) was encountered during this survey. A total of 505 kg (892 individuals) was captured at 44 stations (Table 9.2), and the average standardized density was 679 kg/nmi$^2$. Catches occurred in mid- to deep-water stations, with highest densities near the northwestern shelf break (Figure 9.7) north of the Inaccessible Islands. Highest average densities were encountered in the 150-250 m stratum (Table 9.3), which is somewhat unusual, as *L. squamifrons* has occurred in highest densities in deeper waters during previous AMLR Surveys

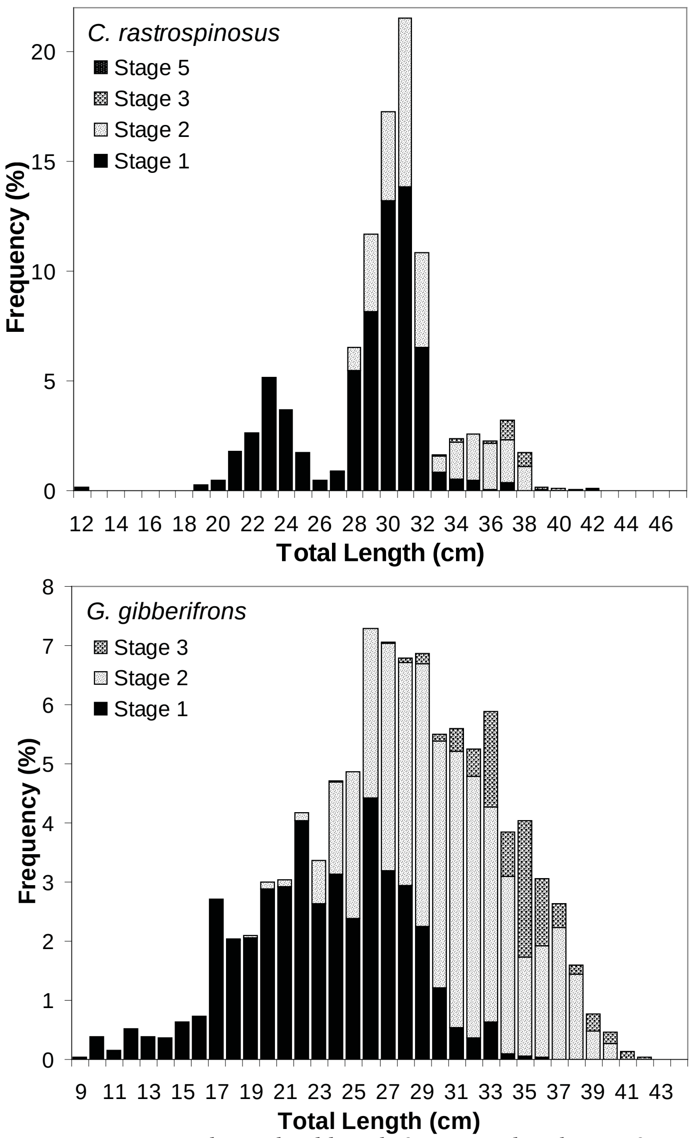

Figure 9.6. Catch-weighted length-frequency distribution for *C. rastrospinosus* and *G. gibberifrons*.

around the South Orkney Islands and northern Antarctic Peninsula regions.

The length-frequency distribution of *L. squamifrons* ranged from 6 to 49 cm, with a broad mode of likely mixed year classes from 32 to 42 cm (Figure 9.8). Fish were found at all five stages of maturity, with most (43%) in maturity stage 2 (resting), and 17%, 11%, .5%, and 27% observed at maturity stages 1, 3, 4, and 5, respectively. The relatively large fraction of spent individuals indicates *L. squamifrons* was well into their spawning season.

A total of 222 stomachs from *L. squamifrons* were analyzed for diet composition. Of these, 196 (88%) had at least 25% full stomachs. The diet of *L. squamifrons* was complex, though comprised mainly of salps (49%; Figure 9.11). Also observed in the diet were unidentified, highly digested benthic invertebrates (26%), krill (10%), fish (7%), and amphipods (4%); isopods, pycnogonids, polychaetes, and echinoderms comprised the remainder of their diet.

*Notothenia coriiceps*: The nototheniid *N. coriiceps* (black rockcod) is an important representative of the demersal finfish community found throughout shallow shelf areas of the Scotia Sea. A total of 109 kg (81 individuals) was captured at 22 stations (Table 9.2), and the average standardized density was 170 kg/nmi$^2$. Fish were found in most shallow stations within the survey area, with the highest densities in the eastern and western shallow shelf areas (Figure 9.7). Concentrations of *N. coriiceps* were found primarily within the 50-150 m strata (Table 9.3).

The length-frequency distribution ranged from 34 to 59 cm, with a broad mode appearing at around 36-39 cm (Figure 9.8). Most individuals (77%) encountered were maturity stage 3 (sexually mature), with 22% and 1% at maturity stages 2 and 1, respectively. Maturation of most gonads appears to be synchronized. This species likely spawns over a comparatively short period of time, probably commencing about 3 – 6 weeks after this survey.

A total of 51 stomachs from *N. coriiceps* were analyzed for dietary composition, 45 of which had at least 25% full stomachs. The diverse diet that *N. coriiceps* has demonstrated from previous AMLR Surveys was confirmed (Figure 9.11), though the diversity was substantially less relative to diet in the South Shetland Islands and northern Antarctic Peninsula. In the South Orkney Islands, diet was dominated by krill (68%) as well as fish (25%). Other components included salps, highly digested unidentified benthic invertebrates, amphipods, and ophiuroids.

*Pseudochaenichthys georgianus*: A total of 656 kg (769 individuals) of the channichthyid *P. georgianus* (South Georgia icefish) was captured from 42 stations (Table 9.2). The majority of catches occurred at stations off the northeastern tip of Coronation Island, as well as at several stations on the southern shelf area (Figure 9.9). Fish were encountered in all shelf strata, with the highest average densities found in the 250-500 m strata (Table 9.4); the average standardized density was 906 kg/nmi$^2$.

The size distribution of *P. georgianus* ranged from 13 to 55 cm (Figure 9.10), with very well defined modes at

30, 38 and 47 cm. Most fish (41%) were maturity stage 2 (developing virgin), with 31%, 27% and 0.01% observed at maturity stages 1, 2 and 5, respectively. Fish with gonads in pre-spawning state, detected along the northern shelf area, will likely spawn in two months. This is consistent with observations of *P. georgianus* during the 1998/99 AMLR Survey of the South Orkney Islands, when a large spawning aggregation was detected north of Coronation Island in late March.

A total of 259 stomachs from *P. georgianus* were analyzed for diet composition. About 65% (169) of these had at least 25% full stomachs. The average diet comprised mainly krill (68%) and fish (26%); the remaining remaining percentage was composed of mysids and unidentified invertebrates (Figure 9.11).

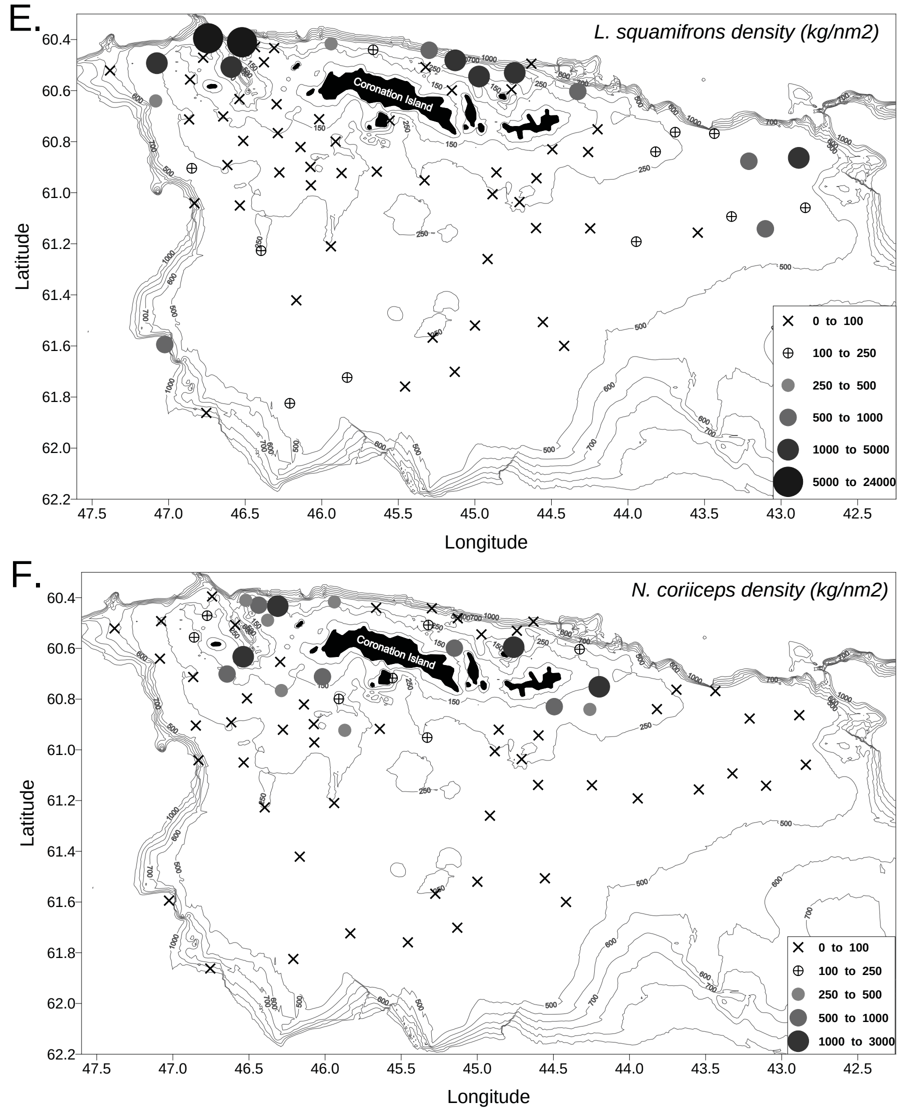


Figure 9.7. Standardized density (kg/nmi$^2$) for *L. squamifrons* and *N. coriiceps*.

*Trematomous eulepidotus*: There were a surprisingly large number of encounters of the nototheniid *T. eulepidotus* (Antarctic rockcod). This species had been targeted in the commercial fishery by the Soviet Union in the high-Antarctic in the 1980s (CCAMLR, 1990a; 1990b), and occurs on the shelf of the South Orkney Islands and other high-latitude Antarctic shelf areas. A total of 92 kg (413 individuals) was collected from 56 stations (Table 9.2), and the average standardized density was 92 kg/nmi$^2$. The species was present in all depth strata, with the highest standardized densities on the shelf occurring in the 350-500 m stratum, and considerably more on the slope sets (Table 9.3). The spatial pattern of *T. eulepidotus* density demonstrated the preference of this species toward deeper regions of the South Orkney Island shelf, with a relatively consistent distribution of densities at depths greater than 250 m (Figure 9.9).

The lenth-frequency distribution ranged from 9 to 36 cm, with broad modes at 23-25 cm and 32-34 cm (Figure 9.10). Most fish (67%) were maturity stage 3, along with 26% and 7%, observed at maturity stages 1 and 2, respectively. Pre-spawning *T. eulepidotus* were caught in larger numbers (38 and 126 specimens) at Stations 103 and 101, respectively, which were positioned in the outflow of the western Weddell Sea from 620 to 745 m depth. The first, shallower, haul contained 126 individuals, of which more than 90% were males. The second haul, about 120 m deeper, contained only females. The two hauls seem to suggest that males occupy a habitat different than females prior to spawning. Whether they occupy territories, as a number of other notothenioids do, is still speculative.

A total of 189 stomachs were analyzed for diet composition; about 59% (111) of these had stomachs at least 25% full. Results from the diet analysis indicated that *T. eulepidotus* have a variable diet, though feed primarily on krill (47%) as well as miscellaneous benthic and pelagic invertebrates, including jellyfish (29%), salps (8%), fish (7%), and mysids (5%), with amphipods, polycheates, and echinoderms composing the re-

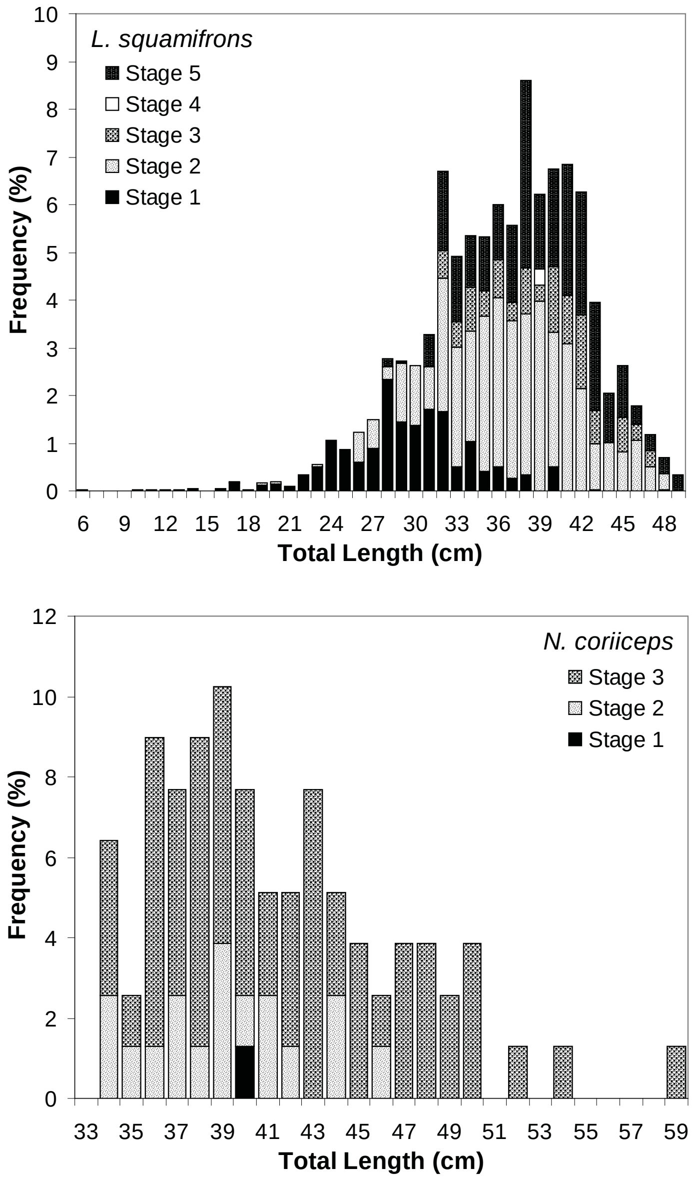


Figure 9.8. Catch-weighted length-frequency distribution for *L. squamifrons* and *N. coriiceps*.

mainder of the diet (Figure 9.11).

*Other Species*

*Notothenia Rossii*: The nototheniid *N. rossii* (Marbled rockcod) was an important commercially targeted species in the South Orkney Islands in the late 1970's and early 1980's (CCAMLR, 1990a; 1990b), and the recovery of this species from depletion is of considerable interest to CCAMLR. Jones et al. (2000) noted that there appeared to be some signals of recovery from the results of the 1998/99 AMLR Survey of the South Orkney Islands. Results from this survey suggest that the species still has not recovered to the level of biomass during the 1970s-1980s. A total of only 49 kg (23 individuals) was captured from 17 stations (Table 9.2). Catches occurred in all depth strata, with the highest average densities encountered within 250-500 meters (Table 9.3).

The size distribution ranged from 38 to 69 cm, with no well defined mode. About half of the individuals staged for sexual maturity were maturity stage 3 (developing), with maturity stages 1 and 2 equally represented in the remaining half. Diet composition was collected from 21 individuals, 18 of which (86%) had at least 25% full stomachs. Their diet consisted mainly of fish (41%), krill (35%), and salps (13%), with the remaining composed of unidentified digested benthic invertebrates and amphipods (Figure 9.11).

*Lepidonotothen larseni*: The ubiquitous nototheniid *L. larseni* (Painted rockcod) is small, relatively abundant throughout the Southern Scotia Arc region, and is an important prey item to fish-eating demersal finfish. A total of 38 kg (888 individuals) were captured from 61 stations (Table 9.2).

The greatest densities of this species were encountered in the 150 and 250 m strata (Table 9.3). The size distribution of *L. larseni* ranged from 6 to 22 cm. Gonads were in an early stage of maturation, with most fish in either maturity stage 2 (69%) or maturity stage 1 (29%), and a few specimens starting to develop. This suggests that spawning will likely not commence before June.

A total of 167 stomachs from *L. larseni* were analyzed for diet composition, 140 (84%) of which had at least 25% full stomachs. Their diet (Figure 9.11) largely comprised krill (40%) and miscellaneous digested benthic invertebrate material (49%). In addition, their diet consisted of salps (7%), mysids (3%), amphipods and polychaetes (2%).

*Dissostichus mawsoni*: The nototheniid *D. mawsoni* (Antarctic toothfish) is currently one of the most important commercially harvested species several in other regions of the high Antarctic Southern Ocean. The closely related *D. eleginiodes* was commercially harvested in small numbers around the South Orkney Islands during the late 1970s and early 1980s (CCAMLR, 1990a; 1990b), though there is some speculation that the species may have been misreported, and may have been *D. mawsoni*. During this survey, as well as during AMLR 1998/99 Survey, only representatives of *D. mawsoni* were encountered.

A total of 21 kg (12 individuals) was captured from five stations (Table 9.2). The size distribution ranged from 33 to 88 cm. Ten of the 12 specimens were immature (maturity stage 1), with the remaining two maturing virgins (maturity stage 2). Stomach contents from 10 individuals were examined, six of which had at least 25% full stomachs. The composition of the diet for those fish with stomach contents consisted mostly of fish (67%), the remaining percentage was highly digested unidentified material (Figure 9.11).

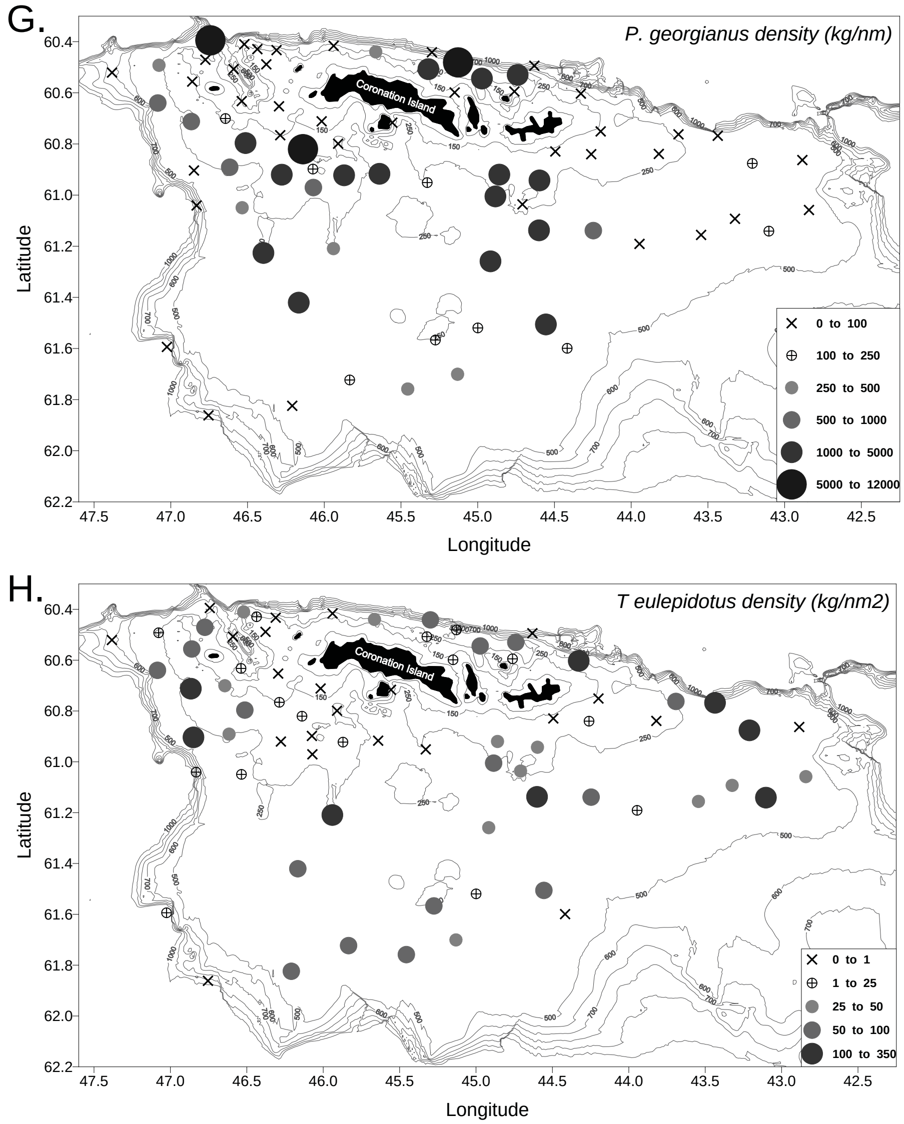


Figure 9.9. Standardized density (kg/nmi$^2$) for *P. georgianus* and *T. eulepidotus*.

*Pleurogramma antarcticum*: A surprisingly large number of the mesopelagic species *P. antarcticum* (Antarctic silverfish) was captured opportunistically during course of the survey. This species, along with *G. nicholsi* and Electrona Antarctica, is an important prey item for several species of finfish, seabirds and mammals, and thus one of the most important finfish species of the Antarctic ecosystem. We captured 94 kg (6,156 individuals) at 22 stations (Table 9.2), by far the most *P. antarcticum* captured during an AMLR bottom trawl survey. In contrast, The 1998/99 AMLR Survey of the South Orkney Islands (using a similar sampling design on the shelf), captured only 12 specimens.

Catches occurred at stations deeper than 250 m along the survey area (Table 9.3). The length-frequency distribution of *P. antarcticum* ranged from 71 to 263 mm, with a mode around 115-125 mm. A limited number of specimens were staged for maturity (n=89); measured fish were primarily immature (85%) or developing gonads (15%). A total of 18 *P. antarcticum* stomachs were sampled for dietary composition, six of which had at least 25% full stomachs. Of this limited sample, the diet was 83% krill, with the remaining percentage consisting of miscellaneous digested pelagic invertebrates (Figure 9.11).

*Gymnoscopelus nicholsi*: The pelagic myctophid *G. nicholsi* was captured opportunistically during the course of the survey. This species, along with *Electrona antarctica* and *P. antarcticum*, constitutes an important prey item for several species of finfish, land-based birds and mammals. Other myctophid species occasionally encountered included *G. braueri*, *G. opisthopterus*, and *K. anderssoni* (Table 9.2)

A total of 77 kg (2,188 individuals) of *G. nicholsi* were captured from 27 stations. Catches occurred at offshore stations in waters deeper than 250 meters. The size distribution of *G. nicholsi* ranged from 122 to 168 mm. A total of 91 *G. nicholsi* were staged for maturity, 93% of which were immature.

Other finfish families: The other two families of the suborder Notothenioidei, the Bathydraconidae (dragon fish) and the Artedidraconidae (plunderfish), were less represented in samples during the course of the survey. The bathydraconids encountered were *Bathydraco marri*, *Gymnodraco acuticeps*, *Parachaenichthys charcoti*, *Prionodraco evansii* and *Racovitzia glacialus*. Artedi-

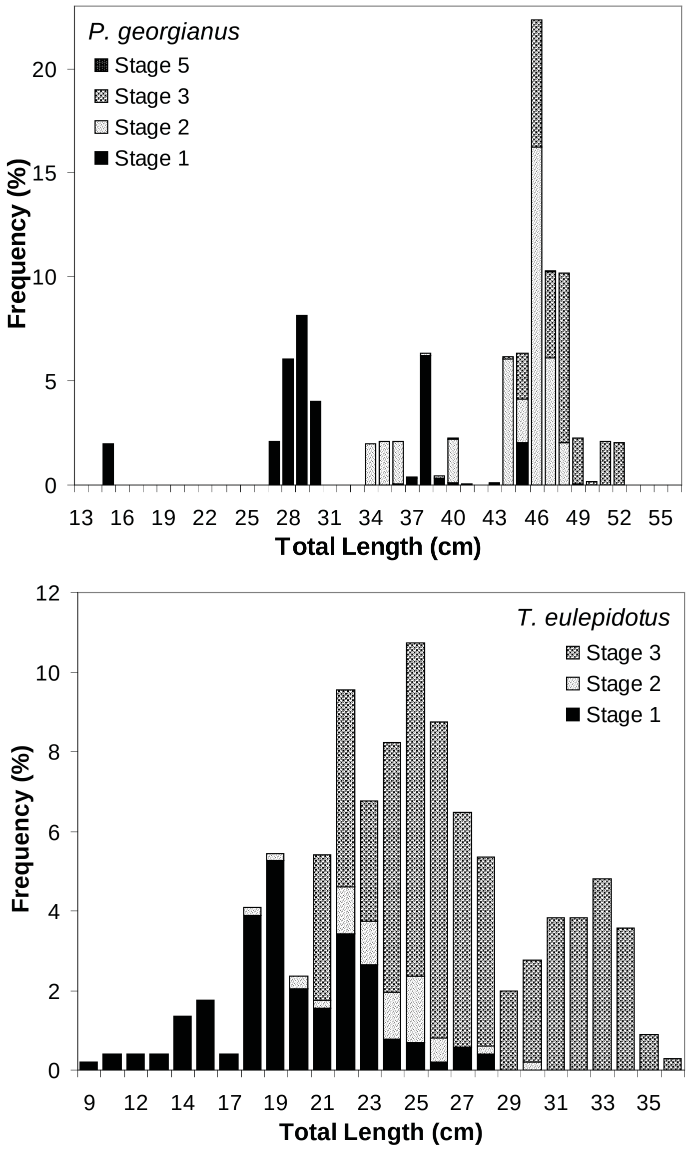


Figure 9.10. Catch-weighted length-frequency distribution for *P. georgianus* and *T. eulepidotus*.

draconids were represented by *Artedidraco skottsbergi* and members of the genus *Pogonophryne*, including *P. barsukovi*, *P. macropodon*, and *P. scotti*.

One of the more interesting Artedidraconid species is *Pogonophryne scotti*, usually encountered in small numbers in a typical survey, with the exception of the 1998/99 AMLR Survey of the South Orkney Islands, during which 100 individuals were captured. During the course of this year's survey, 52 individuals were captured.

We have made additional important observations on diet, reproductive condition, and buoyancy on several rare notothenioid species, including *Bathydraco marri*, *Prionodraco evansii*, *Aethotaxis mitopteryx*, *Pogonophryne barsukovi*, *Artedidraco skottsburgi*, and *Trematomus tokarevi*. In addition, we have confirmed the presence of *Trematomus nicolai* in the South Orkney Islands. The occurrence of this species in the South Orkney Islands had only been recorded once, in the 1960s, and this record was considered erroneous.

Other faunal elements encountered during the course of the survey included the zoarcids (*Pachycara brachycephalum*, *Ophthalmolycus amberensis*), skates (*Bathyraja eatonii*, *B. maccaini*, *Bathydraco sp. 2*) and several snailfishes (Liparididae) of the genus *Paraliparis*. They are either of non-Antarctic origin or form separate species in the Southern Ocean.

*Enrionmetal Observations*

Information on several characteristics of the pelagic and seafloor components of shelf areas around South Orkney Islands were collected in an effort to elucidate the role of mesohabitat ecological features on demersal fish assemblages. Shelf areas of the South Orkney Islands are widely varied in their bathymetry, water mass characteristics, pelagic prey distribution, seabed composition, and benthic invertebrate communities. These features likely play a significant role in the spatial distribution, density, demography, and dietary composition of demersal finfish across the South Orkney Island shelf area.

Data collections during Leg II of the AMLR Survey that complement the demersal finfish survey results included physical oceanographic measurements (Chapter 1), characterization of krill density (Chapters 3 and 12), benthic invertebrate megafauna distribution and composition (Chapter 10) and direct video observation of habitat features (Chapter 11).

*Biodiversity, buoyancy variation, and systematics*

Sixty-five species of notothenioid demersal fish were encountered during the course of the 2008/09 AMLR Survey finfish trawl, which was by far the largest tally for any AMLR Survey bottom trawl. Of these species, 835 finfish specimens and tissue biopsies were collected from 62 species. Tissue biopsies were collected for ongoing phylogenetic and population genetic studies of notothenioid fishes. Whole specimens collected were fixed in formalin for deposition in the fish collection at the Peabody Museum of Natural History, Yale University. Included in the collections are several rare notothenioid species including *Aethotaxis mitopteryx*, *Trematomus tokarevi*, *Vomeridens infuscipinnis*, and *Neopagetopsis ionah*. Specimens of *Notothenia* *coriiceps* and *Trematomus hansoni* have been collected by the Peabody Museum in order to investigate long standing unresolved questions in the taxonomy and systematics of these species.

Work on buoyancy variation is demonstrating that closely related notothenioid species can have significantly different buoyancy measurements. This is hypothesized to reflect water column habitat use, with more buoyant species being less benthic. Most species of teleost fishes use a swim bladder to regulate buoyancy. All notothenioid fishes lack a swim bladder; however, there has been substantial variation in buoyancy detected among notothenioid species (Near et al. 2009). The buoyancy of a specimen, considered as the percent of the weight in air of the weight in water, was measured from all notothenioid species along with other measurements taken for functional morphological characters. To determine the weight in water, specimens were suspended completely in seawater by a silk suture attached to a triple beam balance.

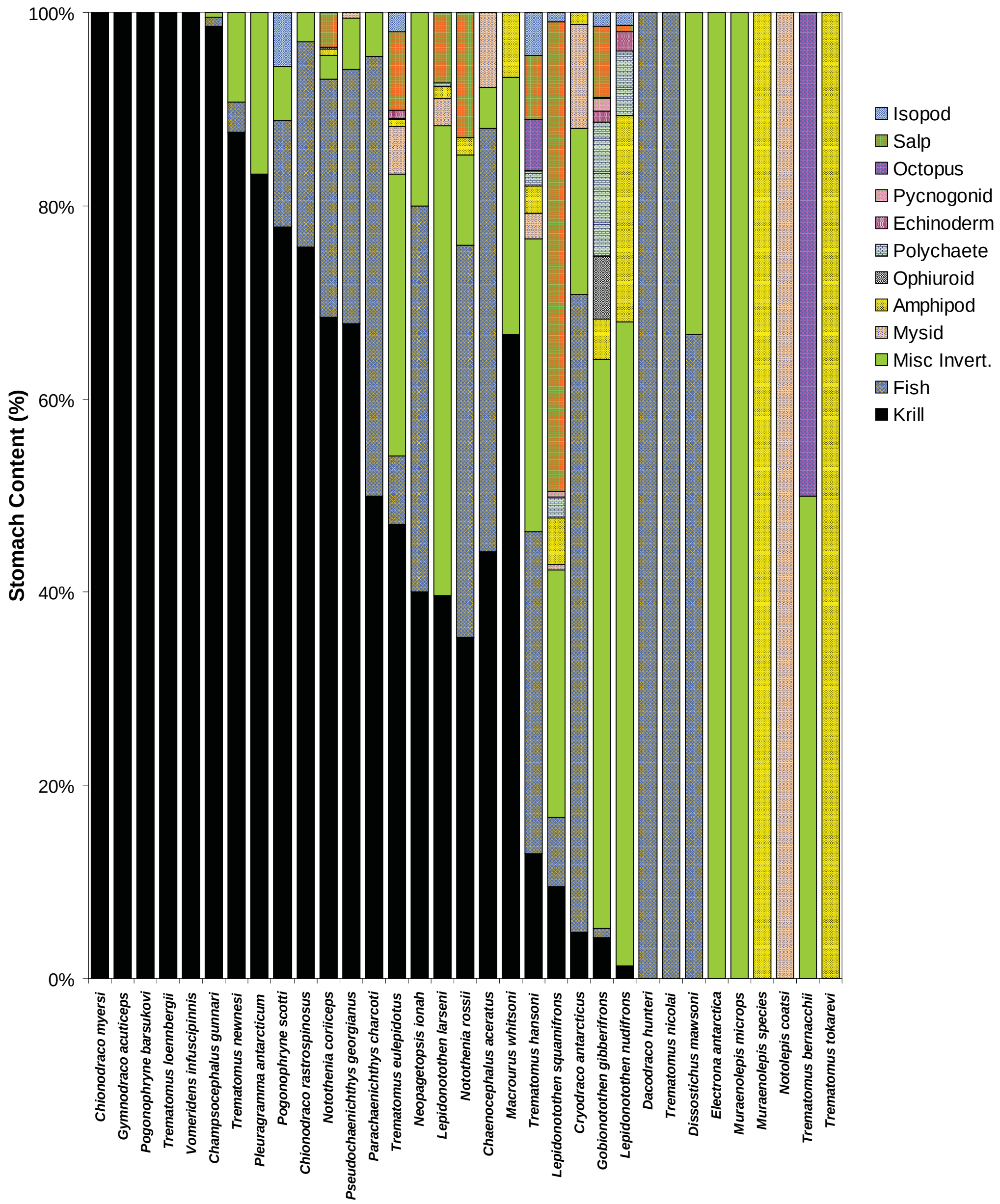


Figure 9.11. Summary of diet composition of 33 species of finfish, based on mean stomach content scores and sorted by % krill, from the 2008/09 AMLR Survey of finfish in the South Orkney Islands.

Sampling during the course of Leg II resulted in collection of specimens of at least two undescribed species: an unknown muaenolepid and a *Bathyraja* species that has been known to scientists for at least 20 years. Investigation and possible species description will take place at Yale University.

*Finfish Age and Growth*

A total of 2,583 otoliths from 21 finfish species were collected. These otoliths are to be used in age estimation and population structure studies based at the Center for Quantitative Fisheries Ecology (CQFE), Old Dominion University (ODU), Norfolk, Virginia. In addition, otoliths and gonads for *C. aceratus* were collected for examining age and growth, reproductive biology, and population structure of this species. Otoliths of *P. antarcticum*, *D. eleginoides*, *D. maswoni*, and *N. coriiceps* are being targeted for the fulfillment of connectivity and population structure projects based at the CQFE. A total of 130 gonads (male and female, maturity stages 1-3) were collected from *C. aceratus*. Gonads have also been collected from *C. gunnari*, *N. coriiceps*, *T. hansoni*, *P. antarcticum*, *L. larseni*, *T. newnesi*, *C. rastrospinosus*, *N. rossii*, and *L. squamifrons*. Total gonad collection for all species was 187 gonads. These gonads will be used in histological studies based at the CQFE and the Consiglio Nazionale delle Ricerche (CNR) in Ancona, Italy.

**Discussion**

Leg II of the 2008/09 AMLR Survey represented the first comprehensive demersal finfish survey in the South Orkney Islands since 1999. Analysis of the results of this survey will prove critical in terms of understanding the present status of South Orkney Islands shelf finfish populations and other ecosystem components. Results from further analysis will be used to develop management advice for the CCAMLR Scientific Committee and potentially develop or revise harvest policy or spatial management initiatives. There has been a moratorium imposed by CCAMLR on all finfish fishing in Subarea 48.2, which includes the South Orkney Island shelf, since the 1990/91 season (CCAMLR CM 32-03). This moratorium was set in place due to a major depletion of finfish, primarily of *C. gunnari* and *N. rossii*, as a result of overfishing that took place primarily prior to the inception of the CCAMLR Convention, and a lack of precautionary management and harvest policy.

Results of Leg II provide the information necessary to estimate standing stock biomass for several finfish species, compare these estimates to historical information, and provide advice as to whether a sustainable fishery for any of the finfish resources could be implemented at this time. Further, the collection of data for several other ecosystem components during the course of Leg II, such as pelagic prey and benthic invertebrate density and distribution, allows the demersal finfish results to be integrated in a more ecosystem context, potentially providing information that could be used toward spatial management initiatives.

**Protocol Deviations**

The demersal survey sampling design of the South Orkney Islands shelf area did not deviate significantly from the protocol outlined during the 1998/99 AMLR Survey of this region. The timing of the survey, though, was about one month earlier than the 1998/99 AMLR Survey. The realized locations of almost all hauls varied from the initially planned coordinates due to sea, wind, bottom, and ice conditions. Several initially planned stations were inaccessible due to heavy ice concentrations. However, these were successfully relocated in the same general shelf region within the same targeted depth strata. Further, there were a number of other research projects that were not undertaken during the previous survey. With respect to sampling off the shelf, another strata with stations set on the slope region was added (these will not impact the estimate of biomass for the shelf survey). There was substantially greater sampling and preservation of finfish specimens and tissue as well.

Other differences from the previous survey of the South Orkney Islands included detailed benthic invertebrate megafauna characterization from the trawling stations, photo/video transects using the skiing camera configuration to characterize seafloor habitat, benthic communities, and to provide direct evidence of Vulnerable Marine Ecosystem (VME) indicator taxa that will be used toward potentially registering VME risk areas in the CCAMLR Convention Area. The survey also included IKMT net tows for krill and zooplankton composition, which will help elucidate spatial relationships between finfish krill predators and prey on the shelf area.

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**Disposition of Data**

Data collected from the trawl survey were documented on hardcopy datasheets and entered into an MS-ACCESS computer database. The U.S. AMLR program maintains these hardcopies and computer databases. Data are available from Christopher Jones, Antarctic Ecosystem Research Division, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA 92037; phone/fax – (858) 546-5605/546-5608; e-mail: Chris.D.Jones@noaa.gov.

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UNITED STATES
AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

# AMLR 2008/2009 FIELD SEASON REPORT

## Objectives, Accomplishments and Tentative Conclusions

Edited by
Amy M. Van Cise

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