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New Zealand Fisheries Data Report No. 49
ISSN 0113-2288
1994

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**Published by MAF Fisheries**
**Wellington**
**1994**

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The *New Zealand Fisheries Data Report* series continues the *Fisheries Research Division Occasional Publication: Data Series.*

ISBN 0-478-04622-7

# Contents

# Introduction

This report describes the stratified random bottom trawl survey of the south Chatham Rise carried out using the chartered commercial trawler *Cordella* between 30 October and 30 November 1990.

This was the third stratified random trawl survey of the south Chatham Rise by MAF Fisheries staff. The earlier surveys also used chartered commercial trawlers, *Arrow* in 1986, *Amaltal Explorer* in 1987, and were reported by Fincham *et al.* (1987) and Fenaughty *et al.* (1988). No surveys were carried out in 1988 and 1989.

These surveys aimed to measure the relative biomass of black oreo (*Allocyttus niger*), smooth oreo (*Pseudocyttus maculatus*), and orange roughy (*Hoplostethus atlanticus*) on the south Chatham Rise, but they were principally designed to sample oreos rather than orange roughy. The design and the timing of the 1986, 1987, and 1990 surveys were essentially the same (*see* Discussion for comments on the differences) and the original intention was to develop a time series of comparable surveys. However, it became clear that quantitative comparison of biomass estimates between surveys would be difficult because of the necessity to use different vessels. Vessels were selected by an open competitive tender process.

## Objectives

1. To estimate the biomass of deepwater species, principally smooth oreo, black oreo, and orange roughy.
2. To collect biological data and materials for reproductive and life history studies, including length, weight, sex, gonad stage, gonad weight, and otoliths from samples of smooth oreo, black oreo, and orange roughy.

# Methods

## Survey area

The survey area was first defined for the 1986 survey and was subdivided into four subareas roughly equal in size (Figure 1). In 1987 the eastern end of the survey area was extended from 176° 20′ W to 176° W. A further easterly extension was made in the 1990 survey from 176° W curving east and north to latitude 44° S. This was defined as a new subarea (subarea 5).

The 1990 survey area of 56 841 km$^2$ was divided into five subareas as follows: subarea 1 from longitude 172° 30′ to 174° 30′ E, subarea 2 from 174° 30′ to 176° E, subarea 3 from 176° to 178° 40′ E, subarea 4 from 178° 40′ E to 176° W, and subarea 5 from 176° to 174° 10′ W (with a northern limit of 44° S).

During the 1990 survey an attempt was made to refine the western boundary of the survey area. Stations 191–207 were made to investigate trawl ground and catches at the western end of subarea 1. These stations were not random and have therefore been excluded from the biomass estimation (*see* Results, Trawl stations).

## Survey design

A two-phase stratified random bottom trawl survey design (*after* Francis 1984) was used. Areas and depths were chosen to sample black oreo, smooth oreo, and orange roughy.

### Stratification

Strata and stratum areas are given in Table 1. Depth stratification for all subareas in 1986, 1987, and 1990 included the intervals 600–800, 800–900, 900–1000, 1000–1100, and 1100–1200 m. In 1990 an additional interval of 1200–1500 m was added in subareas 4 and 5 in response to reported commercial fishing of these depths.

### Station allocation

Allocation of stations to strata was decided after consideration of the station allocation in the 1986 and 1987 surveys. Equal weighting was given to the depth intervals 800–900, 900–1000, and 1000–1100 m because most of the biomass came from those depths. Subareas 2 and 3 had fewer stations because of low biomass there. Two extra stations were allocated to stratum 20 because of previous high biomass results. Stratum 10 (1100–1200 m, subarea 2) and stratum 15 (1100–1200 m, subarea 3) were sampled in the 1986 and 1987 surveys, but not in 1990 because of low biomass results.

Stations for phase 2 were allocated after calculating the number of stations required to reduce the variability (coefficient of variation, *c.v.* %) of the biomass estimates for smooth oreo, black oreo, and orange roughy. Emphasis was placed on reducing the *c.v.* of the largest biomass estimate (smooth oreo) to less than 30%.

### Station position selection

Phase 1 random station positions were first generated for the 1986 survey. The 1986 phase 1 stations were repeated in 1987 and 1990 for subareas 1–4. New phase 1 station positions were generated for strata 21–27 (new) in 1990.

There were fewer stations in some strata in 1990 than in 1987 because of the increased total survey area in 1990. The number of stations was reduced by random selection from the 1987 list in the following strata by the numbers in parentheses: 2 (3), 3 (1), 5 (3), 7 (1), 8 (2), 9 (3), 12 (2), 13 (1), 14 (2), 16 (1), 17 (4), 18 (3), 19 (3).

New random positions (random longitude and depth pairs) were generated on board for phase 2 stations.

### Station execution

Phase 1 stations in subareas 1–4 used the actual start and finish positions of the 1987 stations because these positions were known precisely (Global Positioning System was used). For new phase 1 and 2 positions, the stations were carried out by towing through the random position. Where this was not possible because of bad trawl ground, an area within 2 n. miles of the position was searched for trawlable ground. If a station was still not possible, the position was abandoned and replaced with the next one on the list.

Phase 1 and phase 2 stations were 2 n. miles long where possible: the shortest acceptable station was 0.82 and the longest was 3.0 n. miles ($n$ = 189, mean = 1.91, median = 2.0).

## Survey timing

The survey was carried out from 30 October to 30 November 1990 to correspond with the timing of the previous surveys.

## Vessel and gear

*Cordella*, a stern trawler chartered from Pacifica Shipping, has the following specifications: length, 76 m; gross tonnage, 1238 t; power, 2610 kW. Gear specifications and the net plan are given in Appendix 1.

### Assumptions about gear parameters

The distances between the wings of the net and between the doors were unknown because no measuring equipment was available. We have assumed the values for the similar net and doors used by *Tangaroa* and measured during gear trials in 1991 and during trawl survey TAN9104, i.e., a mean distance between the doors of 117 m and a mean distance between the wings of the net of 28 m. The sweep length was shortened during the survey (92 m for stations 1–105 and 46 m for stations 106–207) because the skipper insisted on using short sweeps on the steep trawl ground at the eastern end of the survey area. We have assumed that the distance between the wings was similar for both sweep lengths, and that the distance between the wings of the net was the effective fishing width of the net for all stations. We are unable to test these assumptions. Equipment to measure trawl gear parameters should be considered for future surveys.

## Biomass estimation

Biomass was estimated by the area-swept method (Francis 1981) using the formulas in Vignaux (1994).

Biomass was calculated with the MAF Fisheries Trawlsurvey Analysis Program held at Greta Point. The combined biomass and length frequency analysis was used and biomass stations were selected from the required strata where gear performance was 1 or 2. Run parameters for the analysis included: recorded distance towed; constant doorspread of 117.0 m; catch data weight as recorded in catch table; length-weight relationship calculated for each species from data collected during the 1990 survey; fish vulnerability, 0.239; vertical availability, 1.0; areal availability, 1.0. Catch rates were expressed as $kg.km^{-1}$.

Biomass estimates for the three main species (black oreo, smooth oreo, and orange roughy) were made for fish of all lengths ("all fish" in the text and tables) and also for fish that were considered to have recruited to the fishery ("recruited"). The recruited length for each species was defined as the length on the left hand limb of the length distribution (to the left of the mode) at which 50% of the fish occurred and was calculated from the length frequency distribution of fish sampled from commercial catches by scientific observers. The length data were selected from the observer database for the area 43°30′ to 45°30′ S and 172° E to

174° W for the years 1986 to 1992 and were not scaled. The mode was observed from a plot of numbers of fish versus length, i.e., 29 cm for black oreo, 36 cm for smooth oreo, and 35 cm for orange roughy. The length where 50% of the fish were to the left of the mode was calculated using a computer spreadsheet. Recruited lengths were 27 cm total length (TL) for black oreo, 34 cm TL for smooth oreo, and 33 cm standard length (SL) for orange roughy.

## Data recording and handling

All data were recorded by hand on to forms (station data on form 030, catch data on 040, length data on 080, and biological data on 090). Data were entered by hand into the main computer at Greta Point at the completion of the survey. The data were checked and edited (by Alan Hart) before being loaded on to the Empress research database.

## Catch sampling

All catches were sorted by species and all bycatch species were weighed and recorded.

Small catches totalling less than about 1000 kg were weighed on a Seaway weigher.

For catches over about 1000 kg the weight of the smooth oreo, black oreo, or orange roughy was back-calculated from the amount of fish processed in the factory. This required the following information: the conversion factor (from unprocessed to headed and gutted state) estimated for most of the large catches from about 200 kg of unprocessed fish (results of conversion factor tests are given in Appendix 2); the average frozen block (tray) weights, estimated from samples of blocks weighed at intervals during the survey (Appendix 2); and the number of frozen blocks of each species produced at each station (provided by the factory manager). The total catch weight for large catches was then calculated from the product of the number of frozen blocks, the conversion factor, and the average block weight. Small specimens of the three main species that could not be processed were sorted out of large catches, weighed, recorded, and discarded.

Rare or unusual fish, molluscs, and crustaceans were labelled with the station number and frozen for the Museum of New Zealand, Wellington.

## Biological sampling

A sample of up to about 200 individuals each of black oreo, smooth oreo, and orange roughy (other species were not sampled because catches were small) was taken at each station to determine the length frequency distribution in different areas and depths (length was measured to the nearest centimetre below). In addition, length (to the nearest millimetre), weight (nearest 10 g), sex, gonad stage, gonad weight (nearest 1 g), and otoliths were collected from up to 20 individual specimens of the three main species at each station for studies of size and age structure (not described in this report), length-weight relationship, and reproductive state of the populations. Reproductive state was assessed by macroscopic gonad staging using the definitions for black oreo, smooth oreo, and orange roughy, given in Appendix 3. About 1000 otolith pairs were sampled from smooth oreo and black oreo and 800 from orange roughy. The stomachs of smooth oreo sometimes contained a large amount of water, probably taken in during capture, and so the stomach was removed before weighing. Black oreo and orange roughy were weighed intact.

### Scaling length data

Length frequency data were scaled or adjusted to represent the population in the survey area using the MAF Fisheries Trawlsurvey Analysis Program. Options selected for running the program were: combined biomass and length frequency; scaled to percent sampled and distance towed; stations were selected from the required strata where gear performance was 1 or 2; length-weight parameters used were obtained from data collected during the 1990 survey (*see* Table 9). The calculations within the program were described by Vignaux (1994).

# Results

## Trawl stations

Of 207 stations completed, 189 were used for biomass calculations, including 136 phase 1 and 53 phase 2 stations. Phase 1 stations used for biomass calculations included 1–71 and 73–137. Phase 2 stations used for biomass included numbers 138–190.

Stations not used for biomass calculation were station 72, which was rejected because the net became fast, and stations 191–207 which were not strictly random within subarea 1 (*see* Methods, Survey area). A summary of the stations carried out in each stratum and subarea appears in Table 1 and station data are given in Appendix 4.

## Catch and catch rates

Total catch and catch of the 10 most abundant species from all stations are given in Table 2 and catches of the three main species at each station in Appendix 5. A list of all species caught is provided in Appendix 6.

Catch and catch rate of the three main species by subarea and stratum from the biomass stations only (i.e., 1–71, 73–190) are given in Table 3 and the catch rates at each station in Figures 2–4.

### Black oreo

Catch was spread across subareas 1–4: catches were negligible in subarea 5. Black oreo dominated catch from subareas 2 and 3. Subarea 3 produced the largest catch of this species followed by subarea 1. The largest catch (6355 kg) came from 900–1000 m in subarea 3 (stratum 13) with 800–900 m in subarea 1 (stratum 2) contributing a lesser amount. Catch of this species came mainly from shallow and intermediate depth strata (600–1100 m) and it was the dominant element of the catch at 600–1000 in subarea 1, 600–900 m in subarea 2, 600–1100 m in subarea 3, and 600–800 in subarea 4.

### Smooth oreo

Catch came mainly from subarea 4 with smaller amounts from subareas 1 and 5. Smooth oreo dominated the catch from subareas 1, 4, and 5. The catch was greatest from the 900–1000 m stratum in subarea 4: 1000–1100 m and 800–900 m also produced large catches

in this subarea. Smooth oreo dominated catch from the 1100–1200 m stratum in subarea 1, 900–1000 in subarea 2, 800–1200 m in subarea 4, and 800–1500 m in subarea 5.

### Orange roughy

The catch was almost exclusively from subareas 4 and 5. Catch was highest from 900 to 1000 m in subarea 5 and from 900 to 1000 m in subarea 4. Orange roughy was not the predominant catch in any stratum.

## Biomass estimates

Biomass estimates for all quota species and commercially important non-quota species are given in Table 4. The survey covered only a fraction of the depth range of species such as hoki, hake, ling, ribaldo, and pale ghost shark and was not designed to measure the biomass of these species.

The totals for all strata, individual stratum values, and separate values for recruited and fish of all lengths for the three main species are given in Table 5. Table 6 summarises the biomass distribution for fish of all lengths for the three main species by subarea and Table 7 summarises biomass distribution for fish of all lengths by depth.

### Black oreo

Most of the recruited biomass came from the 600–800 m stratum in subareas 1–4. This is a consequence of moderate to low catches being extrapolated over large strata. Fish from 600–800 m depths from strata 1, 6, and 11 were dominated by individuals just above the recruited length, i.e., fish of 28 or 29 cm TL modal size. Such fish are not sought by the commercial fleet. Depths of 900–1100 m in subarea 3 also contributed largely to the biomass from fish of modal size 32 and 34 cm TL (strata 13 and 14). Most of the all fish biomass was from subarea 3 and at depths of 600–800 m.

### Smooth oreo

Recruited biomass came mainly from 800–1100 m in subarea 4, 1000–1100 m in subarea 1, and 1200–1500 m in subarea 5. Most of the all fish smooth oreo biomass was from subarea 4 and was almost equally divided between 800–900, 900–1000, and 1000–1100 m.

### Orange roughy

Recruited biomass was spread thinly across depths of 800–1200 m in subarea 4 and 900–1000 m in subarea 5. Most of the all fish biomass was in subarea 4 and at depths of 900–1000 m; 1100–1200 and 1000–1100 m contributed lesser amounts.

## Biological data

The numbers of length and other biological samples taken during the survey are given in Table 8.

Scaled length distributions of fish sampled are given in Figure 5 and length-weight relationships for the fish sampled are shown in Table 9.

The results of macroscopic staging of gonads for fish sampled during the survey are summarised in Table 10. Spawning activity in females is shown by the presence of hyaline eggs and running ripe or spent fish (stages 4–6). In males, spawning activity is indicated by hydrated milt and spent fish (stages 4 and 5). Gonad stage results by depth and subarea are given in Tables 11 and 12, respectively.

### Black oreo

Black oreo females from stages 4 to 6 made up 19.8% of samples. Most fish sampled (75.1%) were either immature or resting (stages 1 and 2) and would be unlikely to spawn that year. Only 9.6% of males were at stages 4 and 5. Most (61.3%) were immature (stage 1). Females of stages 4–6 were found between 600 and 1000 m. Immature and resting fish were spread through the depth range 600–1100 m. Males of stages 4 and 5 were mostly at 800–1100 m with immature fish in a range of depths from 600 to 1100 m. Females of stages 4–6 were spread between subareas 1–4 indicating that spawning was not restricted to a particular part of the south Chatham Rise. Few fish were caught in subarea 5, although we know that the species is present on hills in the area. Hills were not sampled in subarea 5. Immature and resting females were widespread. Males of stages 4 and 5 were widespread like the females, and male stage 1 fish were widespread in subareas 1–4.

### Smooth oreo

Female smooth oreos showed less evidence of spawning: stages 4–6 made up only 11.2% of samples. Most (85.9%) were immature or resting. Many males (25.4%) had hydrated milt or were spent (stages 4 and 5). A large proportion of male fish (42.1%) were immature. Females of stages 4–6 were spread across depths of 800–1200 m, as were males of stages 4 and 5. Immature females and males were mostly at depths of 800–1100 m. Mature female fish (stages 4–6) were widespread. Immature and resting fish predominated in subarea 4. Males of stages 4 and 5 were widespread, but immature fish predominated in subareas 4 and 5, which may be a "nursery" area for this species.

### Orange roughy

Orange roughy showed no spawning activity though eight females and nine males were recorded as spent. Most fish were immature or resting (stages 1 and 2). Immature and resting fish of both sexes were spread between 800 and 1500 m. The species was almost entirely confined to subareas 4 and 5.

# Discussion

This discussion is limited to comparisons of the methods used in this and past surveys. Comparisons of the results of this with other surveys will not be made here.

### Trawl survey time series

The 1986, 1987, and 1990 trawl surveys were designed to develop a time series of relative biomass estimates that could be used as a fishery independent measure of the size of fish stocks on the south Chatham Rise. So far this aim has not been achieved because of the necessity to use different vessels for the three surveys. The effect of using different vessels on the biomass estimates is difficult to assess, but there is no doubt that it has compromised the comparability of the biomass results.

Other aims of the three surveys were achieved and comparisons of biological results, including relative species composition of catches, species depth and geographical distribution, species length distributions, and reproductive status can be made (but not in this report).

The principal difference between the three surveys (Table 13) is the increasing size and power of the vessels: it is likely that the ability of the vessels to catch fish increased from 1986 to 1990. Larger, more powerful, vessels probably fish better because the net is more stable, especially during rough weather.

The nets used were the same design, but differed slightly in size. There were also differences in the trawl door type and size and in the trawl warp diameter.

The timing of the three surveys was similar, although that in 1986 took longer because *Arrow* required a break in the survey to unload fish. The sequence of occupation of stations in the 1986 survey was different from the other two. This survey started in the middle of the Chatham Rise and moved west before the vessel went to port to unload. It resumed in the middle of the survey area and moved east to complete phase 1. Phase 2 was completed moving back to the west. The 1987 and 1990 surveys started at the western end of the survey area and worked towards the east on phase 1 and back to the west during phase 2. Consistent timing and order of occupation of stations may be important for these surveys because anecdotal evidence from fishers suggests that smooth oreo school more during October and become more available to fishing. Schooling persists through October, November, and December.

Strata 1–15 were the same in each of the three surveys. Subarea 4 was extended eastward by a small amount from 176° 20′ W to 176° W in 1987, and consequently strata 16–20 were slightly larger in 1987 and 1990. In 1990 an additional 1200–1500 m stratum (21) was added in subarea 4 and a new subarea (5) was developed with new strata (22–27).

Allocation of phase 1 stations between strata was similar in 1986 and 1987. In 1990, fewer stations were allocated in subareas 2 and 3 because of low catch rates there in the previous surveys, and also to enable stations to be carried out in the new subarea (5). Strata 10 and 15 were not sampled in 1990 because of previous low catch rates.

In summary, strata 1–20 are esssentially the same for all three surveys and we consider that they can be directly compared. Strata 21–27 were new in 1990.

### Biomass estimation

Is the stratified random trawl survey an appropriate method for estimating relative biomass for black oreo, smooth oreo, and orange roughy on the south Chatham Rise? The uneven topography of parts of the area and the strong schooling behaviour of the three species raises questions about whether the area is being surveyed in a representative way and whether all the fish are available to be sampled.

The terrain of the south Chatham Rise varies greatly. The western end has extremely uneven topography caused by volcanism and sliding (Herzer 1975). Most of the south Rise has flat or undulating topography with infrequent small hills and gulleys. At the eastern end, from about 177° W eastward, there are some more extensive areas of hills (unpublished MAF Fisheries data).

We know that the fishing industry takes a substantial proportion of the oreo catch on the edges of gulleys or troughs (termed "drop-offs" by the industry) and on hills. Analysis of catch statistics also suggests that substantial catches of oreos and orange roughy were made in the past in areas that were not very uneven. The concern with the trawl survey is that most of the trawl stations occur on relatively even topography in order to complete the standard 2 n. mile tow. There were some survey stations on drop-offs, but the 1990 survey had no stations on the hills. Hills are relatively small features within the survey area and so are unlikely to be included when station positions are randomly selected.

The reliability of the relative biomass estimates is probably different for each of the three main species and also appears to be different for different parts of the south Chatham Rise. The survey probably provides a good biomass estimate for smooth oreo because the species was caught in large quantities during the survey in subareas 1–4. Black oreo was also taken in quantity in subareas 1–3, but it appears to be much more patchy in distribution and seems to form small, localised aggregations in inaccessible areas. Black oreo biomass estimates from subareas 4 and 5 were low and suggest that the species was virtually absent from subarea 5, but we know from commercial fishing that the species is present on the hills in these areas. The survey clearly did not sample black oreo well in subareas 4 and 5. We are even more uncertain about the ability to estimate the biomass of orange roughy. Commercial catch and research information indicates that the species is now confined to eastern parts of the south Chatham Rise: substantial commercial catches are taken from the hills there. It would appear that this survey did not sample this species well in subareas 4 and 5 because hills were not sampled in any of the surveys to date.

The principal aim of this survey series, to estimate relative biomass of oreos and orange roughy, cannot be achieved if different vessels and gear are used. Success in achieving this aim can only be judged after at least three comparable surveys have been completed. The issue of comparability of surveys is therefore a vital one and it is important that future surveys use the same vessel and that the design of the survey remains largely the same. Ways to randomly sample hills to more adequately estimate the black oreo and orange roughy found on these features at the eastern end of the south Chatham Rise need to be developed.

## Acknowledgments

Thanks to officers and crew of *Cordella* for cooperation and help during the survey and to Bryan Skeggs, Pacifica Shipping, for land-based support. Thanks to Jack Fenaughty who was a shift leader and provided helpful advice on survey planning, gear, and personnel issues.

Thanks to the other scientific staff, Claire Gabriel, Karen Lesley, Michael Huaki, and Michael Garbett. Thanks to members of the Deepwater Group and to Chris Francis and Ian Doonan for advice with survey planning and design, to Marianne Vignaux for advice with the length data scaling, and to Maria Fraser for typing parts of the manuscript.

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**Table 1: Strata, subareas, and numbers of stations**

| Stratum | Depth (m) | Area ($km^2$) | No. of stations | | |
|---|---|---|---|---|---|
| | | | Phase 1 | Phase 2 | Total |
| Subarea 1 | | | | | |
| 1 | 600–800 | 3 630 | 3 | 0 | 3 |
| 2 | 800–900 | 1 732 | 8 | 0 | 8 |
| 3 | 900–1000 | 1 435 | 8 | 0 | 8 |
| 4 | 1000–1100 | 1 272 | 9 | 0 | 9 |
| 5 | 1100–1200 | 2 079 | 3 | 0 | 3 |
| | Subtotal | 10 148 | 31 | 0 | 31 |
| Subarea 2 | | | | | |
| 6 | 600–800 | 4 180 | 3 | 0 | 3 |
| 7 | 800–900 | 2 162 | 5 | 0 | 5 |
| 8 | 900–1000 | 1 086 | 3 | 0 | 3 |
| 9 | 1000–1100 | 1 789 | 3 | 0 | 3 |
| | Subtotal | 9 217 | 14 | 0 | 14 |
| Subarea 3 | | | | | |
| 11 | 600–800 | 3 781 | 3 | 0 | 3 |
| 12 | 800–900 | 1 571 | 5 | 0 | 5 |
| 13 | 900–1000 | 1 677 | 6 | 1 | 7 |
| 14 | 1000–1100 | 2 123 | 5 | 0 | 5 |
| | Subtotal | 9 152 | 19 | 1 | 20 |
| Subarea 4 | | | | | |
| 16 | 600–800 | 4 270 | 4 | 0 | 4 |
| 17 | 800–900 | 2 890 | 8 | 5 | 13 |
| 18 | 900–1000 | 2 364 | 8 | 27 | 35 |
| 19 | 1000–1100 | 2 454 | 8 | 13 | 21 |
| 20 | 1100–1200 | 2 275 | 5 | 5 | 10 |
| 21 | 1200–1500 | 8 864 | 5 | 0 | 5 |
| | Subtotal | 23 117 | 38 | 50 | 88 |
| Subarea 5 | | | | | |
| 22 | 600–800 | 1 329 | 3 | 0 | 3 |
| 23 | 800–900 | 465 | 8 | 0 | 8 |
| 24 | 900–1000 | 315 | 7 | 2 | 9 |
| 25 | 1000–1100 | 593 | 6 | 0 | 6 |
| 26 | 1100–1200 | 614 | 5 | 0 | 5 |
| 27 | 1200–1500 | 1 891 | 5 | 0 | 5 |
| | Subtotal | 5 207 | 34 | 2 | 36 |
| | Total | 56 841 | 136 | 53 | 189 |

Note: Strata 10 and 15, sampled during the 1986 and 1987 surveys, were not sampled on the 1990 survey and have been removed from this table. The numbering of the strata used in the previous surveys has been retained.

**Table 2: Total catch and percentage catch composition by weight of the 10 most abundant species and the number of stations at which each occurred**

| | Total catch (kg) | Percentage composition | No. of stations |
|---|---|---|---|
| Smooth oreo | 153 123 | 75.9 | 193 |
| Black oreo | 25 196 | 12.5 | 170 |
| Orange roughy | 5 101 | 2.5 | 114 |
| Shovelnosed dogfish | 3 530 | 1.7 | 91 |
| Baxter's lantern dogfish | 2 991 | 1.5 | 191 |
| Johnson's cod | 1 267 | 0.6 | 141 |
| Hoki | 1 249 | 0.6 | 97 |
| Bigscaled brown slickhead | 961 | 0.5 | 131 |
| Black javelinfish | 893 | 0.4 | 56 |
| Smallscaled brown slickhead | 868 | 0.4 | 193 |
| All other species | 6 586 | 3.3 | – |
| All species | 201 765 | | 207 |

**Table 3: Catch, percentage of total catch, and mean catch rates of black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) by stratum and subarea (stations 1–71, 72–190)**

| Stratum | Catch (kg) | | | | % of total catch | | | Mean catch rate (kg.km$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BOE | SSO | ORH | All species | BOE | SSO | ORH | BOE | SSO | ORH |
| Subarea 1 | | | | | | | | | | |
| 1 | 937 | 7 | 0 | 1 168 | 80.3 | 0.6 | 0.0 | 347 | 3 | 0 |
| 2 | 4 799 | 4 131 | 0 | 9 572 | 50.1 | 43.2 | 0.0 | 674 | 581 | 0 |
| 3 | 550 | 290 | 0 | 1 601 | 34.4 | 18.1 | 0.0 | 82 | 41 | 0 |
| 4 | 620 | 11 150 | 2 | 12 953 | 4.8 | 86.1 | 0.0 | 73 | 1 396 | < 0.5 |
| 5 | 1 | 65 | 0 | 183 | 0.3 | 35.5 | 0.0 | < 0.5 | 31 | 0 |
| Subtotal | 6 907 | 15 644 | 2 | 25 476 | 27.1 | 61.4 | 0.0 | | | |
| Subarea 2 | | | | | | | | | | |
| 6 | 1 008 | 7 | 0 | 1 067 | 94.4 | 0.7 | 0.0 | 524 | 4 | 0 |
| 7 | 2 315 | 52 | 2 | 2 680 | 86.4 | 1.9 | 0.0 | 511 | 14 | < 0.5 |
| 8 | 83 | 1 663 | 6 | 1 970 | 4.2 | 84.4 | 0.0 | 33 | 618 | 2 |
| 9 | 2 | 14 | 0 | 295 | 0.8 | 4.6 | 0.0 | 1 | 5 | 0 |
| Subtotal | 3 408 | 1 737 | 7 | 6 012 | 56.7 | 28.9 | 0.1 | | | |
| Subarea 3 | | | | | | | | | | |
| 11 | 1 352 | 16 | 0 | 1 642 | 82.3 | 1.0 | 0.0 | 502 | 6 | 0 |
| 12 | 1 259 | 550 | 2 | 2 180 | 57.8 | 25.2 | 0;0 | 284 | 124 | < 0.5 |
| 13 | 6 355 | 2 678 | 25 | 9 588 | 66.3 | 27.9 | 0.0 | 946 | 409 | 4 |
| 14 | 1 471 | 1 067 | 20 | 2 881 | 51.1 | 37.0 | 0.1 | 669 | 477 | 7 |
| Subtotal | 10 437 | 4 312 | 48 | 16 291 | 64.1 | 26.5 | 0.3 | | | |
| Subarea 4 | | | | | | | | | | |
| 16 | 522 | 7 | 0 | 872 | 59.8 | 0.7 | 0.0 | 147 | 2 | 0 |
| 17 | 1 061 | 18 412 | 162 | 20 231 | 5.2 | 91.0 | 0.8 | 93 | 1 707 | 19 |
| 18 | 1 579 | 62 181 | 989 | 68 226 | 2.3 | 91.1 | 1.4 | 58 | 2 235 | 32 |
| 19 | 248 | 34 051 | 398 | 35 939 | 0.7 | 94.7 | 1.1 | 14 | 1 892 | 21 |
| 20 | 2 | 2 692 | 361 | 3 772 | 0.0 | 71.4 | 9.6 | < 0.5 | 299 | 42 |
| 21 | 3 | 5 | 1 | 348 | 0.8 | 1.5 | 0.3 | 1 | 1 | < 0.5 |
| Subtotal | 3 414 | 117 348 | 1 910 | 129 388 | 2.6 | 90.7 | 1.5 | | | |
| Subarea 5 | | | | | | | | | | |
| 22 | 1 | 7 | 0 | 548 | 0.1 | 1.3 | 0.1 | < 0.5 | 3 | < 0.5 |
| 23 | 2 | 1 000 | 46 | 2 332 | 0.1 | 42.9 | 2.0 | < 0.5 | 138 | 6 |
| 24 | 95 | 3 866 | 2 694 | 8 288 | 1.1 | 46.6 | 32.5 | 13 | 539 | 378 |
| 25 | 13 | 285 | 168 | 1 427 | 0.9 | 20.0 | 11.7 | 2 | 54 | 39 |
| 26 | 9 | 4 874 | 131 | 5 663 | 0.2 | 86.1 | 2.3 | 2 | 1 325 | 32 |
| 27 | 1 | 2 929 | 94 | 3 550 | 0.0 | 82.5 | 2.6 | < 0.5 | 594 | 20 |
| Subtotal | 119 | 12 961 | 3 133 | 21 807 | 0.5 | 59.4 | 14.4 | | | |
| Total | 24 284 | 152 000 | 5 100 | 198 973 | 12.2 | 76.4 | 2.6 | | | |

**Table 4: Biomass estimates (for fish of all lengths) for all quota species and commercially important non–quota species***

| | Biomass (t) | *c.v.* (%) |
|---|---|---|
| Smooth oreo | 199 345 | 27.2 |
| Black oreo | 105 994 | 18.9 |
| Hoki | 4 580 | 23.3 |
| Orange roughy | 4 331 | 26.6 |
| Shovelnosed dogfish | 4 164 | 12.4 |
| Pale ghost shark | 1 983 | 18.8 |
| Ling | 963 | 26.8 |
| Ribaldo | 141 | 37.8 |
| Hake | 136 | 37.9 |
| Total | 351 213 | 17.3 |

* The total biomass was calculated using the "Biopc" program held on the main computer at Greta Point. The vulnerability value used in the calculation was restricted to two decimal points, i.e., 0.24 was used rather than the 0.239 which was used for the rest of the biomass calculations.

**Table 5: Biomass estimates (t) for fish of all lengths (all fish) and for recruited fish for black oreo, smooth oreo, and orange roughy***

| Stratum | Area ($km^2$) | No. of stations | Black oreo | | | | Smooth oreo | | | | Orange roughy | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | All fish | *c.v.* (%) | Recruited | *c.v.* (%) | All fish | *c.v.* (%) | Recruited | *c.v.* (%) | All fish | *c.v.* (%) | Recruited | *c.v.* (%) |
| Subarea 1 | | | | | | | | | | | | | | |
| 1 | 3 630 | 3 | 10 774 | 35 | 9 373 | 34 | 82 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 732 | 8 | 9 975 | 41 | 8 867 | 43 | 8 608 | 70 | 2 535 | 64 | 0 | 0 | 0 | 0 |
| 3 | 1 435 | 8 | 1 002 | 38 | 910 | 40 | 504 | 61 | 419 | 65 | 0 | 0 | 0 | 0 |
| 4 | 1 272 | 9 | 791 | 86 | 781 | 87 | 15 172 | 100 | 14 392 | 100 | 2 | 100 | 0 | 0 |
| 5 | 2 079 | 3 | 4 | 100 | 0 | 0 | 547 | 90 | 443 | 100 | 0 | 0 | 0 | 0 |
| Subarea 2 | | | | | | | | | | | | | | |
| 6 | 4 180 | 3 | 18 715 | 36 | 13 795 | 35 | 131 | 86 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 2 162 | 5 | 9 442 | 78 | 8 398 | 86 | 262 | 68 | 31 | 100 | 6 | 100 | 0 | 0 |
| 8 | 1 086 | 3 | 307 | 40 | 222 | 46 | 5 736 | 97 | 3 661 | 97 | 21 | 63 | 0 | 0 |
| 9 | 1 789 | 3 | 14 | 100 | 0 | 0 | 79 | 25 | 47 | 100 | 0 | 0 | 0 | 0 |
| Subarea 3 | | | | | | | | | | | | | | |
| 11 | 3 781 | 3 | 16 223 | 18 | 15 259 | 20 | 192 | 87 | 50 | 100 | 0 | 0 | 0 | 0 |
| 12 | 1 571 | 5 | 3 819 | 60 | 3 666 | 61 | 1 667 | 77 | 324 | 78 | 7 | 74 | 0 | 0 |
| 13 | 1 677 | 7 | 13 559 | 74 | 13 496 | 74 | 5 866 | 49 | 4 999 | 50 | 58 | 79 | 0 | 0 |
| 14 | 2 123 | 5 | 12 131 | 99 | 12 060 | 100 | 8 655 | 97 | 7 886 | 98 | 121 | 42 | 0 | 0 |
| Subarea 4 | | | | | | | | | | | | | | |
| 16 | 4 270 | 4 | 5 374 | 63 | 4 958 | 71 | 67 | 94 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 2 890 | 13 | 2 289 | 30 | 2 129 | 34 | 42 153 | 74 | 16 871 | 76 | 473 | 82 | 92 | 73 |
| 18 | 2 364 | 35 | 1 171 | 43 | 1 118 | 45 | 45 166 | 56 | 27 578 | 62 | 638 | 32 | 320 | 49 |
| 19 | 2 454 | 21 | 288 | 52 | 272 | 60 | 39 691 | 74 | 34 255 | 78 | 434 | 36 | 199 | 58 |
| 20 | 2 275 | 10 | 5 | 54 | 0 | 0 | 5 823 | 72 | 4 379 | 93 | 829 | 53 | 607 | 69 |
| 21 | 8 864 | 5 | 48 | 100 | 0 | 0 | 91 | 72 | 0 | 0 | 15 | 100 | 0 | 0 |
| Subarea 5 | | | | | | | | | | | | | | |
| 22 | 1 329 | 3 | 3 | 100 | 0 | 0 | 32 | 26 | 0 | 0 | 1 | 100 | 0 | 0 |
| 23 | 465 | 8 | 1 | 49 | 0 | 0 | 549 | 71 | 192 | 70 | 26 | 29 | 0 | 0 |
| 24 | 315 | 9 | 34 | 44 | 24 | 63 | 1 452 | 73 | 832 | 69 | 1 018 | 92 | 715 | 96 |
| 25 | 593 | 6 | 12 | 37 | 0 | 0 | 273 | 48 | 120 | 43 | 196 | 52 | 48 | 51 |
| 26 | 614 | 5 | 11 | 54 | 0 | 0 | 6 952 | 60 | 5 181 | 58 | 166 | 35 | 64 | 58 |
| 27 | 1 891 | 5 | 1 | 100 | 0 | 0 | 9 597 | 63 | 8 904 | 63 | 320 | 40 | 146 | 47 |
| Total | 56 841 | 189 | 105 994 | | 95 328 | | 199 345 | | 133 101 | | 4 331 | | 2 191 | |
| Lower bound † | | | 65 862 | | 56 680 | | 91 036 | | 55 002 | | 2 025 | | 516 | |
| Upper bound † | | | 146 127 | | 133 975 | | 307 655 | | 211 200 | | 6 636 | | 3 867 | |
| *c.v.*(%) | | | 18.9 | | 20.3 | | 27.2 | | 29.3 | | 26.6 | | 38.2 | |

* Recruited size for black oreo is ≥ 27 cm TL, for smooth oreo ≥ 34 cm TL, and for orange roughy ≥ 33 cm SL.
† ± 2 standard deviation.

**Table 6: Biomass estimates for black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) of all lengths by subarea**

| Subarea | Area ($km^2$) | % of area | Biomass (t) | | | % of biomass | | |
|---|---|---|---|---|---|---|---|---|
| | | | BOE | SSO | ORH | BOE | SSO | ORH |
| 1 | 10 148 | 17.9 | 22 546 | 24 914 | 2 | 21.3 | 12.5 | 0 |
| 2 | 9 217 | 16.2 | 28 478 | 6 208 | 27 | 26.9 | 3.1 | 0.6 |
| 3 | 9 152 | 16.1 | 45 732 | 16 379 | 186 | 43.1 | 8.2 | 4.3 |
| 4 | 23 117 | 40.7 | 9 175 | 132 990 | 2 389 | 8.7 | 66.7 | 55.2 |
| 5 | 5 207 | 9.2 | 62 | 18 855 | 1 726 | 0 | 9.5 | 39.9 |
| Total | 56 841 | | 105 994 | 199 345 | 4 331 | | | |

**Table 7: Biomass estimates for black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) of all lengths by depth**

| Depth interval | Area ($km^2$) | Biomass (t) | | | % of biomass | | |
|---|---|---|---|---|---|---|---|
| | | BOE | SSO | ORH | BOE | SSO | ORH |
| 600–800 | 17 190 | 51 089 | 504 | 1 | 48.2 | 0.3 | 0 |
| 800–900 | 8 820 | 25 526 | 53 239 | 512 | 24.1 | 26.7 | 11.8 |
| 900–1000 | 6 877 | 16 073 | 58 725 | 1 735 | 15.2 | 29.5 | 40.1 |
| 1000–1100 | 8 231 | 13 236 | 63 868 | 753 | 12.5 | 32.0 | 17.4 |
| 1100–1200 | 4 968 | 21 | 13 322 | 995 | 0 | 6.7 | 23.0 |
| 1200–1500 | 10 755 | 49 | 9 688 | 335 | 0 | 4.9 | 7.7 |
| All depths | 56 841 | 105 994 | 199 345 | 4 331 | | | |

**Table 8: Numbers of length and sex and "biological" (i.e., up to 20 fish per station) samples taken during the survey**

| | Length & sex | Biological | Otoliths |
|---|---|---|---|
| Black oreo | 11 620 | 2 225 | yes |
| Smooth oreo | 13 997 | 2 409 | yes |
| Orange roughy | 2 869 | 1 179 | yes |

**Table 9: Length-weight relationships for oreos and orange roughy***

| | Weight range (g) | Length range (cm) | $a$ | $b$ | $r^2$ | $n$ |
|---|---|---|---|---|---|---|
| Black oreo | 117–1 570 | 11.5–40.1 | 0.015 | 3.09 | 92.0 | 2 225 |
| Smooth oreo | 81.0–2 650 | 15.3–49.5 | 0.029 | 2.91 | 98.8 | 2 409 |
| Orange roughy | 24.0–2 850 | 8.6–44.3 | 0.065 | 2.81 | 99.2 | 1 179 |

*$W = a.L^b$. Lengths are total length for oreos and standard length for orange roughy

**Table 10: Relative proportions of gonad stages of the three main species**

| Gonad stage | Black oreo | | | | Smooth oreo | | | | Orange roughy | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | % | Female | % | Male | % | Female | % | Male | % | Female | % |
| 1 | 683 | 61.3 | 488 | 44.0 | 531 | 42.1 | 661 | 60.6 | 310 | 58.9 | 276 | 41.6 |
| 2 | 197 | 17.7 | 345 | 31.1 | 136 | 10.8 | 276 | 25.3 | 207 | 39.4 | 376 | 56.7 |
| 3 | 128 | 11.5 | 58 | 5.2 | 274 | 21.7 | 31 | 2.8 | | | 3 | 0.5 |
| 4 | 43 | 3.9 | 113 | 10.2 | 298 | 23.7 | 38 | 3.5 | | | | |
| 5 | 63 | 5.7 | 34 | 3.1 | 21 | 1.7 | 35 | 3.2 | 9 | 1.7 | | |
| 6 | | | 72 | 6.5 | | | 49 | 4.5 | | | 8 | 1.2 |
| All | 1 114 | 100.0 | 1 110 | 100.0 | 1 260 | 100.0 | 1 090 | 100.0 | 526 | 100.0 | 663 | 100.0 |

**Table 11: Percentage gonad stage by species by depth range from the total survey area**

**Black oreo**

| Depth range (m) | Males | | | | | | Females | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | *n* | 1 | 2 | 3 | 4 | 5 | 6 | *n* |
| 600– 800 | 66.7 | 15.8 | 17.5 | | | 121 | 39.3 | 42.1 | 1.4 | 5.0 | 2.9 | 9.3 | 144 |
| 800– 900 | 64.4 | 17.4 | 12.9 | 4.1 | 1.3 | 317 | 44.8 | 34.3 | 1.5 | 10.1 | 4.2 | 5.1 | 335 |
| 900–1000 | 64.1 | 15.8 | 9.5 | 3.2 | 7.4 | 462 | 44.1 | 26.0 | 4.8 | 12.4 | 3.4 | 9.3 | 442 |
| 1000–1100 | 41.0 | 27.7 | 13.3 | 7.2 | 10.8 | 166 | 42.5 | 30.4 | 16.6 | 9.4 | 0.6 | 0.6 | 181 |
| 1100–1200 | 70.8 | 8.3 | | 6.3 | 14.6 | 48 | 87.5 | 12.5 | | | | | 8 |
| 1200–1500 | | | | | | 0 | | | | | | | 0 |
| Total *n* | 683 | 197 | 128 | 43 | 63 | 1 114 | 488 | 345 | 58 | 113 | 34 | 72 | 1 110 |

**Smooth oreo**

| Depth range (m) | Males | | | | | | Females | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | *n* | 1 | 2 | 3 | 4 | 5 | 6 | *n* |
| 600– 800 | 64.0 | 24.0 | 4.0 | 8.0 | | 25 | 88.0 | 4.0 | | | 4.0 | 4.0 | 35 |
| 800– 900 | 62.1 | 9.6 | 16.1 | 11.3 | 1.0 | 311 | 71.0 | 17.2 | 1.3 | 2.3 | 2.3 | 5.9 | 155 |
| 900–1000 | 40.1 | 8.4 | 20.1 | 29.2 | 2.2 | 538 | 63.1 | 21.9 | 3.4 | 4.4 | 3.4 | 3.9 | 182 |
| 1000–1100 | 27.2 | 10.0 | 28.0 | 33.2 | 1.6 | 250 | 50.0 | 34.1 | 4.8 | 3.8 | 3.4 | 3.8 | 128 |
| 1100–1200 | 31.3 | 22.3 | 28.6 | 16.1 | 1.8 | 112 | 52.2 | 34.8 | 2.9 | 2.2 | 2.9 | 5.1 | 210 |
| 1200–1500 | 12.5 | 20.8 | 54.2 | 12.5 | | 24 | 10.7 | 67.9 | | 10.7 | 10.7 | | 12 |
| Total *n* | 531 | 136 | 274 | 298 | 21 | 1 260 | 661 | 276 | 31 | 38 | 35 | 49 | 1 090 |

**Orange roughy**

| Depth range (m) | Males | | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | *n* | 1 | 2 | 3 | 6 | *n* |
| 600– 800 | | | | 0 | | | | | 0 |
| 800– 900 | 69.2 | 30.8 | 0.0 | 78 | 78.8 | 21.3 | 0.0 | 0.0 | 80 |
| 900–1000 | 58.8 | 40.8 | 0.4 | 240 | 44.0 | 54.9 | 0.7 | 0.3 | 293 |
| 1000–1100 | 58.2 | 39.1 | 2.7 | 110 | 35.0 | 62.5 | 0.0 | 2.5 | 160 |
| 1100–1200 | 52.4 | 42.9 | 4.8 | 63 | 18.8 | 77.2 | 1.0 | 3.0 | 101 |
| 1200–1500 | 51.4 | 42.9 | 5.7 | 35 | 31.0 | 69.0 | 0.0 | 0.0 | 29 |
| Total *n* | 310 | 207 | 9 | 526 | 276 | 376 | 3 | 8 | 663 |

**Table 12: Percentage of gonads at each stage by species by subarea**

**Black oreo**

| | Males | | | | | | Females | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | 1 | 2 | 3 | 4 | 5 | *n* | 1 | 2 | 3 | 4 | 5 | 6 | *n* |
| 1 | 59.0 | 21.3 | 3.9 | 7.2 | 8.6 | 361 | 43.2 | 39.0 | 8.4 | 6.1 | 2.2 | 1.1 | 359 |
| 2 | 71.2 | 15.4 | 8.7 | 2.9 | 1.9 | 104 | 50.0 | 25.9 | 6.0 | 9.5 | 3.4 | 5.2 | 116 |
| 3 | 47.4 | 25.6 | 25.6 | 1.3 | | 156 | 33.7 | 37.0 | 4.9 | 13.0 | 4.3 | 7.1 | 184 |
| 4 | 60.0 | 15.2 | 14.9 | 2.7 | 7.2 | 415 | 38.9 | 27.1 | 3.2 | 14.2 | 3.5 | 13.1 | 373 |
| 5 | 93.6 | 1.3 | 3.8 | 1.3 | | 78 | 87.2 | 7.7 | | 3.8 | 1.3 | | 78 |
| Total *n* | 683 | 197 | 128 | 43 | 63 | 1 114 | 488 | 345 | 58 | 113 | 34 | 72 | 1 110 |

**Smooth oreo**

| | Males | | | | | | Females | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | 1 | 2 | 3 | 4 | 5 | *n* | 1 | 2 | 3 | 4 | 5 | 6 | *n* |
| 1 | 20.4 | 12.3 | 30.0 | 36.2 | 1.2 | 260 | 46.1 | 31.6 | 5.8 | 4.4 | 3.4 | 8.7 | 206 |
| 2 | 34.8 | 6.1 | 15.2 | 43.9 | | 66 | 57.1 | 26.2 | 4.8 | 9.5 | 2.4 | | 42 |
| 3 | 26.6 | 7.3 | 30.6 | 35.5 | | 124 | 54.5 | 27.6 | 5.7 | 5.7 | 3.3 | 3.3 | 123 |
| 4 | 42.6 | 14.4 | 21.6 | 18.9 | 2.5 | 514 | 68.2 | 23.1 | 2.6 | 2.6 | 2.1 | 2.4 | 425 |
| 5 | 68.6 | 5.7 | 12.5 | 11.5 | 1.7 | 296 | 62.9 | 23.1 | 2.4 | 2.4 | 4.8 | 5.8 | 294 |
| Total *n* | 531 | 136 | 274 | 298 | 21 | 1 260 | 661 | 276 | 31 | 38 | 35 | 49 | 1 090 |

**Orange roughy**

| | Males | | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | 1 | 2 | 5 | *n* | 1 | 2 | 3 | 6 | *n* |
| 1 | | | | | 0 | | | | 0 |
| 2 | 0.0 | 100.0 | 0.0 | 4 | 94.4 | 5.6 | 0.0 | 18 | |
| 3 | 12.5 | 87.5 | 0.0 | 8 | 0.0 | 94.1 | 0.0 | 17 | |
| 4 | 51.3 | 46.1 | 2.6 | 269 | 34.7 | 62.7 | 0.8 | 389 | |
| 5 | 69.8 | 29.4 | 0.8 | 245 | 51.9 | 48.1 | 0.0 | 239 | |
| Total *n* | 310 | 207 | 9 | 526 | 276 | 376 | 3 | 8 | 663 |

**Table 13: Summary of the similarities and differences between the three south Chatham Rise stratified random trawl surveys***

| | *Arrow* (1986) | *Amaltal Explorer* (1987) | *Cordella* (1990) |
|---|---|---|---|
| Length (m) | 57 | 65 | 76 |
| Tonnage (t) | 549 | 1000 | 1238 |
| Power (kW) | 1342 | 2013 | 2610 |
| Navigation | Sat. nav. | GPS(18 h/day) | GPS(23 h/day) |
| Net type | 6 panel wingless | 6 panel wingless | 6 panel wingless |
| Groundrope (m) | 18.7 | 22.4 | 20.8 |
| Doorspread (m) | Unknown, 86.7 † | Unknown, 87 † | Unknown, 117 ‡ |
| Wingspread (m) | Unknown, 19.8 † | Unknown, 19.7 † | Unknown, 28 ‡ |
| Headline hgt (m) | 7.0 | 7.0 | 8.9 |
| Codend mesh (mm) | 100 | 100 | 100 |
| Dates | 31 Oct.-7 Dec. | 3–30 Nov. | 30 Oct.-30 Nov. |
| Survey area ($km^2$) | 47 137 | 47 496 | 61 567 |
| Subareas | 1–4 | 1–4 | 1–5 |
| Depths (m) | 600–1200 | 600–1200 | 600–1500 |
| Strata | 1–20 | 1–20 | 1–9, 11–14, 16–27 |
| No. of stations | 187 | 192 | 189 |

* GPS, Global Positioning System; hgt, height; sat. nav., satellite navigation system.

† distances are assumed from tests of a model trawl in a flume tank.
‡ mean of the value measured during trawl survey TAN9104.

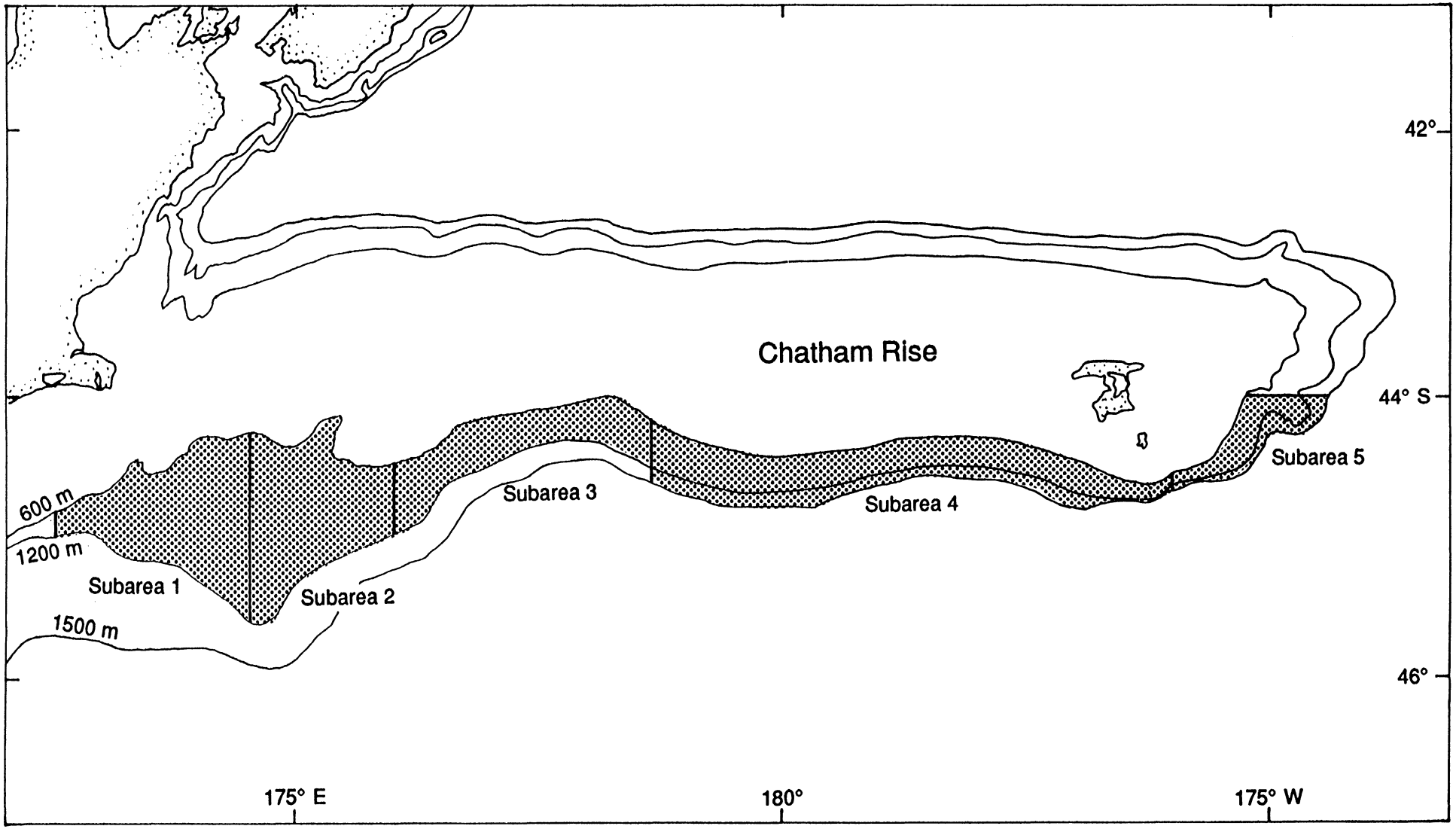



Figure 1: Survey area showing subareas.

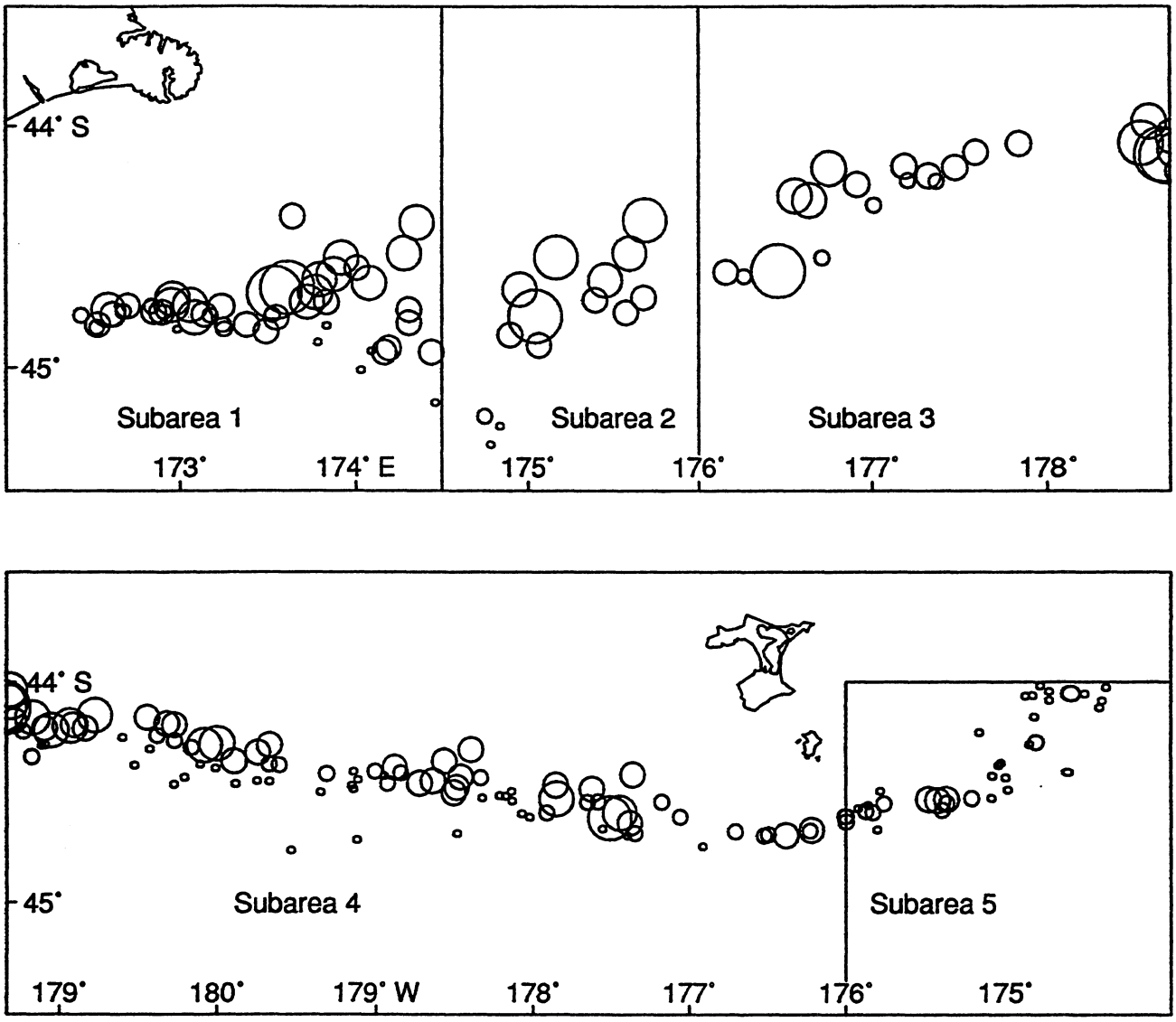



Figure 2: Catch rates ($kg.km^{-1}$) of black oreo.

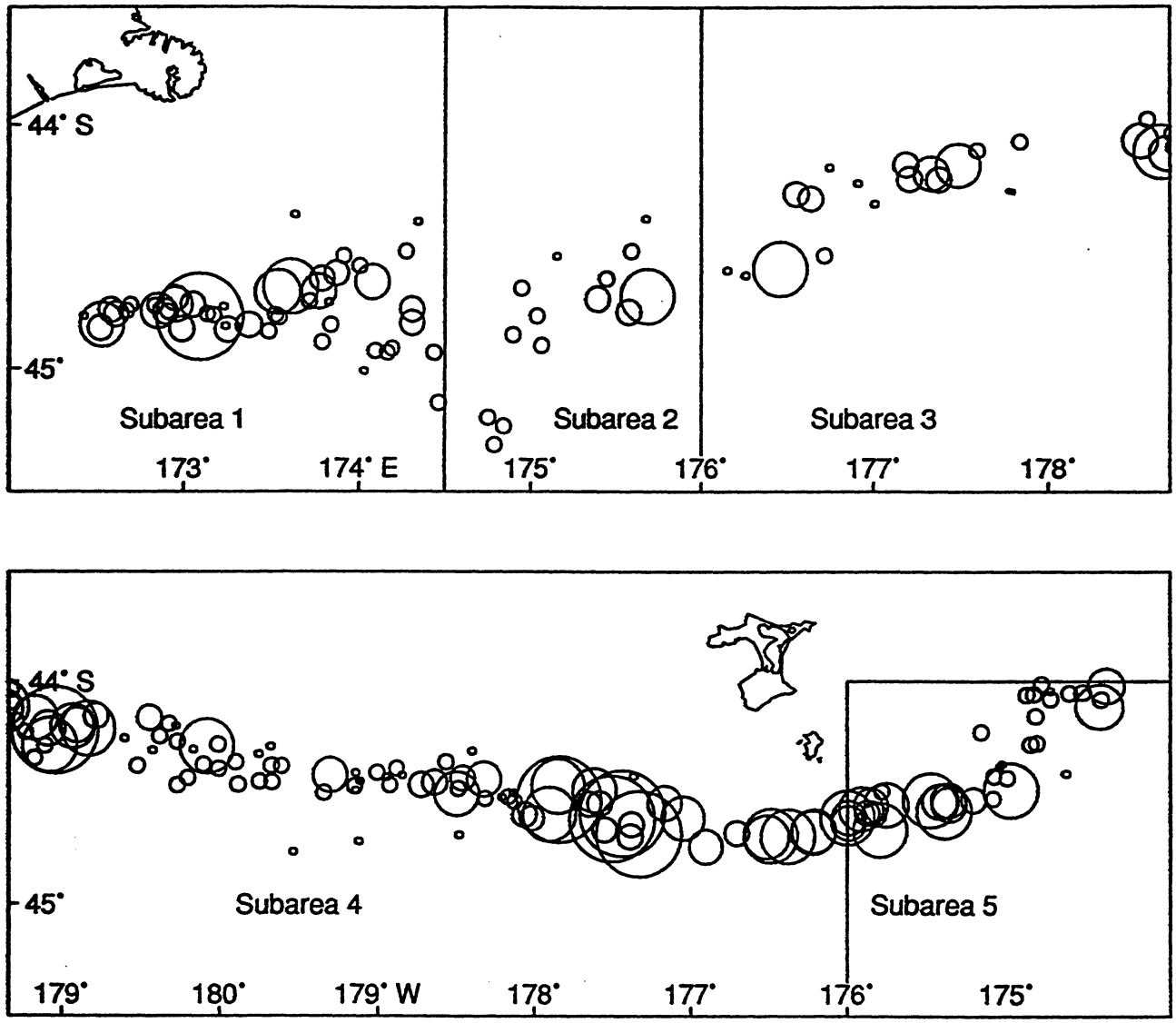



Figure 3: Catch rates (kg.km$^{-1}$) of smooth oreo.

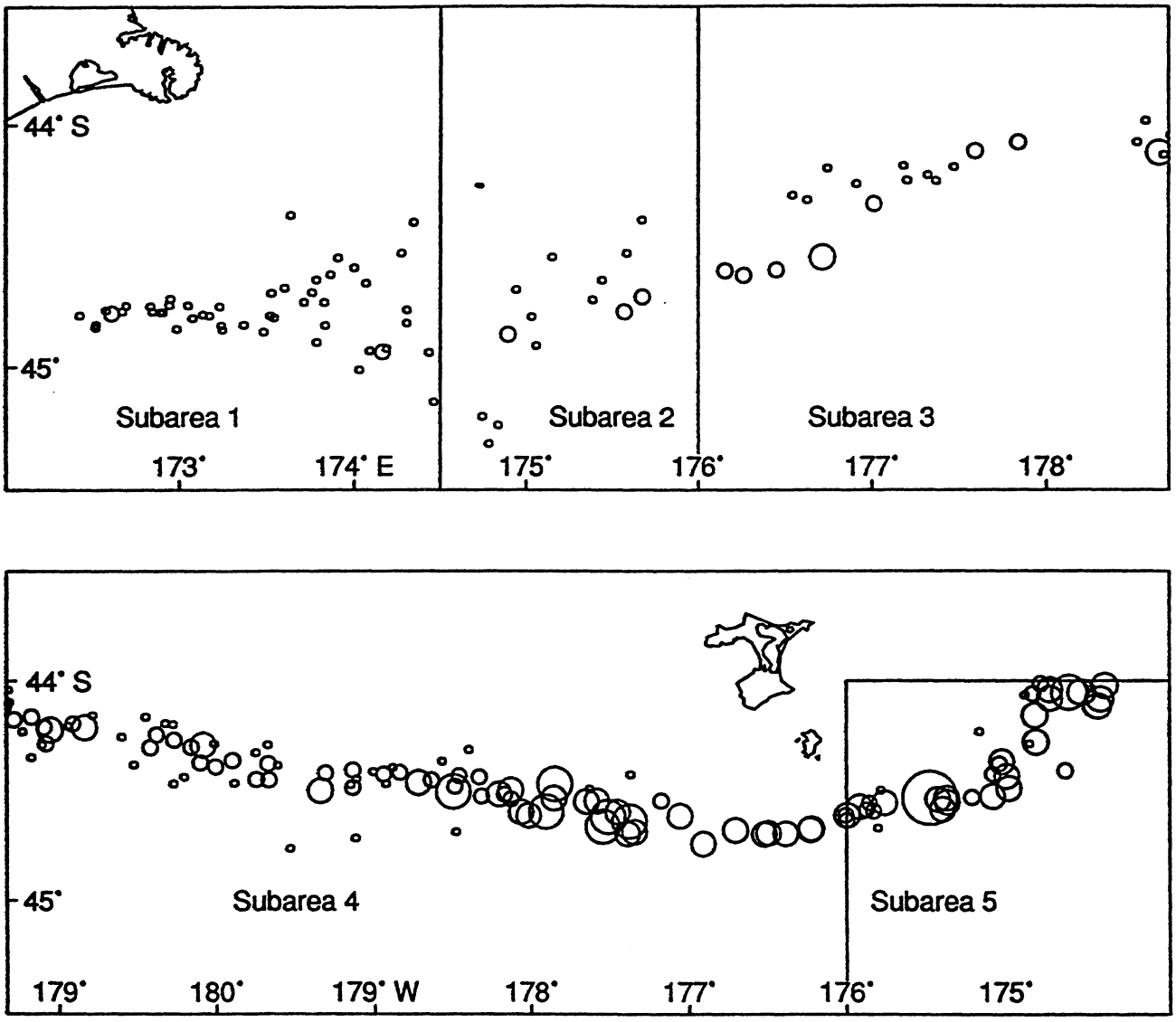



Figure 4: Catch rates (kg.km$^{-1}$) of orange roughy.

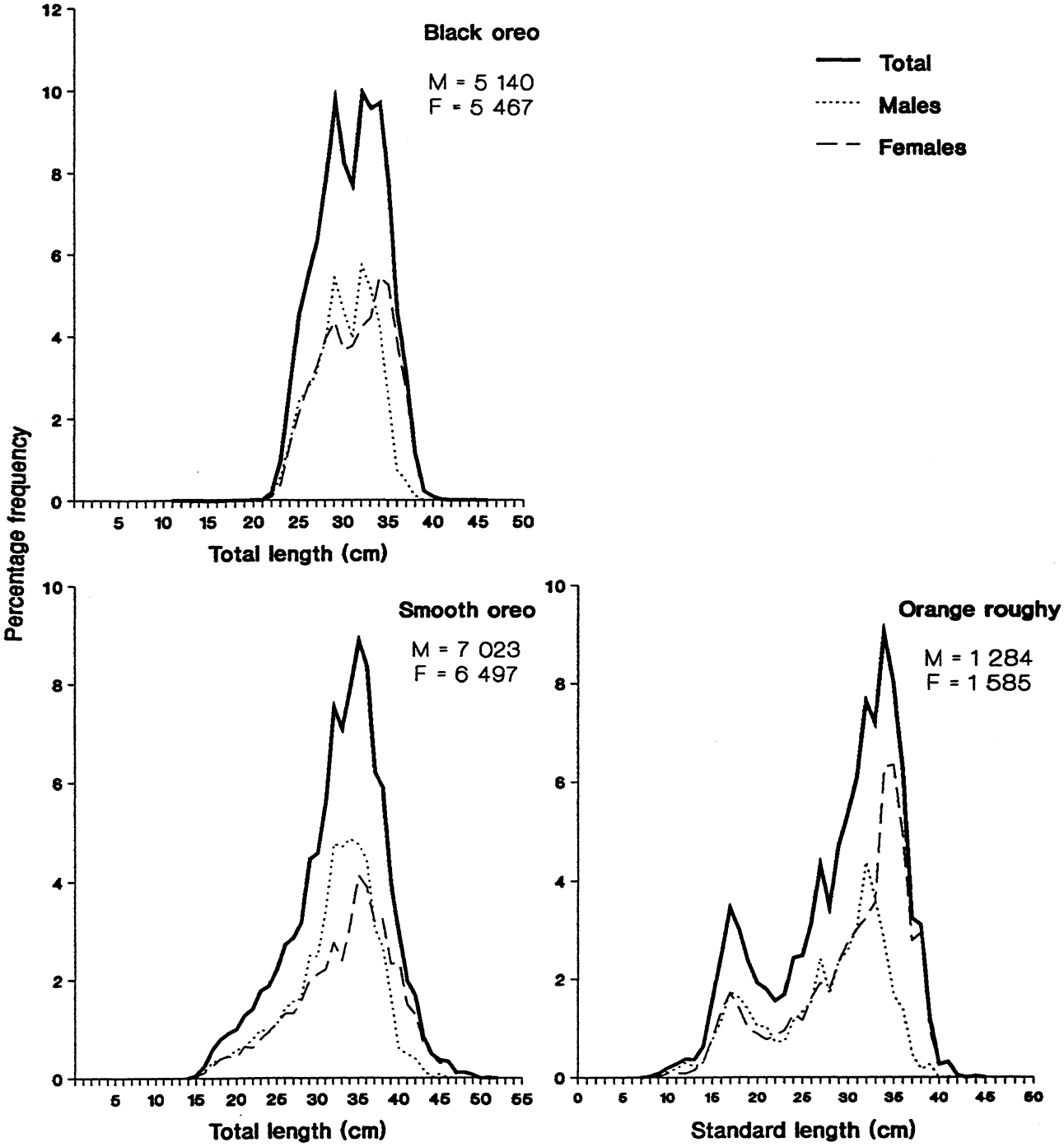
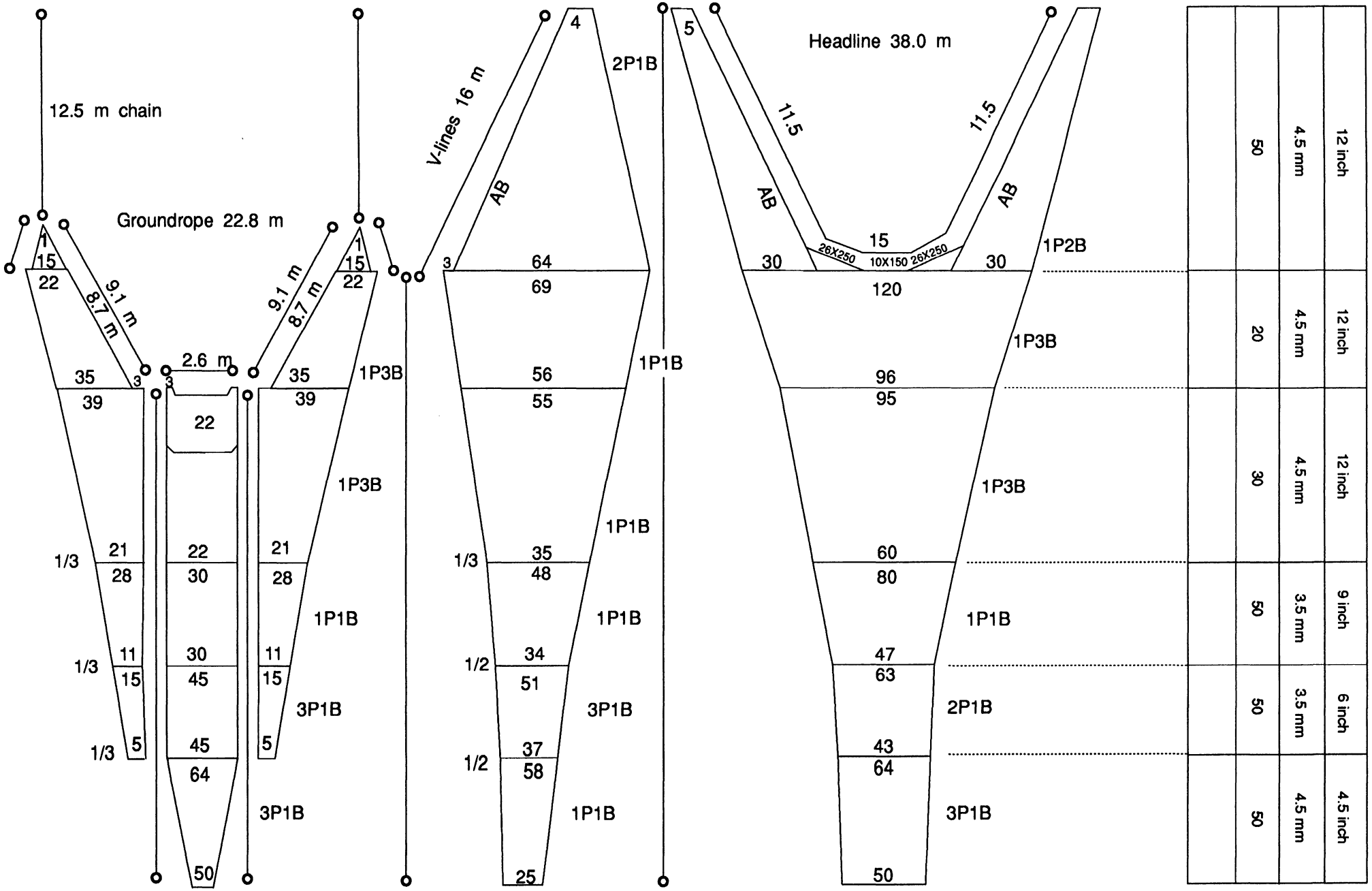



Figure 5: Distribution of scaled black oreo, smooth oreo, and orange roughy length samples for the entire survey area.

**Appendix 1: Gear specifications and net plan for survey COR9004.**

Trawl doors: type WV-doors, 7 $m^2$
Trawl warp diameter: 24 mm
Net type: 6 panel wingless trawl. Codend mesh 100 mm. *See* plan
Ground rope length: 20.8 m
Ground rope construction: 19 steel bobbins
Bridle length: 46 m
Sweep length: 92 m (stations 1–105); 46 m (stations 106–206)
Backstrop length: 15 m
Chain extension length: 2 m
Total length from lower wing end to door: approximately 152 m (stations 1–105) and 106 m (stations 106–206), includes sweep, bridles, plus chain and backstrop
Headline length: 38 m
Headline height: 6–11 m, mean = 8.9 m, $n$ = 189
Distance between the wings of the net: unknown, assumed to be 28 m (from *Tangaroa* gear trial results)
Distance between the doors: unknown, assumed to be 117 m (from *Tangaroa* survey TAN9101 results)
Flotation: 26 × 1500 m floats




| Mesh size | Twine size | No. of meshes | Double twine |
|---|---|---|---|
| 12 inch | 4.5 mm | 50 | |
| 12 inch | 4.5 mm | 20 | |
| 12 inch | 4.5 mm | 30 | |
| 9 inch | 3.5 mm | 50 | |
| 6 inch | 3.5 mm | 50 | |
| 4.5 inch | 4.5 mm | 50 | |

**Appendix 2: Conversion factor (C.F.) and block weight measurements (kg) used to back-calculate large catches*.**

**Conversion factor**

| Station | Green weight | Headed and gutted | C.F. |
|---|---|---|---|
| Smooth oreo | | | |
| 4 | 224.0 | 88.4 | 2.53 |
| 43 | 197.5 | 77.1 | 2.56 |
| 65 | 213.8 | 89.9 | 2.38 |
| 97 | 185.9 | 73.2 | 2.54 |
| 111 | 208.3 | 91.6 | 2.27 |
| 143 | 113.8 | 46.2 | 2.46 |
| 154 | 213.0 | 87.6 | 2.43 |
| 189 | 214.9 | 101.3 | 2.12 |
| **Black oreo** | | | |
| 10 | 159.3 | 59.0 | 2.70 |
| 37 | 183.2 | 63.4 | 2.89 |
| 65 | 169.2 | 58.3 | 2.90 |
| **Orange roughy** | | | |
| 112 | 246.3 | 124.0 | 1.99 |

**Frozen block weights**

| Station | No. of blocks | Total weight | Mean block weight |
|---|---|---|---|
| Smooth oreo | | | |
| 11 | 10 | 227.4 | 22.7 |
| 48 | 10 | 221.0 | 22.1 |
| Black oreo | | | |
| 11 | 10 | 166.4 | 16.6 |
| 48 | 10 | 209.1 | 20.9 |

* All weights were measured on a "Seaway" weigher. Green weight is the weight before processing; headed and gutted is the weight after processing; C.F. is calculated by dividing the green weight by the headed and gutted weight.

**Appendix 3: Black oreo, smooth oreo, and orange roughy gonad stages used during the survey (*from* Pankhurst *et al.* 1987).**

| Stage | Macroscopic condition | Histological condition |
|---|---|---|
| **Females** | | |
| 1 | Immature or regressed; ovary clear. | Previtellogenic oocytes only. |
| 2 | Ovary pink or clear; small clear oocytes visible against the light. | Endogenous vitellogenesis (yolk globule accumulation). |
| 3 | Opaque white (oreos) or orange (orange roughy) oocytes present. | Exogenous vitellogenesis (yolk granule accumulation). |
| 4 | Mature ovary; hyaline oocytes present. | Final oocyte maturation; nuclear migration and breakdown; coalescence of yolk material and oil droplet formation. |
| 5 | Ovulated; eggs flow freely when light pressure applied to abdomen. | Follicular separation and rupture. |
| 6 | Spent; ovary flaccid and "bloody"; residual eggs sometimes present in oviduct. | Post-ovulatory follicles, increased vascularization, follicular atresia. |
| **Males** | | |
| 1 | Immature or regressed; testis threadlike. | Spermatogonia and primary spermatocytes predominate. |
| 2 | Testis increased in size but no milt expressible | Secondary spermatocytes and spermatids present, spermatozoa in larger gonads. |
| 3 | Partially spermiated; viscous milt expressible. | Spermatozoa predominate. |
| 4 | Fully spermiated; hydrated, freely flowing milt. | Spermatozoa predominate. |
| 5 | Spent; testis "bloody" or grey; no milt expressible. | Residual spermatozoa, spermatogonia present towards testis margin. |

**Appendix 4: Summary of station data.**

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 30 Oct | 44 22.31 | 173 37.70 E | 44 23.37 | 173 35.65 E | 656 | 659 | 2.00 | 1 100 |
| 2 | 3 | 31 Oct | 44 44.49 | 172 56.41 E | 44 45.58 | 172 54.09 E | 935 | 967 | 2.00 | 1 500 |
| 3 | 5 | 31 Oct | 44 50.36 | 172 59.16 E | 44 51.46 | 172 57.66 E | 1 133 | 1 145 | 1.56 | 1 850 |
| 4 | 4 | 31 Oct | 44 47.68 | 173 04.52 E | 44 49.12 | 173 02.53 E | 1 032 | 1 066 | 2.00 | 1 700 |
| 5 | 4 | 31 Oct | 44 47.08 | 173 10.15 E | 44 46.78 | 173 12.91 E | 1 061 | 1 083 | 2.00 | 1 750 |
| 6 | 3 | 31 Oct | 44 49.48 | 173 14.33 E | 44 49.30 | 173 11.55 E | 978 | 994 | 2.00 | 1 555 |
| 7 | 4 | 31 Oct | 44 44.78 | 173 13.71 E | 44 44.18 | 173 15.93 E | 1 007 | 1 021 | 1.74 | 1 650 |
| 8 | 4 | 31 Oct | 44 51.11 | 173 28.64 E | 44 50.28 | 173 26.96 E | 1 052 | 1 079 | 1.05 | 1 650 |
| 9 | 4 | 1 Nov | 44 47.17 | 173 30.80 E | 44 46.56 | 173 29.68 E | 1 030 | 1 049 | 1.00 | 1 650 |
| 10 | 2 | 1 Nov | 44 41.57 | 173 31.34 E | 44 43.59 | 173 31.62 E | 856 | 880 | 2.03 | 1 500 |
| 11 | 2 | 1 Nov | 44 40.20 | 173 35.67 E | 44 42.14 | 173 36.48 E | 835 | 878 | 2.00 | 1 450 |
| 12 | 3 | 1 Nov | 44 43.78 | 173 42.51 E | 44 42.11 | 173 46.30 E | 925 | 970 | 1.56 | 1 550 |
| 13 | 3 | 1 Nov | 44 41.38 | 173 45.32 E | 44 40.65 | 173 42.69 E | 890 | 959 | 2.00 | 1 550 |
| 14 | 2 | 1 Nov | 44 38.26 | 173 46.71 E | 44 39.38 | 173 44.32 E | 807 | 872 | 2.00 | 1 450 |
| 15 | 3 | 1 Nov | 44 43.82 | 173 49.51 E | 44 43.31 | 173 52.25 E | 962 | 1 000 | 2.00 | 1 500 |
| 16 | 4 | 1 Nov | 44 49.56 | 173 50.10 E | 44 51.21 | 173 48.62 E | 980 | 1 099 | 2.00 | 1 600 |
| 17 | 5 | 1 Nov | 44 53.62 | 173 46.96 E | 44 51.77 | 173 45.85 E | 1 159 | 1 179 | 2.00 | 1 750 |
| 18 | 2 | 2 Nov | 44 36.95 | 173 51.87 E | 44 37.76 | 173 50.61 E | 835 | 859 | 2.00 | 1 450 |
| 19 | 2 | 2 Nov | 44 32.84 | 173 54.50 E | 44 31.70 | 173 56.90 E | 813 | 820 | 2.00 | 1 500 |
| 20 | 2 | 2 Nov | 44 35.25 | 174 00.12 E | 44 34.72 | 174 03.08 E | 879 | 879 | 2.00 | 1 500 |
| 21 | 2 | 2 Nov | 44 39.15 | 174 04.15 E | 44 37.93 | 174 01.94 E | 820 | 890 | 2.00 | 1 450 |
| 22 | 1 | 2 Nov | 44 31.60 | 174 16.29 E | 44 29.66 | 174 16.94 E | 760 | 797 | 2.08 | 1 400 |
| 23 | 1 | 2 Nov | 44 24.06 | 174 20.76 E | 44 22.64 | 174 22.82 E | 686 | 700 | 2.00 | 1 150 |
| 24 | 2 | 2 Nov | 44 45.71 | 174 18.26 E | 44 47.21 | 174 20.14 E | 879 | 886 | 2.00 | 1 520 |
| 25 | 3 | 2 Nov | 44 49.02 | 174 18.40 E | 44 51.06 | 174 18.55 E | 904 | 999 | 2.00 | 1 570 |
| 26 | 3 | 3 Nov | 44 55.29 | 174 11.33 E | 44 55.29 | 174 14.17 E | 953 | 975 | 2.01 | 1 500 |
| 27 | 4 | 3 Nov | 44 55.83 | 174 05.54 E | 44 55.90 | 174 03.76 E | 1 052 | 1 105 | 1.25 | 1 700 |
| 28 | 5 | 3 Nov | 45 00.54 | 174 01.78 E | 45 00.78 | 174 04.58 E | 1 180 | 1 190 | 2.06 | 1 900 |
| 29 | 4 | 3 Nov | 44 56.27 | 174 09.80 E | 44 58.27 | 174 09.40 E | 985 | 1 080 | 2.06 | 1 750 |
| 30 | 3 | 3 Nov | 44 56.19 | 174 26.19 E | 44 58.01 | 174 25.58 E | 960 | 983 | 1.85 | 1 550 |
| 31 | 4 | 3 Nov | 45 08.48 | 174 27.90 E | 45 10.08 | 174 29.57 E | 1 088 | 1 090 | 2.00 | 1 750 |
| 32 | 9 | 3 Nov | 45 12.05 | 174 44.93 E | 45 13.98 | 174 45.77 E | 1 047 | 1 054 | 2.00 | 1 750 |
| 33 | 9 | 3 Nov | 45 14.18 | 174 50.24 E | 45 12.76 | 174 52.27 E | 1 079 | 1 098 | 2.00 | 1 750 |
| 34 | 9 | 4 Nov | 45 18.72 | 174 47.20 E | 45 18.85 | 174 49.99 E | 1 055 | 1 074 | 2.00 | 1 750 |
| 35 | 7 | 4 Nov | 44 51.94 | 174 53.62 E | 44 51.97 | 174 56.44 E | 882 | 894 | 2.06 | 1 500 |

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 8 | 4 Nov | 44 54.57 | 175 03.68 E | 44 53.62 | 175 05.47 E | 928 | 970 | 1.58 | 1 600 |
| 37 | 7 | 4 Nov | 44 47.39 | 175 02.03 E | 44 47.75 | 174 59.24 E | 826 | 891 | 2.05 | 1 400 |
| 38 | 6 | 4 Nov | 44 40.70 | 174 56.67 E | 44 42.13 | 174 56.98 E | 785 | 800 | 1.49 | 1 300 |
| 39 | 6 | 4 Nov | 44 32.72 | 175 09.14 E | 44 30.84 | 175 09.99 E | 712 | 728 | 2.00 | 1 250 |
| 40 | 7 | 4 Nov | 44 38.33 | 175 26.54 E | 44 40.32 | 175 26.34 E | 802 | 824 | 2.00 | 1 400 |
| 41 | 7 | 4 Nov | 44 43.22 | 175 23.25 E | 44 42.91 | 175 25.35 E | 852 | 899 | 1.52 | 1 450 |
| 42 | 8 | 5 Nov | 44 46.42 | 175 34.15 E | 44 48.23 | 175 33.44 E | 921 | 987 | 1.88 | 1 550 |
| 43 | 8 | 5 Nov | 44 42.65 | 175 40.42 E | 44 43.52 | 175 37.89 E | 906 | 930 | 2.03 | 1 450 |
| 44 | 7 | 5 Nov | 44 31.73 | 175 35.15 E | 44 33.33 | 175 36.76 E | 802 | 840 | 2.07 | 1 400 |
| 45 | 6 | 5 Nov | 44 23.48 | 175 40.41 E | 44 22.84 | 175 39.38 E | 692 | 693 | 1.00 | 1 200 |
| 46 | 13 | 5 Nov | 44 36.22 | 176 09.33 E | 44 34.95 | 176 07.17 E | 928 | 952 | 2.00 | 1 550 |
| 47 | 14 | 5 Nov | 44 37.44 | 176 15.89 E | 44 37.36 | 176 17.67 E | 1 001 | 1 078 | 1.28 | 1 650 |
| 48 | 14 | 5 Nov | 44 36.05 | 176 27.33 E | 44 35.95 | 176 28.67 E | 1 003 | 1 012 | 0.99 | 1 650 |
| 49 | 14 | 6 Nov | 44 32.87 | 176 42.92 E | 44 31.44 | 176 43.49 E | 1 050 | 1 084 | 1.49 | 1 800 |
| 50 | 12 | 6 Nov | 44 18.62 | 176 38.17 E | 44 20.24 | 176 36.47 E | 813 | 817 | 2.05 | 1 400 |
| 51 | 11 | 6 Nov | 44 17.40 | 176 33.08 E | 44 19.40 | 176 32.76 E | 735 | 770 | 2.06 | 1 250 |
| 52 | 11 | 6 Nov | 44 10.67 | 176 44.96 E | 44 12.45 | 176 43.66 E | 665 | 687 | 2.01 | 1 150 |
| 53 | 12 | 6 Nov | 44 14.49 | 176 54.72 E | 44 15.44 | 176 56.90 E | 800 | 860 | 2.00 | 1 350 |
| 54 | 14 | 6 Nov | 44 19.69 | 177 00.74 E | 44 19.93 | 177 03.55 E | 1 012 | 1 088 | 2.00 | 1 700 |
| 55 | 13 | 6 Nov | 44 13.76 | 177 12.29 E | 44 13.72 | 177 09.42 E | 918 | 945 | 2.00 | 1 550 |
| 56 | 12 | 6 Nov | 44 10.12 | 177 11.05 E | 44 11.96 | 177 09.94 E | 818 | 864 | 2.00 | 1 300 |
| 57 | 13 | 7 Nov | 44 12.40 | 177 19.28 E | 44 12.29 | 177 22.09 E | 932 | 952 | 2.00 | 1 550 |
| 58 | 14 | 7 Nov | 44 13.80 | 177 22.22 E | 44 13.44 | 177 25.02 E | 1 005 | 1 045 | 2.02 | 1 650 |
| 59 | 13 | 7 Nov | 44 10.40 | 177 28.46 E | 44 12.30 | 177 29.44 E | 935 | 965 | 2.02 | 1 800 |
| 60 | 12 | 7 Nov | 44 06.57 | 177 35.39 E | 44 08.04 | 177 36.46 E | 882 | 905 | 1.69 | 1 400 |
| 61 | 13 | 7 Nov | 44 04.50 | 177 50.40 E | 44 04.17 | 177 53.16 E | 920 | 960 | 2.06 | 1 600 |
| 62 | 12 | 7 Nov | 44 04.13 | 178 29.75 E | 44 05.15 | 178 27.36 E | 822 | 897 | 2.00 | 1 400 |
| 63 | 11 | 7 Nov | 43 58.84 | 178 32.47 E | 43 58.84 | 178 35.28 E | 687 | 710 | 2.00 | 1 250 |
| 64 | 16 | 7 Nov | 44 02.46 | 178 40.77 E | 44 02.95 | 178 38.09 E | 779 | 795 | 2.00 | 1 250 |
| 65 | 13 | 8 Nov | 44 06.87 | 178 36.80 E | 44 06.13 | 178 34.23 E | 917 | 997 | 2.00 | 1 500 |
| 66 | 19 | 8 Nov | 44 13.50 | 178 56.60 E | 44 14.22 | 178 58.96 E | 1 006 | 1 040 | 1.84 | 1 650 |
| 67 | 19 | 8 Nov | 44 12.95 | 178 54.26 E | 44 13.16 | 178 57.81 E | 1 002 | 1 011 | 2.06 | 1 750 |
| 68 | 17 | 8 Nov | 44 05.77 | 178 41.32 E | 44 05.87 | 178 44.15 E | 867 | 870 | 2.06 | 1 400 |
| 69 | 21 | 8 Nov | 44 20.77 | 178 49.60 E | 44 21.67 | 178 52.11 E | 1 208 | 1 217 | 2.00 | 1 900 |

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 70 | 18 | 8 Nov | 44 11.91 | 179 05.15 E | 44 13.19 | 179 08.05 E | 935 | 941 | 2.00 | 1 600 |
| 71 | 17 | 8 Nov | 44 09.46 | 179 12.92 E | 44 09.48 | 179 15.67 E | 840 | 852 | 2.00 | 1 400 |
| 72 | 18 | 8 Nov | 44 15.30 | 179 24.29 E | 44 15.18 | 179 25.85 E | 937 | 953 | 1.15 | 1 700 |
| 73 | 18 | 9 Nov | 44 14.96 | 179 37.29 E | 44 14.53 | 179 33.96 E | 960 | 970 | 2.06 | 1 550 |
| 74 | 19 | 9 Nov | 44 18.40 | 179 34.87 E | 44 18.35 | 179 37.71 E | 1 027 | 1 030 | 2.02 | 1 650 |
| 75 | 21 | 9 Nov | 44 28.15 | 179 43.76 E | 44 28.95 | 179 46.30 E | 1 214 | 1 217 | 2.00 | 1 950 |
| 76 | 18 | 9 Nov | 44 17.68 | 179 54.62 E | 44 18.90 | 179 56.81 E | 910 | 936 | 2.00 | 1 550 |
| 77 | 17 | 9 Nov | 44 17.26 | 179 59.21 E | 44 17.13 | 179 56.41 E | 835 | 875 | 2.00 | 1 550 |
| 78 | 17 | 9 Nov | 44 12.04 | 179 43.66 E | 44 12.72 | 179 46.25 E | 830 | 836 | 2.00 | 1 350 |
| 79 | 17 | 10 Nov | 44 19.58 | 179 45.26 W | 44 18.91 | 179 42.54 W | 815 | 845 | 2.09 | 1 400 |
| 80 | 16 | 10 Nov | 44 17.51 | 179 40.90 W | 44 17.16 | 179 38.10 W | 741 | 781 | 2.03 | 1 300 |
| 81 | 18 | 10 Nov | 44 22.90 | 179 40.72 W | 44 24.62 | 179 40.54 W | 910 | 1 000 | 1.70 | 1 550 |
| 82 | 19 | 10 Nov | 44 27.33 | 179 40.51 W | 44 28.68 | 179 38.43 W | 1 065 | 1 092 | 2.01 | 1 750 |
| 83 | 21 | 10 Nov | 44 45.82 | 179 32.06 W | 44 45.84 | 179 29.26 W | 1 305 | 1 351 | 2.00 | 2 100 |
| 84 | 21 | 10 Nov | 44 43.10 | 179 07.28 W | 44 42.58 | 179 04.53 W | 1 343 | 1 351 | 2.00 | 2 150 |
| 85 | 20 | 10 Nov | 44 30.14 | 179 20.86 W | 44 31.46 | 179 20.73 W | 1 100 | 1 199 | 1.32 | 1 850 |
| 86 | 19 | 11 Nov | 44 29.40 | 179 08.57 W | 44 30.57 | 179 10.84 W | 1 056 | 1 061 | 2.00 | 1 700 |
| 87 | 18 | 11 Nov | 44 25.72 | 178 56.89 W | 44 26.16 | 178 59.63 W | 940 | 980 | 2.04 | 1 500 |
| 88 | 17 | 11 Nov | 44 21.90 | 178 34.12 W | 44 22.63 | 178 36.15 W | 800 | 860 | 1.62 | 1 300 |
| 89 | 18 | 11 Nov | 44 30.41 | 178 30.55 W | 44 32.60 | 178 27.90 W | 964 | 1 010 | 3.00 | 1 600 |
| 90 | 21 | 11 Nov | 44 41.28 | 178 28.83 W | 44 41.22 | 178 26.01 W | 1 277 | 1 281 | 2.00 | 2 000 |
| 91 | 16 | 11 Nov | 44 18.76 | 178 23.95 W | 44 17.52 | 178 21.74 W | 622 | 670 | 2.00 | 1 050 |
| 92 | 19 | 11 Nov | 44 31.17 | 178 12.70 W | 44 33.29 | 178 11.85 W | 1 015 | 1 050 | 2.00 | 1 550 |
| 93 | 19 | 12 Nov | 44 32.52 | 178 08.07 W | 44 32.63 | 178 04.85 W | 1 048 | 1 054 | 2.00 | 1 600 |
| 94 | 19 | 12 Nov | 44 30.06 | 178 08.19 W | 44 32.01 | 178 07.57 W | 1 000 | 1 064 | 2.02 | 1 650 |
| 95 | 20 | 12 Nov | 44 35.95 | 178 04.17 W | 44 37.95 | 178 03.67 W | 1 101 | 1 170 | 2.04 | 1 850 |
| 96 | 20 | 12 Nov | 44 36.99 | 178 01.24 W | 44 37.19 | 177 59.97 W | 1 125 | 1 150 | 0.92 | 1 850 |
| 97 | 18 | 12 Nov | 44 32.17 | 177 51.61 W | 44 35.10 | 177 50.00 W | 915 | 970 | 2.25 | 1 500 |
| 98 | 17 | 12 Nov | 44 29.54 | 177 37.79 W | 44 29.59 | 177 40.65 W | 804 | 813 | 2.00 | 1 350 |
| 99 | 16 | 12 Nov | 44 25.62 | 177 22.00 W | 44 26.71 | 177 19.55 W | 655 | 670 | 2.00 | 1 150 |
| 100 | 17 | 12 Nov | 44 35.96 | 177 27.41 W | 44 36.13 | 177 30.20 W | 863 | 893 | 2.00 | 1 400 |
| 101 | 18 | 13 Nov | 44 37.38 | 177 31.38 W | 44 38.52 | 177 30.36 W | 933 | 974 | 1.31 | 1 600 |
| 102 | 20 | 13 Nov | 44 40.09 | 177 33.37 W | 44 41.23 | 177 31.07 W | 1 100 | 1 151 | 2.05 | 1 750 |
| 103 | 20 | 13 Nov | 44 44.75 | 176 54.61 W | 44 45.95 | 176 57.04 W | 1 099 | 1 159 | 2.00 | 1 850 |

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 104 | 25 | 13 Nov | 44 38.41 | 176 00.02 W | 44 38.30 | 175 57.19 W | 1 010 | 1 060 | 2.00 | 1 600 |
| 105 | 24 | 14 Nov | 44 36.85 | 176 00.03 W | 44 36.84 | 175 57.24 W | 904 | 945 | 2.00 | 1 450 |
| 106 | 24 | 14 Nov | 44 35.57 | 175 52.63 W | 44 35.60 | 175 49.83 W | 935 | 992 | 2.02 | 1 550 |
| 107 | 25 | 14 Nov | 44 35.84 | 175 50.13 W | 44 36.02 | 175 47.32 W | 1 005 | 1 060 | 2.05 | 1 600 |
| 108 | 23 | 14 Nov | 44 33.63 | 175 51.52 W | 44 33.85 | 175 48.72 W | 818 | 885 | 2.02 | 1 300 |
| 109 | 23 | 14 Nov | 44 34.50 | 175 55.35 W | 44 34.97 | 175 58.11 W | 820 | 844 | 2.06 | 1 300 |
| 110 | 22 | 14 Nov | 44 29.82 | 175 46.94 W | 44 30.22 | 175 49.66 W | 602 | 675 | 2.00 | 1 023 |
| 111 | 27 | 14 Nov | 44 40.20 | 175 48.07 W | 44 39.64 | 175 45.36 W | 1 341 | 1 375 | 2.00 | 2 150 |
| 112 | 24 | 14 Nov | 44 32.12 | 175 29.11 W | 44 32.82 | 175 31.44 W | 930 | 963 | 1.79 | 1 500 |
| 113 | 24 | 15 Nov | 44 32.55 | 175 25.72 W | 44 32.76 | 175 22.89 W | 955 | 992 | 2.03 | 1 500 |
| 114 | 25 | 15 Nov | 44 33.32 | 175 22.28 W | 44 33.98 | 175 24.97 W | 1 035 | 1 045 | 2.04 | 1 650 |
| 115 | 26 | 15 Nov | 44 35.25 | 175 23.88 W | 44 35.47 | 175 21.06 W | 1 101 | 1 144 | 2.04 | 1 800 |
| 116 | 26 | 15 Nov | 44 32.11 | 175 12.61 W | 44 32.07 | 175 09.38 W | 1 141 | 1 200 | 1.67 | 1 800 |
| 117 | 27 | 15 Nov | 44 31.67 | 175 04.91 W | 44 33.20 | 175 06.85 W | 1 312 | 1 333 | 2.00 | 2 050 |
| 118 | 26 | 15 Nov | 44 29.55 | 174 58.72 W | 44 30.08 | 174 59.93 W | 1 099 | 1 113 | 1.00 | 1 770 |
| 119 | 23 | 16 Nov | 44 25.75 | 175 04.65 W | 44 23.28 | 175 04.46 W | 832 | 852 | 2.00 | 1 350 |
| 120 | 23 | 16 Nov | 44 22.96 | 175 02.24 W | 44 24.89 | 175 03.04 W | 810 | 857 | 2.01 | 1 300 |
| 121 | 23 | 16 Nov | 44 22.28 | 175 01.50 W | 44 22.03 | 174 58.56 W | 811 | 849 | 2.07 | 1 350 |
| 122 | 24 | 16 Nov | 44 26.16 | 174 59.78 W | 44 27.28 | 175 01.85 W | 900 | 937 | 1.78 | 1 550 |
| 123 | 27 | 16 Nov | 44 24.71 | 174 37.48 W | 44 23.04 | 174 36.82 W | 1 393 | 1 472 | 1.74 | 2 200 |
| 124 | 25 | 16 Nov | 44 16.82 | 174 48.67 W | 44 18.67 | 174 49.78 W | 1 020 | 1 101 | 2.00 | 1 600 |
| 125 | 23 | 16 Nov | 44 17.15 | 174 50.77 W | 44 17.96 | 174 50.83 W | 852 | 866 | 0.82 | 1 400 |
| 126 | 22 | 17 Nov | 44 13.90 | 175 09.57 W | 44 15.54 | 175 08.72 W | 688 | 743 | 1.75 | 1 100 |
| 127 | 24 | 17 Nov | 44 09.59 | 174 49.12 W | 44 09.73 | 174 47.14 W | 934 | 1 000 | 1.42 | 1 500 |
| 128 | 27 | 17 Nov | 44 07.00 | 174 26.56 W | 44 09.01 | 174 27.55 W | 1 225 | 1 280 | 2.57 | 2 100 |
| 129 | 25 | 17 Nov | 44 04.98 | 174 43.44 W | 44 06.42 | 174 43.20 W | 1 000 | 1 036 | 1.41 | 1 600 |
| 130 | 24 | 17 Nov | 44 02.65 | 174 43.60 W | 44 04.70 | 174 43.75 W | 900 | 941 | 2.01 | 1 450 |
| 131 | 23 | 17 Nov | 44 03.76 | 174 49.73 W | 44 04.89 | 174 47.39 W | 800 | 857 | 2.02 | 1 350 |
| 132 | 22 | 18 Nov | 44 03.94 | 174 52.40 W | 44 05.97 | 174 52.42 W | 777 | 795 | 2.08 | 1 250 |
| 133 | 23 | 18 Nov | 44 01.04 | 174 46.80 W | 43 59.39 | 174 45.45 W | 855 | 894 | 1.91 | 1 400 |
| 134 | 25 | 18 Nov | 44 03.47 | 174 36.62 W | 44 02.27 | 174 35.09 W | 1 094 | 1 100 | 1.63 | 1 700 |
| 135 | 26 | 18 Nov | 44 03.22 | 174 32.03 W | 44 04.51 | 174 34.18 W | 1 110 | 1 157 | 2.04 | 1 800 |
| 136 | 27 | 18 Nov | 44 05.17 | 174 25.68 W | 44 04.73 | 174 22.96 W | 1 200 | 1 240 | 2.00 | 1 950 |
| 137 | 26 | 18 Nov | 44 01.44 | 174 24.14 W | 44 03.17 | 174 22.70 W | 1 138 | 1 194 | 2.00 | 1 800 |

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 138 | 24 | 19 Nov | 44 32.19 | 175 22.38 W | 44 32.10 | 175 25.22 W | 966 | 968 | 2.03 | 1 500 |
| 139 | 24 | 19 Nov | 44 33.42 | 175 45.78 W | 44 33.65 | 175 43.47 W | 901 | 968 | 1.67 | 1 500 |
| 140 | 18 | 19 Nov | 44 36.94 | 176 00.41 W | 44 39.56 | 176 03.12 W | 902 | 1 000 | 1.52 | 1 500 |
| 141 | 18 | 19 Nov | 44 40.55 | 176 13.36 W | 44 42.16 | 176 15.17 W | 912 | 999 | 2.01 | 1 550 |
| 142 | 18 | 19 Nov | 44 40.77 | 176 13.60 W | 44 41.18 | 176 10.81 W | 900 | 975 | 2.00 | 1 500 |
| 143 | 18 | 19 Nov | 44 41.77 | 176 29.52 W | 44 41.79 | 176 26.07 W | 923 | 975 | 2.28 | 1 500 |
| 144 | 19 | 20 Nov | 44 41.94 | 176 23.05 W | 44 42.54 | 176 20.31 W | 1 010 | 1 030 | 2.00 | 1 650 |
| 145 | 18 | 20 Nov | 44 42.07 | 176 31.12 W | 44 42.63 | 176 33.07 W | 942 | 1 000 | 1.15 | 1 550 |
| 146 | 18 | 20 Nov | 44 40.93 | 176 42.22 W | 44 42.55 | 176 42.18 W | 966 | 1 000 | 1.64 | 1 600 |
| 147 | 18 | 20 Nov | 44 37.08 | 177 03.72 W | 44 38.62 | 177 01.84 W | 900 | 950 | 2.06 | 1 500 |
| 148 | 17 | 20 Nov | 44 32.96 | 177 10.80 W | 44 34.12 | 177 08.39 W | 802 | 846 | 2.00 | 1 350 |
| 149 | 19 | 20 Nov | 44 41.40 | 177 20.80 W | 44 41.27 | 177 17.14 W | 1 046 | 1 060 | 2.24 | 1 750 |
| 150 | 18 | 20 Nov | 44 38.67 | 177 23.09 W | 44 40.00 | 177 20.80 W | 935 | 1 000 | 2.00 | 1 500 |
| 151 | 20 | 20 Nov | 44 41.92 | 177 23.57 W | 44 42.26 | 177 25.98 W | 1 103 | 1 175 | 1.78 | 1 900 |
| 152 | 18 | 21 Nov | 44 33.05 | 177 35.21 W | 44 34.24 | 177 32.92 W | 895 | 910 | 2.04 | 1 450 |
| 153 | 18 | 21 Nov | 44 33.18 | 177 39.14 W | 44 33.42 | 177 41.97 W | 910 | 956 | 2.04 | 1 500 |
| 154 | 17 | 21 Nov | 44 28.43 | 177 51.69 W | 44 28.35 | 177 49.84 W | 865 | 880 | 1.35 | 1 350 |
| 155 | 19 | 21 Nov | 44 35.90 | 177 54.92 W | 44 37.27 | 177 52.43 W | 1 011 | 1 100 | 2.20 | 1 600 |
| 156 | 19 | 21 Nov | 44 31.31 | 178 10.33 W | 44 31.77 | 178 07.57 W | 1 024 | 1 047 | 2.00 | 1 600 |
| 157 | 18 | 21 Nov | 44 26.48 | 178 20.11 W | 44 28.06 | 178 21.72 W | 954 | 998 | 2.00 | 1 500 |
| 158 | 19 | 21 Nov | 44 31.78 | 178 19.13 W | 44 33.38 | 178 17.40 W | 1 023 | 1 053 | 2.00 | 1 600 |
| 159 | 18 | 22 Nov | 44 26.26 | 178 27.94 W | 44 27.48 | 178 30.20 W | 900 | 919 | 2.02 | 1 550 |
| 160 | 18 | 22 Nov | 44 29.11 | 178 29.41 W | 44 29.77 | 178 32.08 W | 955 | 966 | 2.04 | 1 550 |
| 161 | 18 | 22 Nov | 44 27.37 | 178 38.40 W | 44 26.72 | 178 35.74 W | 916 | 948 | 2.02 | 1 500 |
| 162 | 18 | 22 Nov | 44 27.90 | 178 43.50 W | 44 29.59 | 178 44.38 W | 900 | 1 000 | 1.93 | 1 530 |
| 163 | 18 | 22 Nov | 44 25.30 | 178 50.54 W | 44 25.22 | 178 53.36 W | 901 | 920 | 2.00 | 1 500 |
| 164 | 17 | 22 Nov | 44 23.60 | 178 52.98 W | 44 23.54 | 178 55.69 W | 850 | 861 | 2.00 | 1 400 |
| 165 | 18 | 22 Nov | 44 24.71 | 179 00.60 W | 44 25.09 | 178 57.87 W | 921 | 947 | 2.00 | 1 500 |
| 166 | 19 | 22 Nov | 44 28.08 | 178 55.77 W | 44 29.16 | 178 58.14 W | 1 014 | 1 026 | 2.00 | 1 600 |
| 167 | 18 | 23 Nov | 44 26.86 | 179 07.06 W | 44 25.74 | 179 09.36 W | 979 | 1 000 | 2.00 | 1 600 |
| 168 | 19 | 23 Nov | 44 28.37 | 179 09.22 W | 44 28.68 | 179 06.42 W | 1 045 | 1 048 | 2.04 | 1 700 |
| 169 | 18 | 23 Nov | 44 24.64 | 179 08.53 W | 44 25.20 | 179 05.80 W | 938 | 945 | 2.03 | 1 500 |
| 170 | 18 | 23 Nov | 44 25.42 | 179 18.96 W | 44 26.69 | 179 16.80 W | 947 | 949 | 2.04 | 1 550 |
| 171 | 18 | 23 Nov | 44 23.00 | 179 37.10 W | 44 22.80 | 179 39.89 W | 947 | 956 | 2.00 | 1 520 |
| 172 | 19 | 23 Nov | 44 27.15 | 179 45.22 W | 44 27.73 | 179 48.02 W | 1 070 | 1 073 | 2.00 | 1 750 |
| 173 | 19 | 23 Nov | 44 27.88 | 179 53.07 W | 44 27.77 | 179 54.19 W | 1 079 | 1 099 | 0.83 | 1 770 |

| Station | Stratum | Date 1990 | Start Latitude ° 'S | Start Longitude ° 'E/W | Finish Latitude ° 'S | Finish Longitude ° 'E/W | Depth (m) Min. | Depth (m) Max. | Distance towed (n. mile) | Warp length (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 174 | 18 | 24 Nov | 44 21.87 | 179 54.09 W | 44 22.09 | 179 56.88 W | 919 | 946 | 2.05 | 1 450 |
| 175 | 19 | 24 Nov | 44 23.70 | 179 59.45 E | 44 23.71 | 179 56.61 E | 1 015 | 1 039 | 2.03 | 1 700 |
| 176 | 19 | 24 Nov | 44 22.53 | 179 53.71 E | 44 22.03 | 179 50.21 E | 1 028 | 1 048 | 1.98 | 1 650 |
| 177 | 20 | 24 Nov | 44 26.22 | 179 47.74 E | 44 27.64 | 179 45.69 E | 1 120 | 1 160 | 2.04 | 1 850 |
| 178 | 18 | 24 Nov | 44 18.37 | 179 50.16 E | 44 17.21 | 179 47.90 E | 970 | 991 | 2.02 | 1 600 |
| 179 | 18 | 24 Nov | 44 16.34 | 179 43.94 E | 44 16.78 | 179 41.23 E | 948 | 968 | 2.00 | 1 550 |
| 180 | 17 | 24 Nov | 44 11.69 | 179 40.84 E | 44 13.42 | 179 42.25 E | 827 | 865 | 2.00 | 1 400 |
| 181 | 17 | 25 Nov | 44 09.84 | 179 33.16 E | 44 11.11 | 179 35.37 E | 830 | 846 | 2.00 | 1 400 |
| 182 | 20 | 25 Nov | 44 22.86 | 179 28.86 E | 44 23.77 | 179 27.33 E | 1 149 | 1 200 | 1.42 | 1 850 |
| 183 | 18 | 25 Nov | 44 13.00 | 179 09.70 E | 44 12.80 | 179 12.60 E | 941 | 953 | 2.06 | 1 550 |
| 184 | 18 | 25 Nov | 44 12.36 | 179 03.58 E | 44 11.98 | 179 00.83 E | 956 | 968 | 2.03 | 1 550 |
| 185 | 13 | 25 Nov | 44 07.39 | 178 38.49 E | 44 06.67 | 178 34.84 E | 925 | 981 | 2.72 | 1 500 |
| 186 | 19 | 25 Nov | 44 10.90 | 178 42.77 E | 44 11.57 | 178 45.48 E | 1 005 | 1 020 | 2.04 | 1 650 |
| 187 | 20 | 25 Nov | 44 17.40 | 178 55.01 E | 44 16.01 | 178 56.95 E | 1 103 | 1 140 | 2.06 | 1 750 |
| 188 | 20 | 26 Nov | 44 17.49 | 178 53.68 E | 44 18.92 | 178 51.73 E | 1 120 | 1 162 | 2.00 | 1 750 |
| 189 | 18 | 26 Nov | 44 10.01 | 178 49.57 E | 44 10.12 | 178 52.35 E | 954 | 977 | 2.05 | 1 550 |
| 190 | 19 | 26 Nov | 44 13.85 | 178 46.34 E | 44 15.09 | 178 44.23 E | 1 053 | 1 100 | 1.96 | 1 670 |
| 191 | 29 | 27 Nov | 44 45.81 | 172 34.56 E | 44 47.50 | 172 31.27 E | 800 | 837 | 2.00 | 1 275 |
| 192 | 28 | 27 Nov | 44 47.12 | 172 25.62 E | 44 48.23 | 172 23.31 E | 603 | 605 | 2.00 | 1 015 |
| 193 | 29 | 27 Nov | 44 49.38 | 172 31.19 E | 44 50.41 | 172 28.77 E | 925 | 962 | 2.00 | 1 600 |
| 194 | 31 | 27 Nov | 44 50.08 | 172 31.07 E | 44 50.46 | 172 29.99 E | 1 022 | 1 048 | 0.80 | 1 650 |
| 195 | 29 | 27 Nov | 44 46.86 | 172 36.32 E | 44 48.02 | 172 34.77 E | 893 | 900 | 1.27 | 1 400 |
| 196 | 30 | 28 Nov | 44 46.17 | 172 40.29 E | 44 45.20 | 172 41.31 E | 913 | 940 | 1.26 | 1 580 |
| 197 | 29 | 28 Nov | 44 44.71 | 172 41.64 E | 44 45.09 | 172 39.08 E | 813 | 862 | 1.22 | 1 400 |
| 198 | 31 | 28 Nov | 44 46.06 | 172 50.74 E | 44 46.66 | 172 48.04 E | 1 002 | 1 038 | 2.01 | 1 650 |
| 199 | 30 | 28 Nov | 44 44.87 | 172 50.11 E | 44 45.33 | 172 47.39 E | 910 | 915 | 2.04 | 1 500 |
| 200 | 31 | 28 Nov | 44 46.22 | 172 53.40 E | 44 46.69 | 172 50.64 E | 1 004 | 1 041 | 2.00 | 1 600 |
| 201 | 31 | 28 Nov | 44 46.29 | 172 54.39 E | 44 46.23 | 172 57.23 E | 1 009 | 1 018 | 2.00 | 1 600 |
| 202 | 29 | 28 Nov | 44 42.91 | 172 56.93 E | 44 42.88 | 172 59.41 E | 818 | 838 | 1.70 | 1 400 |
| 203 | 30 | 29 Nov | 44 44.49 | 173 03.04 E | 44 44.73 | 173 06.02 E | 914 | 915 | 2.15 | 1 500 |
| 204 | 4 | 29 Nov | 44 46.84 | 173 08.01 E | 44 46.64 | 173 04.26 E | 1 013 | 1 074 | 2.02 | 1 600 |
| 205 | 4 | 29 Nov | 44 50.53 | 173 14.86 E | 44 52.45 | 173 13.95 E | 1 000 | 1 070 | 2.03 | 1 600 |
| 206 | 4 | 29 Nov | 44 49.34 | 173 22.07 E | 44 50.23 | 173 21.33 E | 1 000 | 1 070 | 1.03 | 1 600 |
| 207 | 4 | 29 Nov | 44 47.61 | 173 32.17 E | 44 48.52 | 173 32.83 E | 1 011 | 1 061 | 1.00 | 1 600 |

* Gear performance was rated 2 at stations 25, 50, 104, and 194 and 3 at station 72.

**Appendix 5: Catch (kg) of black oreo, smooth oreo, and orange roughy at each station.**

| Station | Black oreo | Smooth oreo | Orange roughy |
|---|---|---|---|
| 1 | 94.1 | 0.0 | 0.0 |
| 2 | 143.2 | 159.8 | 0.0 |
| 3 | 0.0 | 59.3 | 0.0 |
| 4 | 505.0 | 11 100.0 | 0.0 |
| 5 | 2.8 | 1.3 | 0.0 |
| 6 | 5.8 | 1.0 | 0.0 |
| 7 | 28.1 | 0.0 | 0.0 |
| 8 | 10.5 | 0.8 | 0.0 |
| 9 | 2.1 | 1.5 | 0.0 |
| 10 | 1 793.0 | 887.0 | 0.0 |
| 11 | 1 585.0 | 2 930.0 | 0.0 |
| 12 | 98.5 | 2.6 | 0.0 |
| 13 | 211.3 | 110.7 | 0.0 |
| 14 | 515.9 | 58.3 | 0.0 |
| 15 | 22.3 | 0.5 | 0.0 |
| 16 | 0.0 | 2.6 | 0.0 |
| 17 | 0.6 | 5.5 | 0.0 |
| 18 | 381.0 | 43.4 | 0.0 |
| 19 | 135.6 | 3.7 | 0.0 |
| 20 | 30.8 | 1.7 | 0.0 |
| 21 | 302.2 | 190.2 | 0.0 |
| 22 | 394.8 | 7.3 | 0.0 |
| 23 | 448.5 | 0.0 | 0.0 |
| 24 | 55.2 | 16.7 | 0.0 |
| 25 | 23.6 | 11.6 | 0.0 |
| 26 | 29.4 | 1.3 | 0.0 |
| 27 | 0.3 | 2.1 | 0.0 |
| 28 | 0.0 | 0.2 | 0.0 |
| 29 | 15.2 | 1.3 | 1.7 |
| 30 | 15.7 | 2.8 | 0.0 |
| 31 | 0.0 | 5.6 | 0.0 |
| 32 | 2.4 | 6.6 | 0.0 |
| 33 | 0.0 | 4.5 | 0.0 |
| 34 | 0.0 | 2.6 | 0.0 |
| 35 | 24.0 | 2.2 | 1.5 |
| 36 | 16.9 | 1.3 | 0.0 |
| 37 | 1 902.0 | 4.7 | 0.0 |
| 38 | 102.6 | 6.6 | 0.0 |
| 39 | 556.9 | 0.7 | 0.0 |
| 40 | 116.3 | 2.8 | 0.0 |
| 41 | 10.0 | 35.2 | 0.0 |
| 42 | 13.5 | 27.1 | 4.0 |
| 43 | 53.0 | 1 635.0 | 1.7 |
| 44 | 262.3 | 7.1 | 0.0 |
| 45 | 348.3 | 0.1 | 0.0 |
| 46 | 29.6 | 1.0 | 2.0 |
| 47 | 3.3 | 0.5 | 3.7 |
| 48 | 1 456.0 | 1 022.0 | 3.3 |
| 49 | 2.4 | 4.6 | 10.8 |
| 50 | 203.1 | 76.1 | 0.0 |
| 51 | 554.1 | 14.8 | 0.0 |
| 52 | 509.1 | 0.0 | 0.0 |
| 53 | 79.1 | 0.5 | 0.0 |
| 54 | 6.8 | 0.8 | 2.5 |
| 55 | 8.2 | 57.7 | 0.0 |
| 56 | 106.5 | 24.3 | 0.0 |
| 57 | 11.4 | 130.7 | 0.0 |

| Station | Black oreo | Smooth oreo | Orange roughy |
|---|---|---|---|
| 58 | 2.5 | 39.2 | 0.0 |
| 59 | 65.9 | 717.4 | 0.0 |
| 60 | 25.7 | 5.9 | 1.4 |
| 61 | 15.4 | 1.8 | 1.6 |
| 62 | 844.8 | 443.5 | 0.5 |
| 63 | 288.7 | 1.4 | 0.0 |
| 64 | 376.9 | 6.2 | 0.0 |
| 65 | 4 367.0 | 1 261.0 | 20.5 |
| 66 | 115.7 | 23 546.0 | 17.0 |
| 67 | 45.3 | 540.2 | 6.5 |
| 68 | 351.9 | 6.2 | 0.0 |
| 69 | 2.8 | 3.9 | 0.0 |
| 70 | 54.1 | 166.4 | 3.5 |
| 71 | 119.7 | 14.0 | 0.0 |
| 72 | 0.0 | 0.0 | 0.0 |
| 73 | 1.6 | 2.4 | 2.1 |
| 74 | 0.6 | 0.1 | 2.7 |
| 75 | 0.0 | 1.4 | 0.9 |
| 76 | 131.8 | 1 175.3 | 12.4 |
| 77 | 109.9 | 6.5 | 0.0 |
| 78 | 39.0 | 0.2 | 0.0 |
| 79 | 31.4 | 0.6 | 0.0 |
| 80 | 44.4 | 0.3 | 0.0 |
| 81 | 6.5 | 2.2 | 6.0 |
| 82 | 0.0 | 3.6 | 6.6 |
| 83 | 0.0 | 0.0 | 0.0 |
| 84 | 0.0 | 0.0 | 0.0 |
| 85 | 0.0 | 2.2 | 14.3 |
| 86 | 0.6 | 0.9 | 5.7 |
| 87 | 0.5 | 0.0 | 4.1 |
| 88 | 20.9 | 4.6 | 0.0 |
| 89 | 24.3 | 1 264.1 | 229.3 |
| 90 | 0.0 | 0.0 | 0.0 |
| 91 | 48.0 | 0.0 | 0.0 |
| 92 | 1.0 | 0.8 | 35.3 |
| 93 | 0.9 | 1.5 | 10.6 |
| 94 | 0.0 | 0.2 | 29.6 |
| 95 | 0.0 | 16.8 | 19.5 |
| 96 | 0.3 | 5.8 | 9.2 |
| 97 | 208.9 | 29 495.0 | 70.7 |
| 98 | 26.3 | 916.9 | 0.7 |
| 99 | 52.8 | 0.0 | 0.0 |
| 100 | 153.7 | 14 498.0 | 33.7 |
| 101 | 485.4 | 19 878.0 | 107.7 |
| 102 | 0.0 | 81.4 | 210.5 |
| 103 | 0.5 | 492.2 | 78.0 |
| 104 | 5.2 | 122.8 | 5.9 |
| 105 | 7.2 | 120.2 | 11.3 |
| 106 | 1.7 | 23.7 | 3.3 |
| 107 | 1.5 | 26.9 | 1.7 |
| 108 | 0.3 | 293.1 | 6.4 |
| 109 | 0.5 | 691.5 | 12.4 |
| 110 | 0.0 | 3.7 | 0.0 |
| 111 | 0.0 | 1 565.7 | 0.0 |
| 112 | 39.4 | 2 891.0 | 2 511.0 |
| 113 | 14.0 | 171.7 | 11.9 |
| 114 | 3.6 | 118.8 | 13.6 |

| Station | Black oreo | Smooth oreo | Orange roughy |
|---|---|---|---|
| 115 | 5.0 | 3 584.0 | 17.9 |
| 116 | 3.0 | 10.1 | 3.0 |
| 117 | 0.0 | 3.2 | 29.6 |
| 118 | 0.2 | 1 058.3 | 9.6 |
| 119 | 0.2 | 10.2 | 4.3 |
| 120 | 0.0 | 0.3 | 1.7 |
| 121 | 0.0 | 0.2 | 13.1 |
| 122 | 0.0 | 7.9 | 18.4 |
| 123 | 0.0 | 0.0 | 1.7 |
| 124 | 1.1 | 3.8 | 12.8 |
| 125 | 0.0 | 0.5 | 0.0 |
| 126 | 0.6 | 1.4 | 0.0 |
| 127 | 0.4 | 7.3 | 28.1 |
| 128 | 0.5 | 1 357.0 | 28.4 |
| 129 | 0.0 | 7.4 | 42.5 |
| 130 | 0.2 | 0.9 | 31.4 |
| 131 | 0.0 | 2.7 | 2.4 |
| 132 | 0.0 | 2.2 | 0.3 |
| 133 | 0.9 | 1.2 | 5.9 |
| 134 | 1.1 | 5.2 | 91.0 |
| 135 | 0.4 | 10.6 | 61.2 |
| 136 | 0.0 | 3.3 | 33.9 |
| 137 | 0.0 | 210.9 | 39.7 |
| 138 | 24.3 | 173.9 | 18.4 |
| 139 | 7.6 | 469.2 | 60.2 |
| 140 | 2.3 | 1 065.0 | 8.0 |
| 141 | 29.7 | 868.3 | 46.8 |
| 142 | 7.2 | 868.3 | 18.7 |
| 143 | 3.0 | 1 334.6 | 20.6 |
| 144 | 39.1 | 1 182.0 | 95.6 |
| 145 | 2.1 | 344.5 | 19.2 |
| 146 | 2.6 | 66.0 | 13.2 |
| 147 | 3.3 | 782.0 | 18.3 |
| 148 | 9.3 | 394.0 | 3.0 |
| 149 | 2.7 | 6 992.4 | 30.2 |
| 150 | 16.1 | 105.2 | 247.0 |
| 151 | 0.9 | 88.5 | 27.3 |
| 152 | 2.4 | 49.9 | 12.1 |
| 153 | 2.5 | 21.7 | 25.2 |
| 154 | 26.4 | 2 548.0 | 122.1 |
| 155 | 7.7 | 1 742.0 | 120.8 |
| 156 | 0.3 | 3.0 | 8.5 |
| 157 | 1.8 | 254.9 | 6.4 |
| 158 | 0.0 | 8.6 | 8.9 |
| 159 | 68.9 | 68.8 | 4.7 |
| 160 | 24.1 | 2.8 | 9.9 |
| 161 | 33.1 | 37.9 | 6.0 |
| 162 | 24.0 | 10.8 | 54.1 |
| 163 | 3.8 | 1.0 | 3.2 |
| 164 | 30.2 | 6.4 | 0.8 |
| 165 | 4.2 | 1.5 | 0.8 |
| 166 | 1.4 | 6.8 | 0.0 |
| 167 | 0.8 | 0.7 | 1.0 |
| 168 | 0.5 | 3.6 | 0.0 |
| 169 | 0.2 | 0.0 | 1.3 |
| 170 | 2.1 | 280.4 | 4.8 |
| 171 | 6.7 | 3.4 | 0.0 |
| 172 | 0.8 | 1.3 | 1.3 |

| Station | Black oreo | Smooth oreo | Orange roughy |
|---|---|---|---|
| 173 | 0.0 | 2.9 | 0.0 |
| 174 | 17.0 | 5.2 | 1.6 |
| 175 | 0.0 | 2.3 | 4.7 |
| 176 | 0.0 | 6.9 | 5.1 |
| 177 | 0.0 | 1.8 | 1.0 |
| 178 | 1.7 | 0.9 | 3.4 |
| 179 | 2.3 | 1.1 | 10.1 |
| 180 | 47.1 | 4.7 | 1.0 |
| 181 | 94.8 | 11.6 | 0.5 |
| 182 | 0.0 | 1.8 | 0.0 |
| 183 | 77.7 | 2 171.0 | 12.6 |
| 184 | 138.5 | 932.0 | 0.0 |
| 185 | 1 857.0 | 508.3 | 1.3 |
| 186 | 20.8 | 2.8 | 8.6 |
| 187 | 0.0 | 1 996.7 | 1.6 |
| 188 | 0.0 | 4.7 | 0.0 |
| 189 | 187.6 | 920.0 | 3.7 |
| 190 | 10.3 | 3.4 | 0.0 |
| 191 | 215.6 | 24.3 | 0.0 |
| 192 | 3.6 | 0.0 | 0.0 |
| 193 | 48.5 | 783.0 | 0.0 |
| 194 | 4.3 | 25.6 | 0.0 |
| 195 | 28.1 | 23.5 | 1.5 |
| 196 | 4.7 | 0.8 | 0.0 |
| 197 | 61.7 | 5.0 | 0.0 |
| 198 | 30.4 | 150.8 | 0.5 |
| 199 | 8.0 | 9.9 | 0.0 |
| 200 | 11.0 | 24.0 | 0.0 |
| 201 | 6.1 | 4.0 | 0.0 |
| 202 | 344.7 | 19.8 | 0.0 |
| 203 | 145.9 | 52.0 | 0.0 |
| 204 | 21.1 | 7.8 | 0.0 |
| 205 | 2.4 | 13.5 | 0.0 |
| 206 | 25.2 | 12.4 | 0.0 |
| 207 | 7.4 | 1.1 | 0.0 |

**Appendix 6: Species caught.**

| Species code | Scientific name | Common name |
|---|---|---|
| **Crustacea** | | |
| APE | *Acanthephyra pelagica* | |
| LHO | *Lipkius holthuisi* | omega prawn |
| NEB | *Neolithodes brodiei* | southern stone crab |
| **Cephalopods** | | |
| SQB | *Brachioteuthis* sp. | scaly squid |
| CHQ | Chranchiidae | cranchiid squid |
| VSQ | *Histioteuthis* spp. | violet squid |
| MIQ | *Moroteuthis ingens* | warty squid |
| MRQ | *M. robsoni* | warty squid |
| WSQ | *Moroteuthis* spp. | warty squid |
| DWO | *Octopus* sp. | deepwater octopus |
| RSQ | *Ommastrephes bartrami* | red squid |
| **Chondrichthyes** | | |
| Squalidae | | |
| CSQ | *Centrophorus squamosus* | |
| CYP | *Centroscymnus crepidater* | |
| CYO | *C. owstoni* | smooth skinned dogfish |
| SND | *Deania calcea* | shovelnosed spiny dogfish |
| ETB | *Etmopterus baxteri* | Baxter's lantern dogfish |
| ETL | *E. lucifer* | Lucifer dogfish |
| PLS | *Scymnodon plunketi* | Plunket's shark |
| BSH | *Scymnorhinus licha* | seal shark |
| ZAS | *Zameus squamulosus* | |
| Scyliorhinidae | | |
| APR | *Apristurus* spp. | catshark |
| Rajidae | | |
| PSK | *Bathyraja shuntovi* | longnosed deepsea skate |
| BTH | *Pavoraja* spp. | bluntnosed skate |
| DSK | *Raja (Amblyraja)* sp. | deepwater spiny skate |
| Rhinochimaeridae | | |
| LCH | *Harriotta raleighana* | longnosed chimaera |
| RCH | *Rhinochimaera pacifica* | widenosed chimera |
| Chimaeridae | | |
| CHG | *Chimaera* sp.B | giant chimaera |
| CHP | *Chimaera* sp.C | purple chimaera |
| HYB | *Hydrolagus* sp.A | black hydrolagus |
| GSP | *Hydrolagus* sp.B | pale hydrolagus |
| HYP | *Hydrolagus* sp.C | longnosed blue hydrolagus |
| **Teleosts** | | |
| Notocanthidae | | |
| SBK | *Notacanthus sexspinis* | spineback eel |
| Nemichthyidae | | |
| AVO | *Avocettina* spp. | black snipe eel |
| NEM | *Nemichthys scolopaceus* | slender snipe eel |

| | | |
|---|---|---|
| Synaphobranchidae | | |
| BEE | *Diastobranchus capensis* | basketwork eel |
| SNE | *Simenchelys parasiticus* | snubnosed eel |
| Bathylagidae | | |
| DSS | *Bathylagus* sp. | deepsea smelt |
| Alepocephalidae | | |
| SSM | *Alepocephalus australis* | smallscaled brown slickhead |
| SBI | *Alepocephalus* sp. | bigscaled brown slickhead |
| TAL | *Talismania longifilis* | threadfin slickhead |
| BSL | *Xenodermichthys copei* | black slickhead |
| Photichthyidae | | |
| PHO | *Photichthys argenteus* | lighthouse fish |
| Chauliodontidae | | |
| CHA | *Chauliodus sloani* | viperfish |
| Astronesthidae | | |
| AST | *Astronesthes* spp. | snaggletooths |
| | *Borostomias antarcticus* | snaggletooth |
| NMI | *Neonesthes microcephalus* | snaggletooth |
| Melanostomiidae | | |
| OMI | *Opostomias micripnus* | scaleless black dragonfish |
| Notosudidae | | |
| SPL | *Scopelosaurus* spp. | waryfishes |
| Paralepididae | | |
| PAL | Paralepididae | barracudinas |
| Evermannellidae | | |
| SAB | *Evermannella indica* | sabretooth |
| Alepisauridae | | |
| ABR | *Alepisaurus brevirostris* | shortsnouted lancetfish |
| Myctophidae | | |
| LAN | Myctophidae (family) | lanternfish |
| Moridae | | |
| VCO | *Antimora rostrata* | violet cod |
| HJO | *Halargyreus johnsonii* | Johnson's cod |
| SMC | *Lepidion microcephalus* | smallheaded cod |
| LEG | *L. schmidti* | giant lepidion |
| RIB | *Mora moro* | ribaldo |
| Merlucciidae | | |
| LYC | *Lyconus* sp. | blackmouth hake |
| HOK | *Macruronus novaezelandiae* | hoki |
| HAK | *Merluccius australis* | hake |
| Macrouridae | | |
| CKX | *Caelorinchus acanthiger* | spottyfaced rattail |
| CBO | *C. bollonsi* | Bollons's rattail |
| CFA | *C. fasciatus* | banded rattail |
| CIN | *C. innotabilis* | notable rattail |
| CKA | *C. kaiyomaru* | Kaiyomaru rattail |

| | | |
|---|---|---|
| CMA | *C. matamua* | Mahia rattail |
| COL | *C. oliverianus* | Oliver's rattail |
| CMX | *Coryphaenoides mcmillani* | |
| CMU | *C. murrayi* | abyssal rattail |
| CSE | *C. serrulatus* | serrulate rattail |
| CTR | *C. striatura* | |
| CSU | *C. subserrulatus* | fourrayed rattail |
| CBA | *Coryphaenoides* sp. B | longbarbel rattail |
| NPU | *Kuronezumia leonis* | false bulbous rattail |
| JAV | *Lepidorhynchus denticulatus* | javelinfish |
| MCA | *Macrourus carinatus* | ridgescaled rattail |
| BJA | *Mesobius antipodum* | black javelinfish |
| NNA | *Nezumia namatahi* | squashfaced rattail |
| OMU | *Odontomacrurus murrayi* | largefanged rattail |
| TRX | *Trachonurus* sp. A | |
| WHR | *Trachyrincus longirostris* | white rattail |
| WHX | *Trachyrincus* sp. | unicorn rattail |
| VNI | *Ventrifossa nigromaculata* | blackspotted rattail |
| Ophidiidae | | |
| BCR | *Brotulotaenia crassa* | blue cusk eel |
| LIN | *Genypterus blacodes* | ling |
| Carapidae | | |
| ECR | *Echiodon cryomargarites* | messmate fish |
| Ceratiidae | | |
| SDE | *Cryptosaras couesi* | seadevil |
| Linophrynidae | | |
| BAF | *Haplophryne mollis* | angler fish |
| Himantolophidae | | |
| HIA | *Himantolophus appelii* | prickly anglerfish |
| Trachipteridae | | |
| DEA | *Trachipterus trachypterus* | dealfish |
| Trachichthyidae | | |
| ORH | *Hoplostethus atlanticus* | orange roughy |
| Diretmidae | | |
| SFN | *Diretmoides parini* | spinyfin |
| DIS | *Diretmus argenteus* | discfish |
| Anoplogastridae | | |
| ANO | *Anoplogaster cornuta* | fangtooth roughy |
| Berycidae | | |
| BYD | *Beryx decadactylus* | longfinned beryx |
| BYS | *B. splendens* | alfonsino |
| Zeidae | | |
| LDO | *Cyttus traversi* | lookdown dory |
| Oreosomatidae | | |
| BOE | *Allocyttus niger* | black oreo |
| WOE | *A. verrucosus* | warty oreo |
| SOR | *Neocyttus rhomboidalis* | spiky oreo |
| SSO | *Pseudocyttus maculatus* | smooth oreo |

| | | |
|---|---|---|
| Macrorhamphosidae | | |
| BBE | *Centriscops humerosus* | redbanded bellowsfish |
| BLB | *C. obliquus* | blue bellowsfish |
| Scorpaenidae | | |
| TRS | *Trachyscorpia capensis* | cape scorpionfish |
| Psychrolutidae | | |
| COT | *Cottunculus nudus* | bonyskull toadfish |
| PSY | *Psychrolutes* sp. | blobfish |
| Bramidae | | |
| RBM | *Brama brama* | Ray's bream |
| Apogonidae | | |
| EPL | *Epigonus lenimen* | bigeyed cardinalfish |
| EPR | *E. robustus* | robust cardinalfish |
| EPT | *E. telescopus* | black cardinalfish |
| ROS | *Rosenblattia robusta* | |
| Serranidae | | |
| SPE | *Helicolenus* sp. | sea perch |
| Chiasmodontidae | | |
| CNI | *Chiasmodon niger* | black swallower |
| KAI | *Kali indica* | |
| Uranoscopidae | | |
| STA | *Kathetostoma giganteum* | giant stargazer |
| Centrolophidae | | |
| RUD | *Centrolophus niger* | rudderfish |
| WWA | *Seriolella caerulea* | white warehou |
| TUB | *Tubbia tasmanica* | |
| Nomeidae | | |
| CBX | *Cubiceps baxteri* | cubehead |
| Trichiuridae | | |
| BEN | *Benthodesmus* sp. ? | scabbard fish |
| Tetragonuridae | | |
| TET | *Tetragonurus cuvieri* | squaretail |
| Bothidae | | |
| MAN | *Neoachiropsetta milfordi* | finless flounder |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