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Te Tautiaki I nga tini a Tangaroa

**A summary of observer biological information on the
New Zealand black oreo and smooth oreo fisheries
from 1979-80 to 2002-03**

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EXECUTIVE SUMMARY

Hart, A.C.; McMillan, P.J.; Doonan, I.J. (2005). A summary of observer biological information on the New Zealand black oreo and smooth oreo fisheries from 1979–80 to 2002–03.

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Black oreo and smooth oreo biological data (total length/sex/gonad stage) collected mainly by observers from the Ministry of Fisheries Observer Programme (OP) plus samples from the Orange Roughy Management Company (ORMC) from 1979–80 to 2002–03 from the main oreo fisheries in OEO 3A and OEO 4 were summarised. For both species, annual length data by sex were tabulated to provide number of tows sampled and number of fish measured (usually about 100 fish per sample). Mean length by year by sex scaled by catch weight was calculated, tabulated, and plotted to determine trends. Annual length frequency distributions scaled by catch weight were plotted by management area for each species.

OP and ORMC observer biological samples from the smaller black oreo and smooth oreo fisheries on the northwest Chatham Rise (OEO 3A), northeast Chatham Rise (OEO 4), Southland, Pukaki Rise (west), Pukaki Rise (east), Bounty Plateau, Auckland Islands, and Puysegur were also summarised. For both species, annual total length data by sex were tabulated to provide number of tows sampled and number of fish measured. Mean length by year by sex scaled by catch weight was calculated and tabulated. Most of the recent ORMC data were from these smaller fisheries, so the data were reported separately as well as being combined with the OP data.

Gonad stage data for the Chatham Rise (OEO 3A and OEO 4 south of 44° S) were summarised by month for all years (1990–91 to 2002–03) combined.

The main results were as follows.

Sampling of black oreo and smooth oreo in OEO 3A and OEO 4 was highly variable between 1979–80 and 1998–99 with 0–43 tows sampled per year in OEO 3A and 0–98 tows sampled per year in OEO 4. Sampling of black oreo and smooth oreo in OEO 3A increased in 1999–2000 and 2000–01 with 82–136 tows sampled per year, but declined markedly in 2001–02 to 22–42 tows and again in 2002–03 to 25–28 tows. In OEO 4 there was a trend of increased sampling from 1999–2000 to 2002–03 for black oreo (7–47 tows per year) and smooth oreo (32–134 tows per year).

OEO 3A black oreo mean lengths for males and females appear to show a spatial effect (small fish are in shallower water and larger fish in deeper water). The annual total (sexes combined) mean was 32 cm or less (usually 29–30) in 11 years and over 32 cm in 7 years. From 1998–99 on total means were all about 31–32 cm and were lower than the means of 33–35 cm observed in the early years of the time series. OEO 3A smooth oreo mean length for males declined over time, although there was a slight increase in the last four years. Female scaled mean annual length showed a steady decline over time.

OEO 4 black oreo mean length varied over time, perhaps due to the progressive discovery of new fishing areas along the south Chatham Rise. Smooth oreo mean length appeared to decline over time by about 1 cm for males and about 2 cm females, but there are likely to be sampling depth and area effects.

Sampling of black oreo and smooth oreo in the smaller fisheries started in the early 1990s, but sampling was erratic for any one fishery. Most of the data collected by the OP was in the last 7 years (1996–97 to 2002–03) and most of the ORMC sampling was in the four years from 1998–99 to 2001–02.

Female gonad stage data for black oreo from OEO 3A and OEO 4 from 1990-91 to 2002-03 combined averaged about 770 fish sampled per month. Most fish sampled (1147-1946 per month) were taken by OP observers from September to December. There was little evidence of a spawning period, with only 1.3-2.6% running ripe in October to December: 488 fish were sampled for gonad stage in 2002-03.

Female gonad stage data for smooth oreo from OEO 3A and OEO 4 from 1990-91 to 2002-03 combined averaged about 1880 fish sampled per month. Most samples taken by OP observers were from April to June (1205-3436) and September to December (2149-4365). There was little evidence of a spawning period, with only 2.1-3.2% running ripe in October to December. 969 fish were sampled for gonad stage in 2002-03.

1. INTRODUCTION

This report presents analyses for the following objectives for the Ministry of Fisheries funded research project "Oreo stock assessment" (OEO2003/02).

Overall objective

1. To carry out a stock assessment of black oreo (*Allocyttus niger*) and smooth oreo (*Pseudocyttus maculatus*), including estimating biomass and sustainable yields.

Specific objective

2. To analyse length frequency, sex ratio, and reproductive condition data for black oreo and smooth oreo collected by the Observer Programme and other sources during the 2002/03 fishing year for input into stock assessment models.

The work analysed the biological data collected on commercial fishing vessels by observers funded either by the Ministry of Fisheries (OP) or by the fishing industry (ORMC). Data from the 2002–03 fishing year were analysed in addition to summaries from 1979–80 to 2001–02 which are included to document past work and enable comparison between years. This work provided a summary of the quantity and quality of biological data collected and available for use in stock assessment analyses. Trends in mean length by sex by species for each of the main oreo fisheries were examined. The work focused on the Chatham Rise, management areas OEO 3A and OEO 4 (Figure 1), the site of the main oreo fisheries. Small oreo fisheries and developing fisheries were also analysed where increased observer coverage in recent years has provided some data. The main fisheries away from the Chatham Rise included Southland (OEO 1), Puysegur/Snares (OEO 1), Pukaki Rise east (OEO 6), Bounty Plateau (OEO 6), and Auckland Islands (OEO 6) (Figure 1).

Length data were used in a stock assessment analysis of OEO 3A black oreo by Hicks et al. (2002) who noted strong area and depth effects for observer data and modelled the stock using three sub-areas. It seems highly likely that depth and area effects are also present for observer-collected black oreo data from other areas, and also for smooth oreo, so analysis of the length data for stock assessment needs to be handled carefully.

2. METHODS

Data sources

Total length and sex and gonad stage were extracted from the MFish Obs_Ifs database for black oreo and smooth oreo, along with associated catch and position data from the 1979–80 to 2002–03 fishing years for the whole of the New Zealand EEZ. Data were extracted for tows where the target species was smooth oreo, black oreo, unspecified oreo, or orange roughy only. Oreo samples from tows where the target was hoki were excluded as they did not represent the fish at depths exploited in the target oreo or orange roughy fisheries.

Analyses

Hicks et al. (2002) determined that five or more length samples per year were acceptable for their stock assessment analysis. Five or more samples per year were therefore judged to be an adequate level of sampling. Subsets of data were selected for each of the fisheries or areas listed below using latitude and longitude coordinates. Most of the analyses involved tabulation of data, but mean lengths by area were calculated using length distribution data scaled to represent the catch. The length

distribution from each sampled tow was scaled according to the proportion of the catch from that tow divided by the sum of the catches from all the sampled tows.

The following analyses were performed.

OEO 3A south of 44° S, black oreo and smooth oreo

Mean lengths, weighted by catch, for males, females, and all fish by fishing year were estimated and tabulated. Numbers of tows sampled, and numbers of fish measured for all fish by fishing year were tabulated. All fish included unsexed fish. Plots of mean length scaled to catch for males and females by fishing year were made along with plots of length distributions for all fish (sexes combined) by fishing year. There were no ORMC data for either species used in these analyses.

OEO 4 south of 44° S, black oreo and smooth oreo

Mean lengths weighted by catch, for males, females, and all fish by fishing year were estimated and tabulated. In addition, the same analyses are presented split into five major fishing areas plus the remaining area within OEO 4 (Figure 2) based on known spatial and temporal fishing patterns for oreos in OEO 4 (Coburn et al. 2001a, 2001b). The areas are:

- Area 1 178° E to 177° 08' W. Flat ground and dropoffs excluding seamounts (includes Bobbin Tow and Urk).
- Area 2 177° 08' W to 176° 16' W. Includes seamounts such as Hegerville and Paranoia.
- Area 3 176° 16' W to 175° W. Includes seamounts such as Condoms and Big Chief.
- Area 4 175° to 174° W. Includes the Andes seamount complex.
- Area 5 178° E to 178° 40' W. Older seamounts including Trev's, Fletchers Pinni, and Mt. Kiso.
- Area 6 The remainder of OEO 4 south of 44° S and west of 178° E.

The number of tows sampled and number of fish measured by fishing area and fishing year were tabulated. Plots of mean length scaled to catch by fishing year for males and females were made along with plots of length distributions for all fish by fishing year. There were seven length samples from ORMC observers for smooth oreo from 2000–01 and they were combined with the OP data in the analyses.

Samples from other areas of the Chatham Rise

The number of tows sampled and number of fish measured from areas excluding OEO 3A and OEO 4 south of 44° S were tabulated. These analyses were performed on areas larger than, but encompassing, the individual fisheries identified in previous descriptive analyses of oreo CPUE (McMillan et al. 2002) (see Figure 1 for locations of fishing areas). The analyses were performed separately for data sourced from OP and ORMC observers and also for the combined data.

Descriptive female gonad stage data

Gonad stage data from black oreo and smooth oreo females sampled from the south Chatham Rise (OEO 3A and OEO 4 south of 44° S) by OP observers were selected and tabulated by stage and month for all years combined. Data are not presented separately by fishing year due to the sparse collection of data.

3. RESULTS

OEO 3A south of 44° S, black oreo

There was a large increase in sample numbers in 1999–2000 and 2000–01, but previous years had an erratic sampling history and sampling declined again in 2001–02 and 2002–03 (Table 1). Mean length of black oreo appeared to decline from 1979–80 to 2002–03 by about 3 cm for males and about 4 cm for females (Table 2, Figures 3 and 4). The means (total, male, female) at the end of the data series are less than those at the start, but are variable among years. Doonan et al. (1999) examined black oreo observer length sampling and found a spatial pattern to the distribution of small and large fish and an erratic sampling history. Smaller fish (32 cm or less) were caught in shallower water than larger fish and in some years most of the samples came from shallow water and consequently scaled mean annual length was less in those years. This pattern is shown in our data (Table 2) where the annual total (sexes combined) mean was 32 cm or less (usually 29–30) in 11 years and over 32 cm in 7 years. Annual length frequency distributions scaled to catch weight are shown in Appendix 2.

OEO 3A south of 44° S, smooth oreo

Observer sampling for smooth oreo has similar variability to black oreo (Table 3). Mean length appeared to decline from 1979–80 to 2002–03 by about 2 cm for males and about 3 cm for females (Table 4, Figures 5 and 6). Many years had zero or low sample sizes, but there was a large increase in observer coverage from 1999–2000 and 2000–01 (Table 3) and this resulted in the very small 95% confidence interval for the mean estimates given in Figures 5 and 6. Annual length frequency distributions scaled to catch weight are shown in Appendix 3.

OEO 4 south of 44° S, black oreo

There was a very erratic sampling history with good numbers of samples from the early to mid 1990s but few samples since 1995–96, presumably because the fishery in those years was small. Sampling increased in the last fishing year 2002–03 (Tables 5 and 6). The total area mean length fluctuated for both sexes (Figures 7 and 8, Table 7) and there was no trend.

Strong spatial structure and the erratic nature of observer sampling were revealed when the data were analysed by fishing area (Tables 5 and 6). Area 1 was sparsely sampled with the first data taken in 1988–89 even though the area was fished by Soviet vessels from and before 1981 (McMillan 1985). Numerous samples were taken in areas 3 and 4 from 1990–91 to 1994–95 during development of fishing on seamounts in those areas, but few samples were taken from 1994–95 to 2000–01. Large fish would be expected from previously unfished or lightly fished seamounts. No area had three or more consecutive years when 1000 or more fish were measured (Table 6). The jump in mean length in the 2000–01 fishing year was driven by one area with a small sample size (228 fish). The increase in mean length in the 2001–02 and 2002–03 fishing years was driven by samples from the seamount complexes (areas 3 and 4). Annual length frequency distributions scaled to catch weight are shown in Appendix 4.

OEO 4 south of 44° S, smooth oreo

There were few samples taken in the early years of the observer programme (1986 on) but numbers of samples increased from 1990–91 (Tables 8 and 9). The total area mean length appeared to decline from 1986–87 to 2002–2003 by about 2 cm for males and females (Table 10, Figures 9 and 10). But analyses by fishing area showed that the sampling had a spatial structure, e.g., there were numerous samples from areas 3 and 4 from 1990–91 to 1994–95, then few samples in the five subsequent years (See Tables 8 and 9). Sample sizes were generally much larger than those made in the same area and time for black oreo although sampling was erratic, e.g., there were no data for 1987–88 or years before 1986–87, and there were few samples anywhere in 1989–90 (See Table 8). Sample sizes increased in the last three fishing years, reaching a maximum of 134 tows in 2002–03, but many of

these tows had few fish measured. There were seven ORMC observed tows (2000–01) available for these analyses. Annual length frequency distributions scaled to catch weight are shown in Appendix 5

Other areas

Black oreo

Few samples were collected and only modest numbers of fish were measured in most of the other areas. Sampling increased in some areas in the last 2–7 years (Tables 11 and 12). The areas where numbers of samples were acceptable included Southland, Pukaki (east), Auckland Island, and Puysegur/Snares. Mean lengths by area are shown in Table 13.

Smooth oreo

Generally more smooth oreo tows were sampled and fish measured than for black oreo, with the best areas being the north Chatham Rise in OEO 4, Southland, Pukaki (east), Bounty Plateau, Auckland Island, Puysegur/Snares (Tables 14 and 15). Sampling increased in some areas in the last 2–7 years (Tables 14 and 15). Mean lengths by area are shown in Table 16.

Descriptive female gonad stage data

Black oreo

There are few data on gonad stages, which is not surprising as observers were not specifically asked to collect gonad stage data. Samples were mostly stage 1 or 2 (Appendix 2), i.e., immature or maturing fish (Table 17). There was little evidence for a spawning season, although research sampling indicated that black oreo spawn in October to December (Annala et al. 2002).

Smooth oreo

There were more samples collected than for black oreo and most were stage 1 or 2 (Table 18). There was little evidence of a spawning season, although research sampling indicated that smooth oreo spawn in October to December (Annala et al. 2002).

4. SUMMARY

This analysis used Ministry of Fisheries observer-collected biological data from 1979–80 (mostly 1985–86 on) to 2002–03 and Orange Roughy Management Company data collected from 1998–99 to 2001–02. Analyses summarised the amount and quality of data available. Analyses of mean length by sex scaled by catch weight were made for the south Chatham Rise and for the smaller oreo fisheries. Pooled female gonad stage data for the south Chatham Rise from 1990–91 to 2002–03 were summarised by month.

Mean length, OEO 3A

Annual data from the whole area were analysed. Previous analysis for black oreo suggested that the area and depth where samples were taken (spatial structure) influenced the annual mean length (Hicks et al. 2002), so conclusions about mean length trends for the whole area should be treated with caution.

Black oreo

From 1979–80 to 2002–03 mean length decreased by about 3 cm for both males and females. There were 18 years in the data series, but only 12 years had samples of 1000 fish or more. There was a big increase in the number of fish measured in 1999–2000 and 2000–01 (OP data), but a decrease in samples from 2001–02 and 2002–03.

Smooth oreo

From 1979–80 to 2002–03 mean length decreased by about 2 cm for males and by about 3 cm for females. There were 17 years in the data series, but only 10 years had samples of 1000 fish or more. There was a big increase in the number of fish measured in 1999–2000 and 2000–01 (OP data), but a decrease in samples from 2001–02 and 2002–03.

Mean length, OEO 4

Annual data from the whole area combined were analysed and sample sizes were presented for six areas within OEO 4 that were considered to constitute discrete fisheries, i.e., areas of flat ground or groups of seamounts that were fished over successive years.

Black oreo

From 1990–91 to 2002–03 no mean length trends were apparent for males or females for the whole area, or by fishing area. There were only 14 years in the data series although the fishery has operated since the late 1970s. There were only six years when more than 1000 fish were measured (1990–91 to 1994–95, and 2001–02 to 2002–03) (OP data).

Smooth oreo

From 1986–87 to 2002–03 mean length for the whole area decreased by about 2 cm for both males and females. Several fishing areas were infrequently sampled. There were only 16 years in the data series with 14 years when more than 1000 fish were measured (mostly OP data with 7 samples from ORMC).

Length data – other areas

Black oreo. There were few OP or ORMC observer samples taken in most areas although the following had at least 1000 fish measured per year: Southland 1998–99 to 1999–2000 and 2001–2002; Pukaki (east) 1997–98 to 2002–03; Auckland Island 1998–99; Puysegur/Snares 1993–94, 1996–97 to 2000–01. ORMC data exceeded 1000 length samples in Southland in 1998–99, Pukaki (east) in 1998–99, 2000–01, and 2001–02, and Puysegur/Snares in 1998–99 and 2000–01.

Smooth oreo. There were few OP or ORMC observer samples taken in most areas although the following had at least 1000 fish measured per year: Southland 1998–99 to 2001–02; Pukaki (west) in 2000–01 to 2001–02; Pukaki (east) 1997–98 to 2002–03; Bounty 1998–99 and 2000–01 to 2002–03; Auckland Island 1997–98 to 2002–03; Puysegur 1997–98 to 2001–02. ORMC data exceeded 1000 length samples in Southland in 1998–99 and 2000–01 and 2001–02; Pukaki (west) in 2000–01 and 2001–02; Pukaki (east) in 1998–99 and 2000–01 to 2001–02; Bounty in 1998–99, 2000–01 and 2002–03; Auckland Island from 1997–98 to 2002–03; and Puysegur/Snares from 1997–98 to 2001–02.

Female gonad stage data

All data from the Chatham Rise were pooled by month. Small proportions of running ripe fish were recorded for black oreo (1.3–2.6%) and for smooth oreo (2.1–3.2%) from October to December when research survey data suggested spawning was taking place.

5. ACKNOWLEDGMENTS

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Table 1: OEO 3A black oreo. Numbers of fish measured from all OP length/sex samples, and numbers of tows (n) where length/sex samples were taken from all vessels, total includes unsexed fish.

Fishing year	Total	Male	Female	n
1979-80	3 179	415	448	30
1980-81	0	0	0	0
1981-82	0	0	0	0
1982-83	0	0	0	0
1983-84	0	0	0	0
1984-85	0	0	0	0
1985-86	103	45	58	1
1986-87	978	308	543	8
1987-88	1 284	584	698	9
1988-89	5 284	2 656	2 542	43
1989-90	2 288	919	1 037	19
1990-91	1 541	594	947	15
1991-92	1 155	490	665	11
1992-93	0	0	0	0
1993-94	2 485	1 188	1 283	26
1994-95	805	364	441	7
1995-96	866	423	441	8
1996-97	504	237	267	4
1997-98	1 863	928	922	20
1998-99	825	378	447	6
1999-00	12 309	6 005	6 272	115
2000-01	13 751	6 639	7 093	136
2001-02	4 033	2 142	1 826	42
2002-03	2 720	1 385	1 306	28

Table 2: OEO 3A black oreo. Mean length (cm) for males, females, and both sexes combined (Total) from all OP samples from 1979-80 to 2002-03 from all vessels, scaled to catch. See Table 2 for numbers of tows and fish sampled. -, no data.

Fishing year	Total	Male	Female
1979-80	35.1	34.5	35.7
1980-81	-	-	-
1981-82	-	-	-
1982-83	-	-	-
1983-84	-	-	-
1984-85	-	-	-
1985-86	37.2	36.9	37.4
1986-87	33.7	33.6	33.9
1987-88	34.2	33.6	34.7
1988-89	30.0	29.6	30.4
1989-90	29.1	28.9	29.2
1990-91	33.9	32.6	34.6
1991-92	34.9	34.3	35.3
1992-93	-	-	-
1993-94	29.8	29.6	30.1
1994-95	34.8	33.9	35.5
1995-96	29.8	29.5	30.1
1996-97	32.0	31.8	32.2
1997-98	29.9	29.5	30.3
1998-99	31.2	31.0	31.4
1999-00	31.0	30.8	31.3
2000-01	31.4	31.1	31.7
2001-02	31.3	31.0	31.7
2002-03	31.5	31.3	31.8

Table 3: OEO 3A smooth oreo. Numbers of fish measured from OP observers and numbers of tows (n) where length/sex samples were taken from all vessels. Total includes unsexed fish.

Fishing year	Total	Male	Female	n
1979-80	2 345	417	217	24
1980-81	0	0	0	0
1981-82	0	0	0	0
1982-83	0	0	0	0
1983-84	0	0	0	0
1984-85	0	0	0	0
1985-86	106	49	55	1
1986-87	387	185	190	4
1987-88	1 300	621	675	10
1988-89	1 540	899	614	15
1989-90	0	0	0	0
1990-91	3 029	1 533	1 495	28
1991-92	919	388	531	9
1992-93	0	0	0	0
1993-94	1 454	728	726	24
1994-95	778	380	398	8
1995-96	207	91	116	2
1996-97	365	173	192	3
1997-98	1 720	787	933	13
1998-99	770	414	356	5
1999-00	7 700	4 235	3 457	82
2000-01	9 450	4 706	4 727	97
2001-02	3 068	1 595	1 467	22
2002-03	1 667	784	880	25

Table 4: OEO 3A smooth oreo. Mean length (cm) for males, females, and both sexes combined (Total) from all OP samples from 1979-80 to 2002-03 from all vessels, scaled to catch. See Table 4 for numbers of tows and fish sampled. -, no data.

Fishing year	Total	Male	Female
1979-80	39.2	38.2	41.2
1980-81	-	-	-
1981-82	-	-	-
1982-83	-	-	-
1983-84	-	-	-
1984-85	-	-	-
1985-86	39.3	37.5	40.9
1986-87	39.1	37.9	40.5
1987-88	38.6	37.3	39.9
1988-89	37.5	36.9	38.4
1989-90	-	-	-
1990-91	37.8	36.9	38.9
1991-92	37.9	36.1	39.2
1992-93	-	-	-
1993-94	34.2	33.5	34.9
1994-95	36.9	36.4	37.6
1995-96	39.0	35.7	40.8
1996-97	37.5	36.5	38.3
1997-98	37.5	36.1	38.6
1998-99	35.9	35.8	36.0
1999-00	35.7	34.6	36.7
2000-01	35.6	34.8	36.4
2001-02	36.2	35.3	37.0
2002-03	36.8	36.0	37.6

Table 5: OEO 4 black oreo. Numbers of tows where OP and ORMC observer length/sex samples were taken in OEO 4 from all vessels. See page 6 and Figure 2 for an explanation of the areas.

Fishing year	Area 1	Area 2	Area 3	Area 4	Area 5	Rest of OEO 4	Total
1988-89	5	0	0	0	1	2	7
1989-90	0	0	0	0	0	0	0
1990-91	2	0	21	0	0	2	23
1991-92	3	1	1	54	2	1	61
1992-93	0	0	16	9	0	1	25
1993-94	1	6	23	28	1	0	59
1994-95	1	4	3	30	0	2	39
1995-96	1	2	0	1	3	0	7
1996-97	0	0	1	1	0	1	2
1997-98	3	0	0	1	2	1	7
1998-99	2	0	0	0	0	1	3
1999-00	1	0	3	1	1	2	7
2000-01	6	0	6	0	1	3	15
2001-02	3	2	2	13	1	0	21
2002-03	2	0	11	29	0	5	47

Table 6: OEO 4 black oreo. Numbers of fish measured from OP and ORMC observers taken from all vessels. Total includes unsexed fish. See page 6 and Figure 2 for an explanation of the areas.

Fishing year	Area 1	Area 2	Area 3	Area 4	Area 5	Rest of OEO 4	Total
1988-89	764	0	0	0	35	171	899
1989-90	0	0	0	0	0	0	0
1990-91	171	0	2 454	0	0	131	2 625
1991-92	220	57	100	5 298	193	83	5 868
1992-93	0	0	1 775	944	0	101	2 719
1993-94	144	441	1 903	2 791	102	0	5 381
1994-95	182	349	288	3 463	0	216	4 399
1995-96	128	193	0	102	308	0	731
1996-97	0	0	85	92	0	104	177
1997-98	152	0	0	103	204	99	558
1998-99	259	0	0	0	0	267	526
1999-00	122	0	328	97	156	218	815
2000-01	162	0	228	0	20	233	628
2001-02	245	31	54	1 009	52	0	1 391
2002-03	40	0	699	628	0	106	1 473

Table 7: OEO 4 black oreo. Mean length (cm) for males, females and both sexes combined (Total) from observer samples from 1988-89 to 2002-03 from all vessels, scaled to catch. See Table 5 for numbers of tows, and Table 6 for numbers of fish sampled. -, no data.

Fishing year	Total	Male	Female
1988-89	32.9	31.3	33.8
1989-90	-	-	-
1990-91	35.6	34.6	36.3
1991-92	36.1	35.6	37.1
1992-93	37.2	36.8	37.8
1993-94	37.2	36.4	37.8
1994-95	34.0	33.0	34.8
1995-96	32.3	33.0	32.8
1996-97	37.3	37.3	37.1
1997-98	31.4	31.8	31.3
1998-99	32.7	32.4	33.0
1999-00	33.2	32.6	33.9
2000-01	35.7	34.6	37.0
2001-02	36.9	34.4	37.8
2002-03	36.2	35.4	36.9

Table 8: OEO 4 smooth oreo. Numbers of tows where observer length/sex samples were taken from all vessels. See page 6 and Figure 2 for an explanation of the areas.

Fishing year	Area 1	Area 2	Area 3	Area 4	Area 5	Rest of OEO 4	Total
OP							
1986-87	7	0	0	0	0	0	7
1987-88	0	0	0	0	0	0	0
1988-89	16	0	0	0	3	1	20
1989-90	3	0	0	0	1	0	4
1990-91	16	2	21	1	9	0	46
1991-92	11	5	4	50	8	1	78
1992-93	1	5	11	9	1	0	26
1993-94	1	23	32	42	0	0	98
1994-95	13	17	11	29	0	0	70
1995-96	14	10	0	2	6	0	32
1996-97	14	19	3	2	4	0	42
1997-98	10	14	7	2	6	2	40
1998-99	8	38	7	0	4	1	57
1999-00	9	2	5	4	1	18	32
2000-01	18	11	21	20	10	15	83
2001-02	5	9	4	28	1	9	56
2002-03	7	6	16	52	5	48	134
ORMC							
2000-01	2	0	2	3	0	0	7
2001-02	0	0	0	0	0	0	0
2002-03	0	0	0	0	0	0	0

Table 9: OEO 4 smooth oreo. Numbers of fish measured taken from all vessels. Total includes unsexed fish. See page 6 and Figure 2 for an explanation of the areas.

Fishing year	Area 1	Area 2	Area 3	Area 4	Area 5	Rest of OEO 4	Total
OP							
1986-87	992	0	0	0	0	0	992
1987-88	0	0	0	0	0	0	0
1988-89	2 517	0	0	0	342	105	3 382
1989-90	321	0	0	0	130	0	555
1990-91	2 887	210	2 649	102	1 326	0	7 428
1991-92	1 032	495	433	4 560	735	102	7 605
1992-93	111	545	1 039	1 053	111	0	3 189
1993-94	36	2 598	3 054	4 228	0	0	11 069
1994-95	1 881	1 724	1 185	3 299	0	0	9 098
1995-96	1 876	1 278	0	297	576	0	4 394
1996-97	1 677	2 437	287	211	425	0	5 712
1997-98	1 330	1 448	711	187	582	195	5 209
1998-99	1 267	5 733	691	0	544	624	9 022
1999-00	971	351	578	389	146	1590	4 025
2000-01	1 677	973	2 043	1 564	748	833	8 092
2001-02	567	1 295	289	1 845	150	525	4 671
2002-03	866	649	1 429	1 977	625	902	6 448
ORMC							
2000-01	200	0	200	254	0	0	654
2001-02	0	0	0	0	0	0	0
2002-03	0	0	0	0	0	0	0

Table 10: OEO 4 smooth oreo mean length (cm) for males, females and both sexes combined (Total) from observer samples scaled to catch from 1986-87 to 2002-03 from all vessels. See Table 8 for numbers of tows, and Table 9 for numbers of fish sampled. -, no data.

Fishing year	Total	Male	Female
OP			
1986-87	37.3	37.0	39.3
1987-88	-	-	-
1988-89	38.9	37.5	40.7
1989-90	37.1	36.3	38.1
1990-91	37.4	36.2	38.4
1991-92	36.8	35.6	37.9
1992-93	36.3	35.5	37.4
1993-94	36.3	35.5	37.2
1994-95	36.5	35.6	37.6
1995-96	36.4	35.7	37.3
1996-97	38.3	37.2	39.4
1997-98	36.0	35.4	36.9
1998-99	37.5	36.2	38.5
1999-00	35.1	34.5	35.7
2000-01	37.2	36.3	38.2
2001-02	36.1	35.4	36.9
2002-03	36.3	35.7	37.3
ORMC			
2000-01	37.0	36.4	37.5
2001-02	-	-	-
2002-03	-	-	-
OP+ORMC			
2000-01	37.2	36.3	38.2
2001-02	36.1	35.4	36.9
2002-03	36.3	35.7	37.3

Table 11: Areas excluding the south Chatham Rise (OEO 3A & OEO 4), black oreo. Numbers of tows where observer length/sex samples were taken from all vessels. OEO 3A.ncr, OEO 3A north Chatham Rise; OEO 4.ncr, OEO 4 north Chatham Rise; Southland, Otago/Southland; Pukaki.w, Pukaki (west); Pukaki.e, Pukaki (east); Bounty, Bounty Plateau; Aucklands, Auckland Islands; Puysegur, Puysegur/Snares. See Figure 1.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1988-89	0	2	1	0	0	0	0	0
1989-90	0	0	0	0	0	0	0	0
1990-91	0	2	0	0	0	0	0	0
1991-92	0	1	0	0	0	0	0	1
1992-93	0	1	0	0	0	0	0	9
1993-94	0	0	1	0	0	0	0	22
1994-95	0	1	1	0	0	0	0	4
1995-96	0	0	2	0	0	0	0	2
1996-97	0	1	2	1	7	0	2	30
1997-98	0	1	8	0	26	0	0	10
1998-99	0	0	0	0	8	0	10	3
1999-00	1	1	19	2	10	0	3	15
2000-01	1	1	0	0	14	1	0	0
2001-02	0	1	26	1	4	0	3	4
2002-03	0	7	1	1	13	1	3	5
ORMC								
1998-99	0	0	12	0	61	0	9	31
1999-00	0	0	0	0	1	0	0	2
2000-01	0	0	6	0	21	0	1	15
2001-02	0	0	7	0	10	0	5	2
2002-03	0	0	0	0	2	0	0	0

Table 12: Areas excluding the south Chatham Rise, black oreo. Numbers of fish measured by observers, taken from all vessels. See Table 11 for an explanation of the areas.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1988-89	0	182	100	0	0	0	0	0
1989-90	0	0	0	0	0	0	0	0
1990-91	0	131	0	0	0	0	0	0
1991-92	0	83	0	0	0	0	0	118
1992-93	0	101	0	0	0	0	0	932
1993-94	0	0	45	0	0	0	0	2 399
1994-95	0	99	11	0	0	0	0	335
1995-96	0	0	258	0	0	0	0	228
1996-97	0	104	211	104	784	0	218	3 223
1997-98	0	50	878	0	2 447	0	0	1 149
1998-99	0	0	0	0	635	0	187	484
1999-00	46	106	1 743	83	945	0	299	1 693
2000-01	20	15	0	0	932	1	0	0
2001-02	0	10	2 782	5	290	0	332	451
2002-03	0	123	25	25	1 121	25	57	447
ORMC								
1998-99	0	0	1 265	0	5 876	0	896	2 696
1999-00	0	0	0	0	98	0	0	200
2000-01	0	0	599	0	2 106	0	71	1 500
2001-02	0	0	703	0	1 009	0	355	100
2002-03	0	0	0	0	290	0	0	0

Table 13: Areas excluding the south Chatham Rise, black oreo. Mean length (cm TL) from observer samples scaled to catch from 1988–89 to 2002–03 from all vessels by fishing year and fishing area. See Table 11 for an explanation of the areas. –, no data or insufficient data.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1988–89	–	–	–	–	–	–	–	–
1989–90	–	–	–	–	–	–	–	–
1990–91	–	–	–	–	–	–	–	–
1991–92	–	–	–	–	–	–	–	–
1992–93	–	–	–	–	–	–	–	35.4
1993–94	–	–	–	–	–	–	–	33.7
1994–95	–	–	–	–	–	–	–	–
1995–96	–	–	–	–	–	–	–	–
1996–97	–	–	–	–	34.9	–	–	34.4
1997–98	–	–	33.3	–	33.5	–	–	34.2
1998–99	–	–	–	–	33.3	–	35.1	–
1999–00	–	–	32.7	–	32.4	–	–	33.5
2000–01	–	–	–	–	32.7	–	–	–
2001–02	–	–	31.9	–	–	–	–	–
2002–03	–	36.6	–	–	32.1	–	–	31.7
ORMC								
1998–99	–	–	33.3	–	33.5	–	36.2	35.4
1999–00	–	–	–	–	21.8	–	–	22.2
2000–01	–	–	33.4	–	34.3	–	38.6	34.1
2001–02	–	–	34.7	–	34.8	–	38.2	36.6
2001–02	–	–	–	–	33.0	–	–	–
OP + ORMC								
1998–99	–	–	33.3	–	33.5	–	35.6	35.2
1999–00	–	–	32.7	–	32.3	–	32.9	32.9
2000–01	–	–	33.4	–	33.9	–	–	34.1
2001–02	–	–	32.4	–	34.6	–	36.7	33.8
2002–03	–	37.0	–	–	32.2	–	36.3	31.6

Table 14: Areas excluding the south Chatham Rise, smooth oreo. Numbers of tows where observer length/sex samples were taken from all vessels. See Table 11 for an explanation of the areas.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1986-87	0	0	1	0	0	0	0	0
1987-88	0	0	0	0	0	0	0	0
1988-89	0	9	2	0	0	0	0	0
1989-90	0	1	0	0	0	0	0	0
1990-91	0	5	0	0	0	0	0	0
1991-92	0	3	0	0	0	4	0	1
1992-93	0	3	0	0	0	0	0	8
1993-94	4	11	1	0	0	0	1	8
1994-95	0	11	3	0	0	3	6	2
1995-96	0	3	2	0	0	4	0	2
1996-97	0	7	4	0	1	0	5	6
1997-98	0	9	3	0	15	1	33	9
1998-99	3	5	0	0	9	0	19	9
1999-00	6	7	36	1	36	8	22	38
2000-01	12	12	4	0	14	13	1	8
2001-02	1	15	4	5	18	5	30	8
2002-03	0	48	8	1	11	12	20	5
ORMC								
1998-99	0	0	31	1	61	35	40	46
1999-00	0	0	1	0	5	0	0	2
2000-01	0	0	41	13	24	4	41	38
2001-02	0	0	43	17	25	4	22	7
2002-03	0	0	1	3	1	0	0	0

Table 15: Areas excluding the south Chatham Rise, smooth oreo. Numbers of fish measured by observers, from all vessels. See Table 11 for an explanation of the areas.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1986-87	0	0	119	0	0	0	0	0
1987-88	0	0	0	0	0	0	0	0
1988-89	0	418	189	0	0	0	0	0
1989-90	0	104	0	0	0	0	0	0
1990-91	0	432	0	0	0	0	0	0
1991-92	0	248	0	0	0	336	0	100
1992-93	0	330	0	0	0	0	0	869
1993-94	268	1 153	102	0	0	0	110	882
1994-95	0	1 009	139	0	0	318	603	17
1995-96	0	367	229	0	0	352	0	124
1996-97	0	675	438	0	40	0	506	509
1997-98	0	756	403	0	1 535	91	3 144	1 144
1998-99	294	680	0	0	523	0	1 155	1 188
1999-00	383	520	3 593	6	3 970	833	2 329	4 508
2000-01	739	561	178	0	825	864	17	153
2001-02	174	1 041	3 643	124	2 041	297	3 265	644
2002-03	0	891	720	25	1 085	1 055	1 883	558
ORMC								
1998-99	0	0	3 449	100	5 924	3 491	4 100	4 217
1999-00	0	0	99	0	490	0	0	200
2000-01	0	0	4 009	1 250	2 340	410	3 990	3 788
2001-02	0	0	4 168	1 703	2 361	398	2 213	632
2002-03	0	0	100	348	99	0	0	0

Table 16: Areas excluding the south Chatham Rise, smooth oreo. Mean length (cm TL) from observer samples scaled to catch from 1986-87 to 2002-03 from all vessels by fishing year and fishing area. See Table 11 for explanation of areas. -, no data or insufficient data.

	OEO3A.ncr	OEO4.ncr	Southland	Pukaki.w	Pukaki.e	Bounty	Aucklands	Puysegur
OP								
1986-87	-	-	-	-	-	-	-	-
1987-88	-	-	-	-	-	-	-	-
1988-89	-	38.6	-	-	-	-	-	-
1989-90	-	-	-	-	-	-	-	-
1990-91	-	40.2	-	-	-	-	-	-
1991-92	-	-	-	-	-	-	-	-
1992-93	-	-	-	-	-	-	-	40.5
1993-94	-	40.3	-	-	-	-	-	41.5
1994-95	-	35.7	-	-	-	-	42.2	-
1995-96	-	-	-	-	-	-	-	-
1996-97	-	46.3	-	-	-	-	40.4	44.7
1997-98	-	30.8	-	-	32.3	-	41.7	41.6
1998-99	-	36.5	-	-	34.1	-	39.0	42.9
1999-00	33.8	39.4	33.4	-	36.7	36.3	42.1	40.1
2000-01	32.3	32.2	-	-	34.6	37.3	-	42.9
2001-02	-	36.4	-	36.6	36.3	36.8	41.0	39.4
2002-03	-	37.7	42.6	-	33.5	36.8	39.0	39.3
ORMC								
1998-99	-	-	33.7	-	34.1	37.2	41.7	38.2
1999-00	-	-	-	-	27.0	-	-	36.4
2000-01	-	-	44.2	36.8	37.9	-	44.8	44.4
2001-02	-	-	-	-	-	-	43.6	27.6
2002-03	-	-	-	-	-	-	-	-
OP + ORMC								
1998-99	29.5	36.5	33.7	33.6	34.1	37.2	40.6	39.7
1999-00	33.8	39.4	33.2	32.3	36.6	36.3	42.1	40.0
2000-01	32.3	32.2	44.0	36.8	37.0	37.0	44.7	44.3
2001-02	34.3	36.4	38.5	37.1	36.5	36.5	41.9	30.9
2002-03	-	37.7	42.5	36.3	33.4	36.8	39.0	39.3

Table 17: OEO 3A and OEO 4 black oreo. Female gonad stages (%) by month from OP observer samples from 1990-91 to 2002-03, all years combined. n, number of fish sampled. See Appendix 2 for gonad codes.

Month	Gonad stage					n
	1	2	3	4	5	
Jan	56.3	39.2	4.1	0.3	0	678
Feb	40.8	46.1	11.8	1.3	0	76
Mar	37.1	49.1	8.1	0.3	5.5	385
Apr	51.7	40.7	7.4	0.2	0	609
May	50.0	49.3	0.2	0	0.4	456
Jun	72.4	25.0	2.6	0	0	700
Jul	46.8	53.2	0.0	0	0	235
Aug	53.4	46.0	0.5	0	0	189
Sep	69.1	27.3	3.5	0	0.1	1 474
Oct	44.8	44.4	9.5	1.3	0.1	1 946
Nov	43.3	28.9	25.7	1.8	0.2	1 147
Dec	56.1	32.7	6.1	2.6	2.5	1 333

Table 18: OEO 3A and OEO 4 smooth oreo. Female gonad stages (%) by month from OP observer samples from 1990–91 to 2002–03, all years combined. n, number of fish sampled.

Month	Gonad stage					n
	1	2	3	4	5	
Jan	40.1	56.0	3.9	0	0	900
Feb	27.5	71.4	1.1	0	0	1 886
Mar	56.8	38.4	1.3	0	3.4	614
Apr	50.7	44.0	5.3	0	0	1 356
May	60.4	36.6	3.0	0	0	3 436
Jun	49.7	40.4	9.5	0.3	0	1 205
Jul	13.5	85.4	1.1	0	0	89
Aug	10.8	82.7	2.8	0	3.7	942
Sep	63.6	30.1	6.2	0.1	0	3 290
Oct	56.7	25.6	15.0	2.2	0.5	4 365
Nov	49.8	27.2	20.9	2.1	0	2 311
Dec	63.9	26.0	5.6	3.2	1.3	2 149

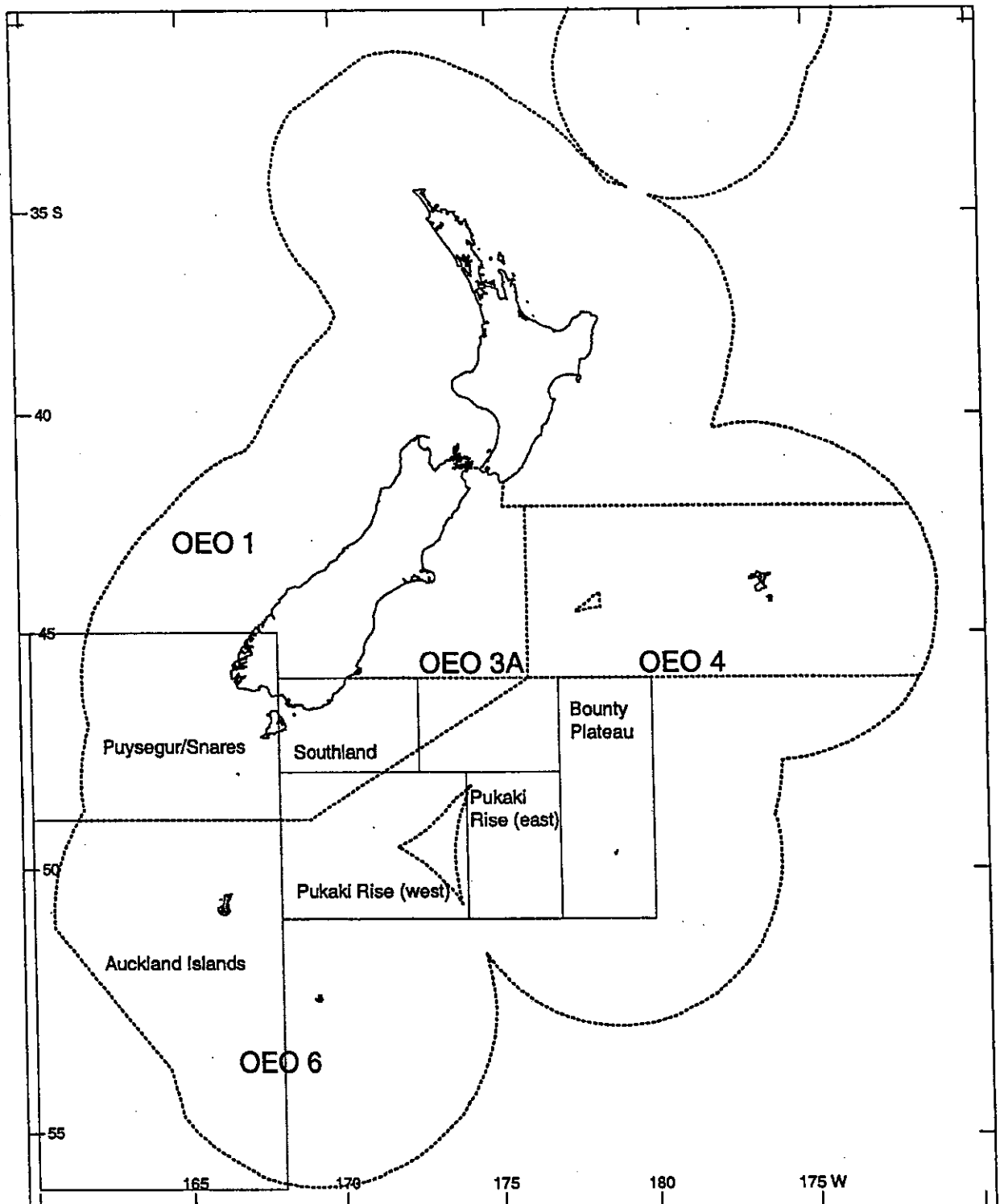


Figure 1: Oreo management areas OEO 1, OEO 3A, OEO 4, OEO 6 (dotted lines) and the fishing areas (rectangles, solid lines) where length and associated data were extracted for each analysis.

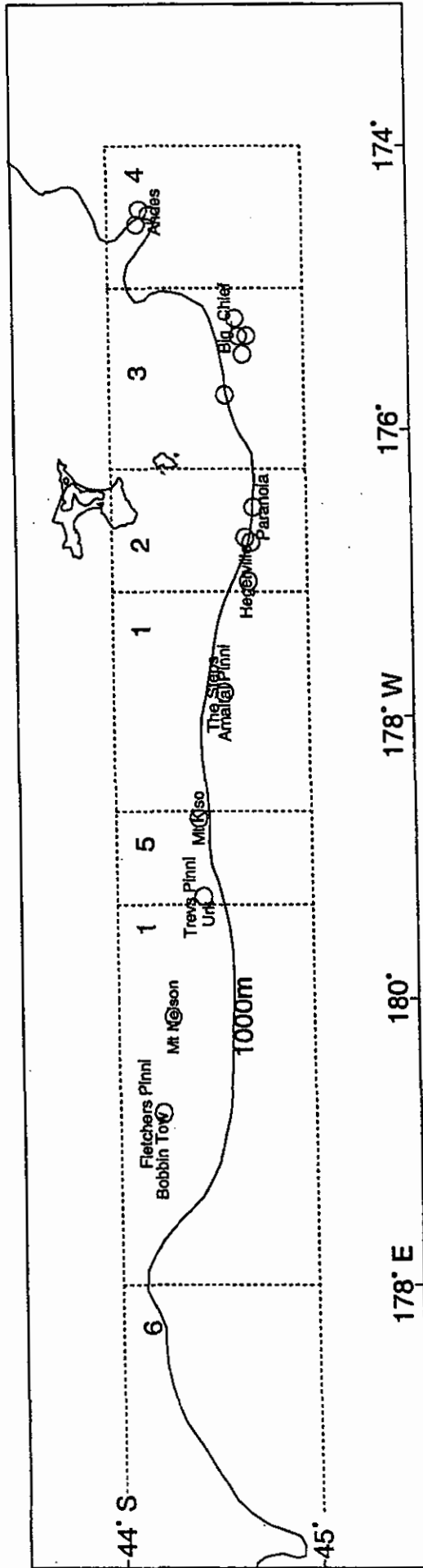


Figure 2: Sample areas defined for OEO 4 (1-6), with the major seamounts denoted by open circle, and some other main fishing areas.

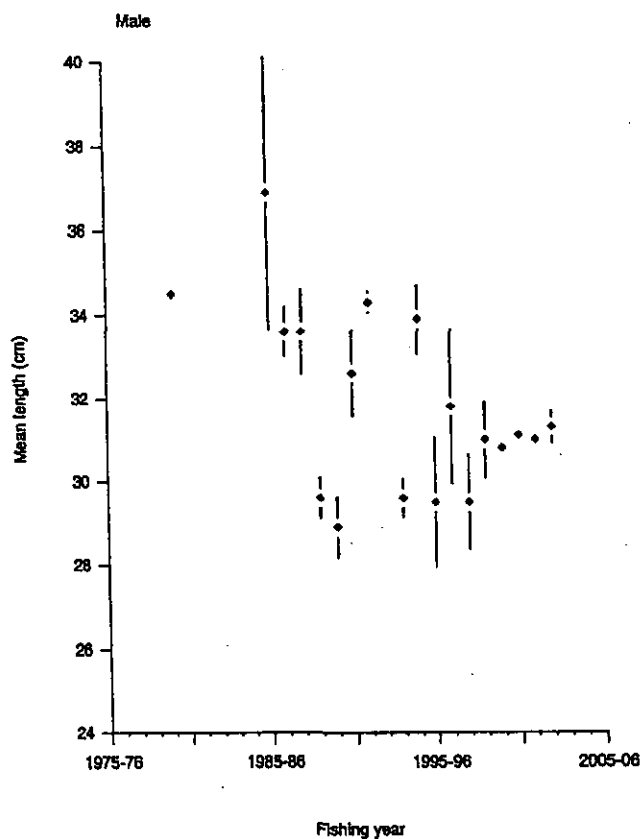


Figure 3: OEO 3A black oreo male OP mean length from all samples combined for 1979–80 to 2002–03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

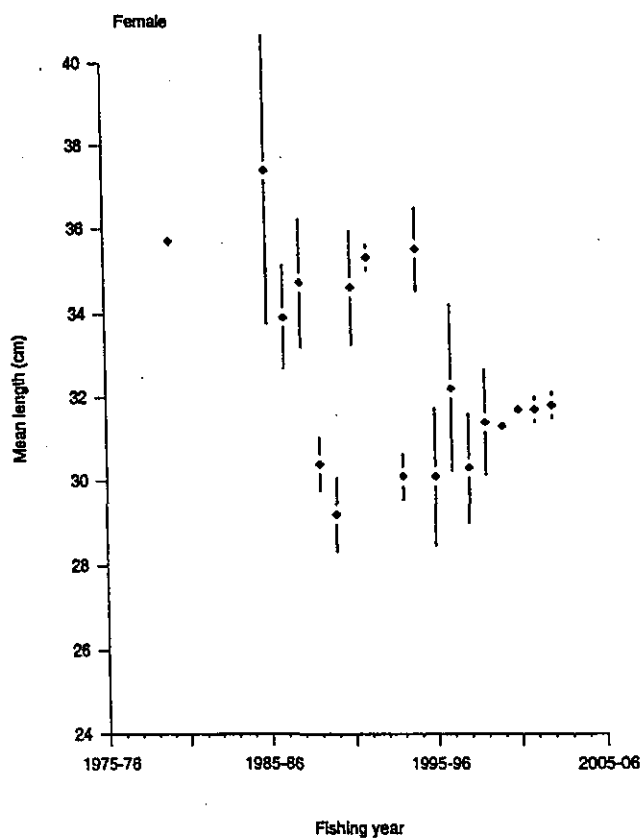


Figure 4: OEO 3A black oreo female OP mean length from all samples combined for 1979–80 to 2002–03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

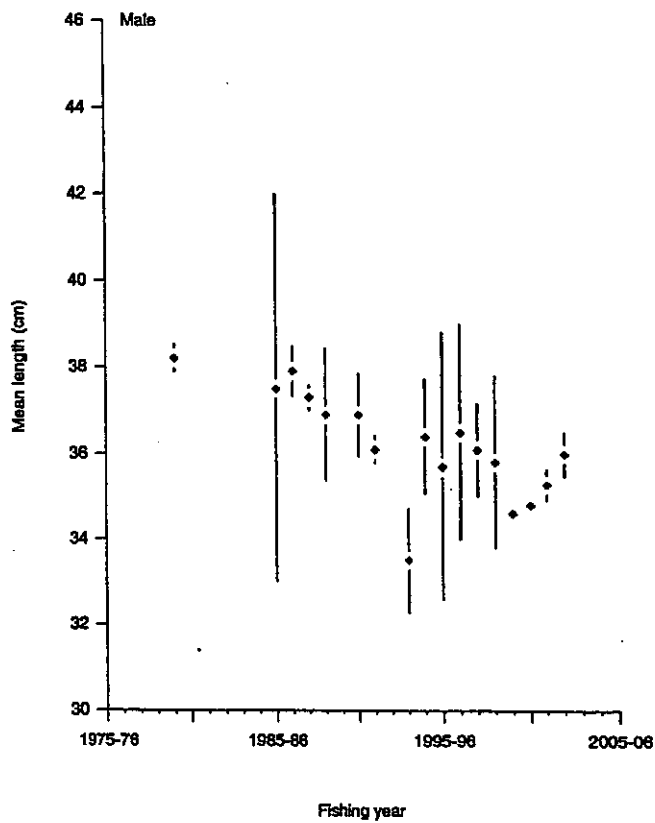


Figure 5: OEO 3A smooth oreo male OP mean length from all samples combined for 1979-80 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

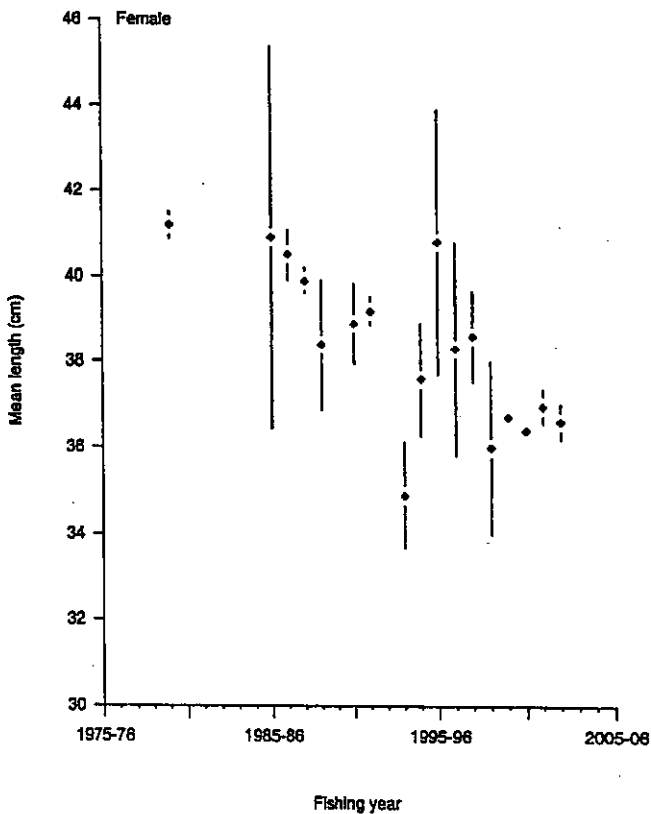


Figure 6: OEO 3A smooth oreo female OP mean length from all samples combined for 1979-80 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

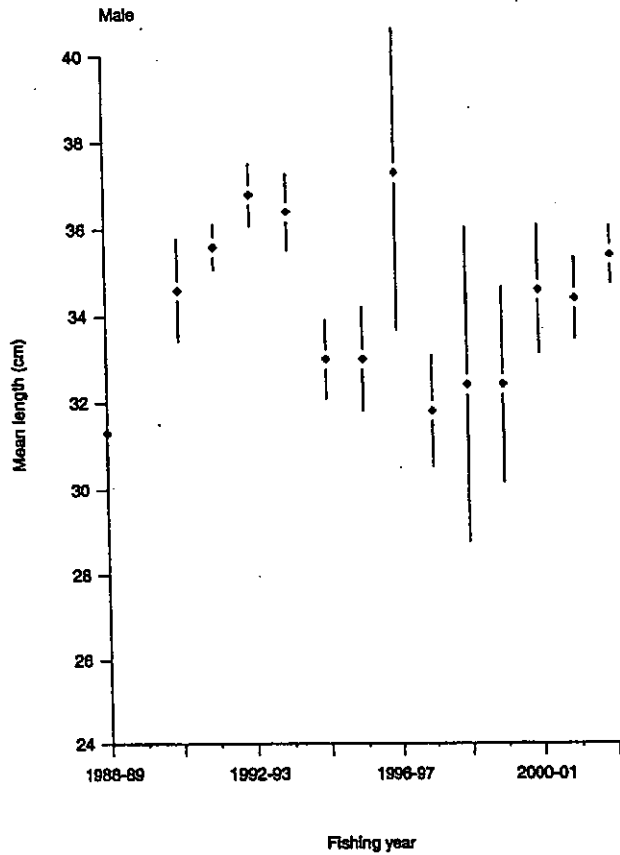


Figure 7: OEO 4 black oreo male OP observer mean length from all samples combined for 1979-80 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

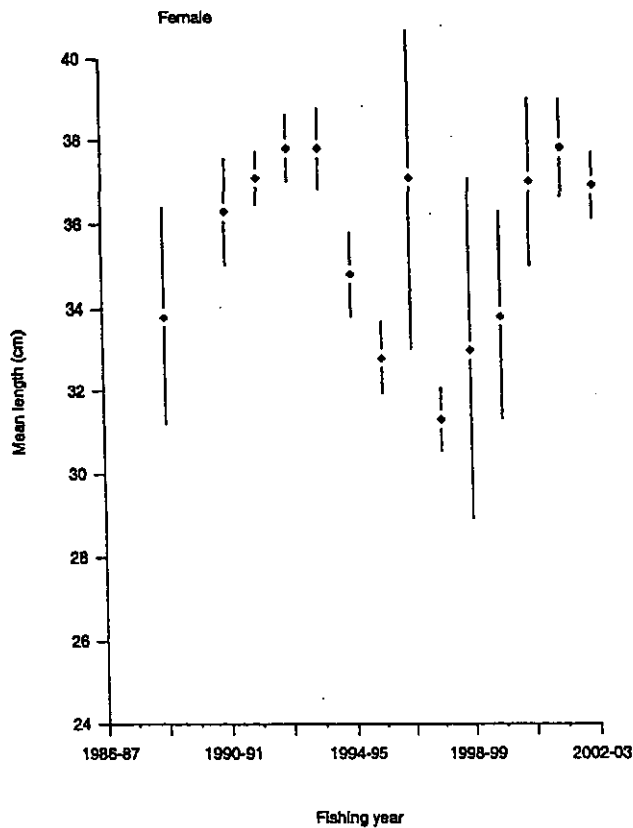


Figure 8: OEO 4 black oreo female OP observer mean length from all samples combined for 1979-80 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

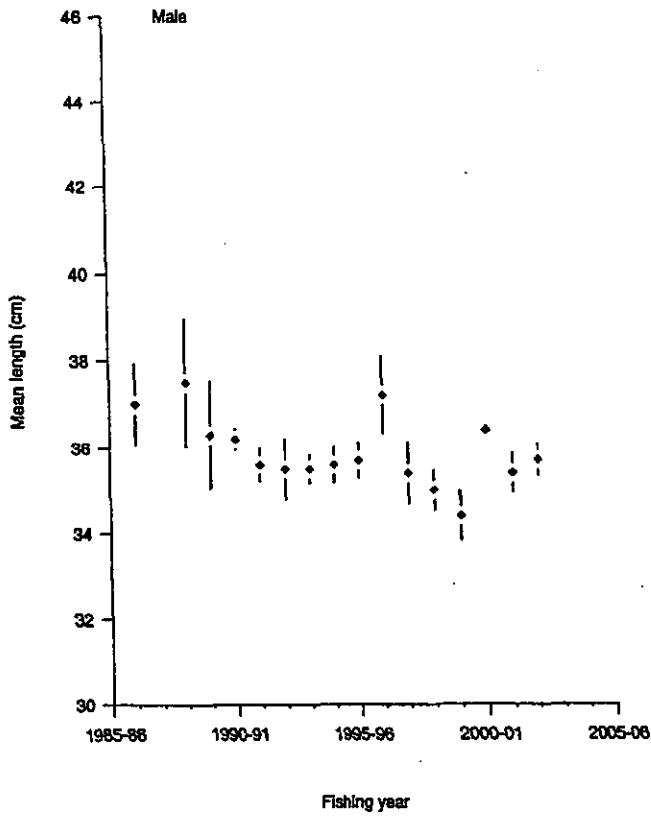


Figure 9: OEO 4 smooth oreo male OP and ORMC observer mean length from all samples combined for 1986-87 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

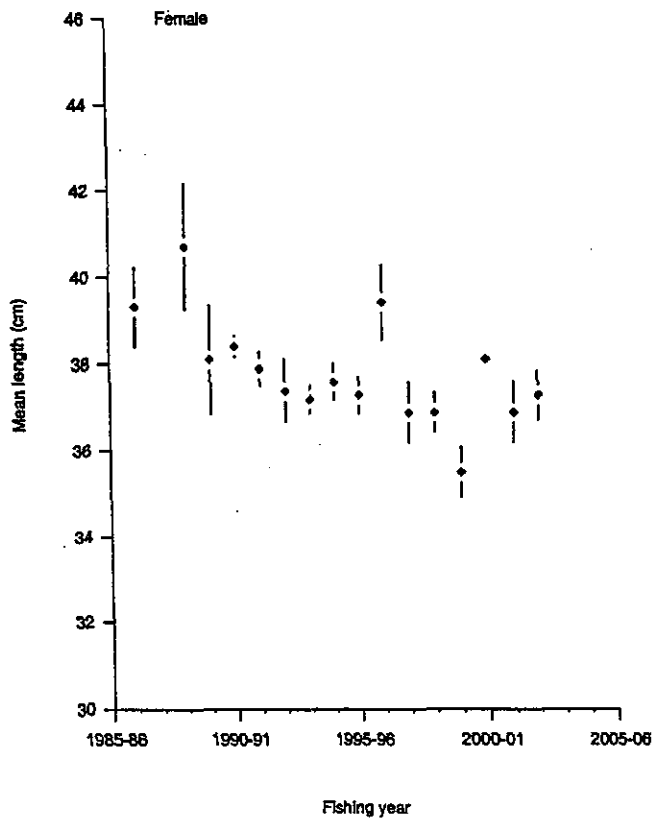


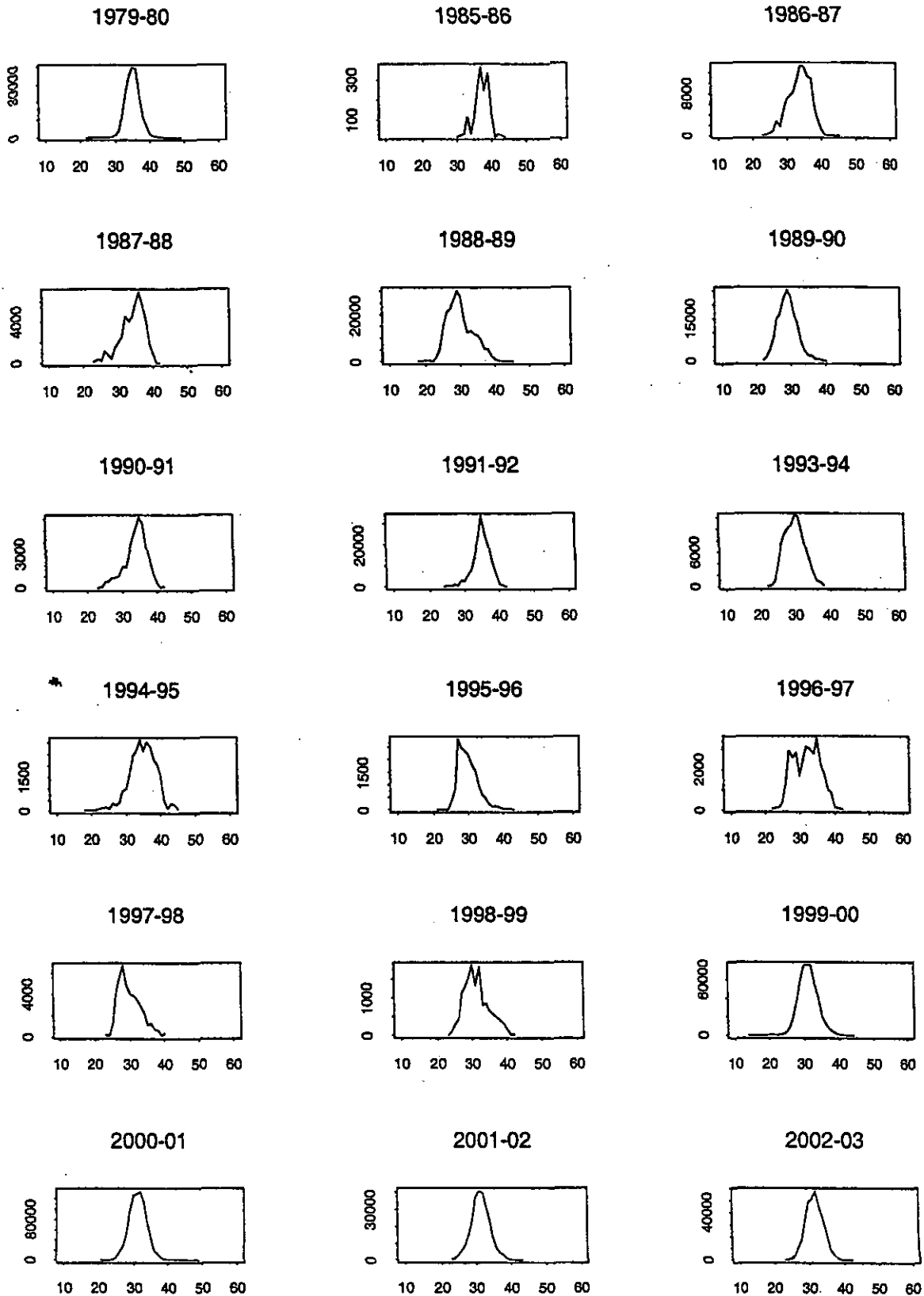
Figure 10: OEO 4 smooth oreo female OP and ORMC observer mean length from all samples combined for 1986-87 to 2002-03 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

Appendix 1: Scientific Observer Programme generalised female gonad stage gonad definitions probably used to stage black oreo and smooth oreo*.

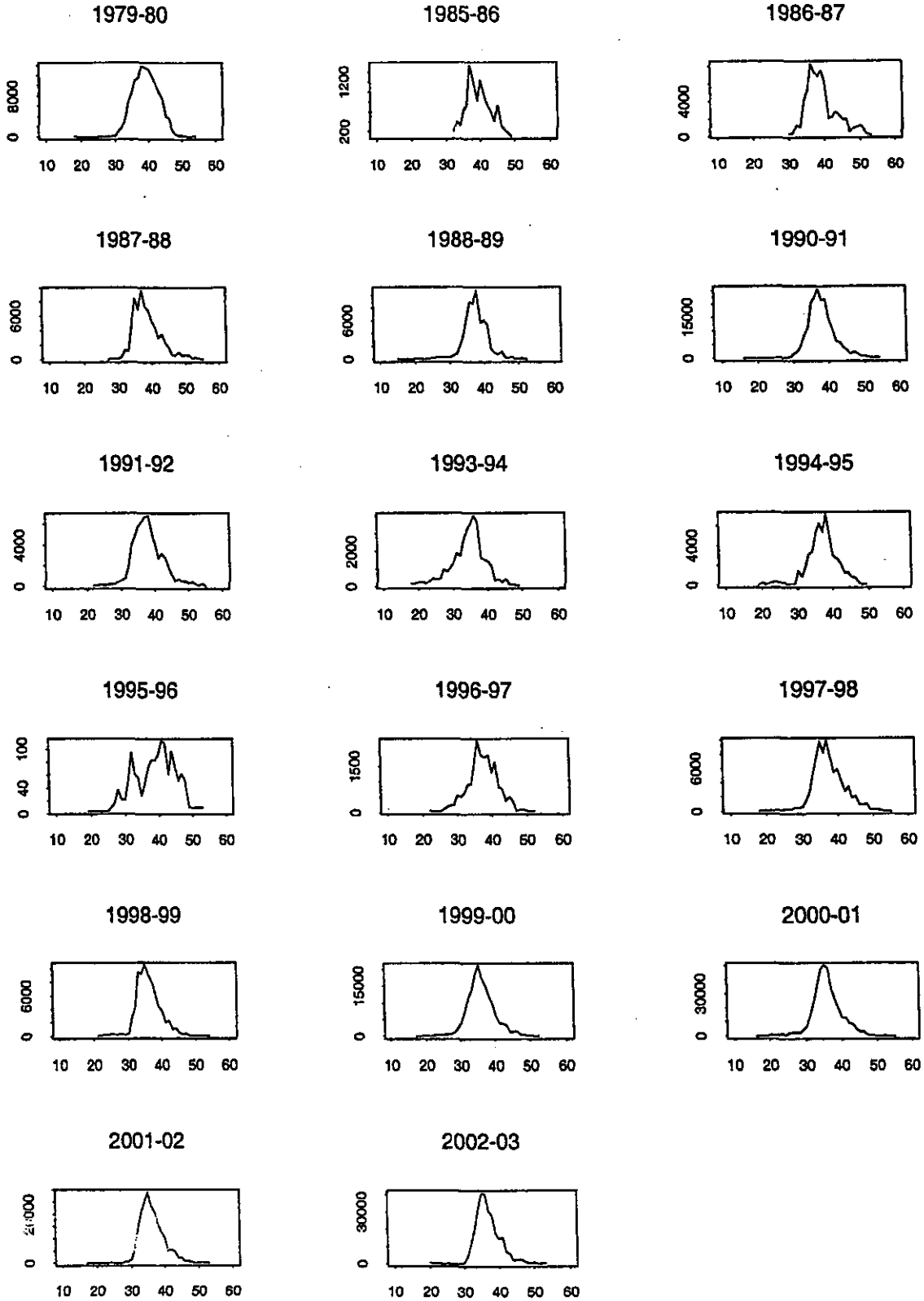
Stage	Name	Description
1	Immature/resting	Ovary translucent or pink, small with no eggs visible.
2	Maturing	Eggs visible, opaque/coloured, but not hyaline (clear).
3	Ripening	Ovary large and firm. Clear eggs are present (more than just one or two).
4	Running ripe	Ovary large, thin walled and fragile. Large clear eggs flow out freely, or are obvious in large numbers when the ovary is cut.
5	Spent	Ovary flaccid and bloody, size much reduced from stage 4. Some residual large clear or opaque eggs may still be present.

* The staging definitions used for these data are uncertain and may be a mixture of the four-stage oreo scale and the five-stage orange roughy scale (Appendix 1) provided in the observer manual. In the five-stage scale, stages 3 and 4 are equivalent to stage 3 in the four-stage scale.

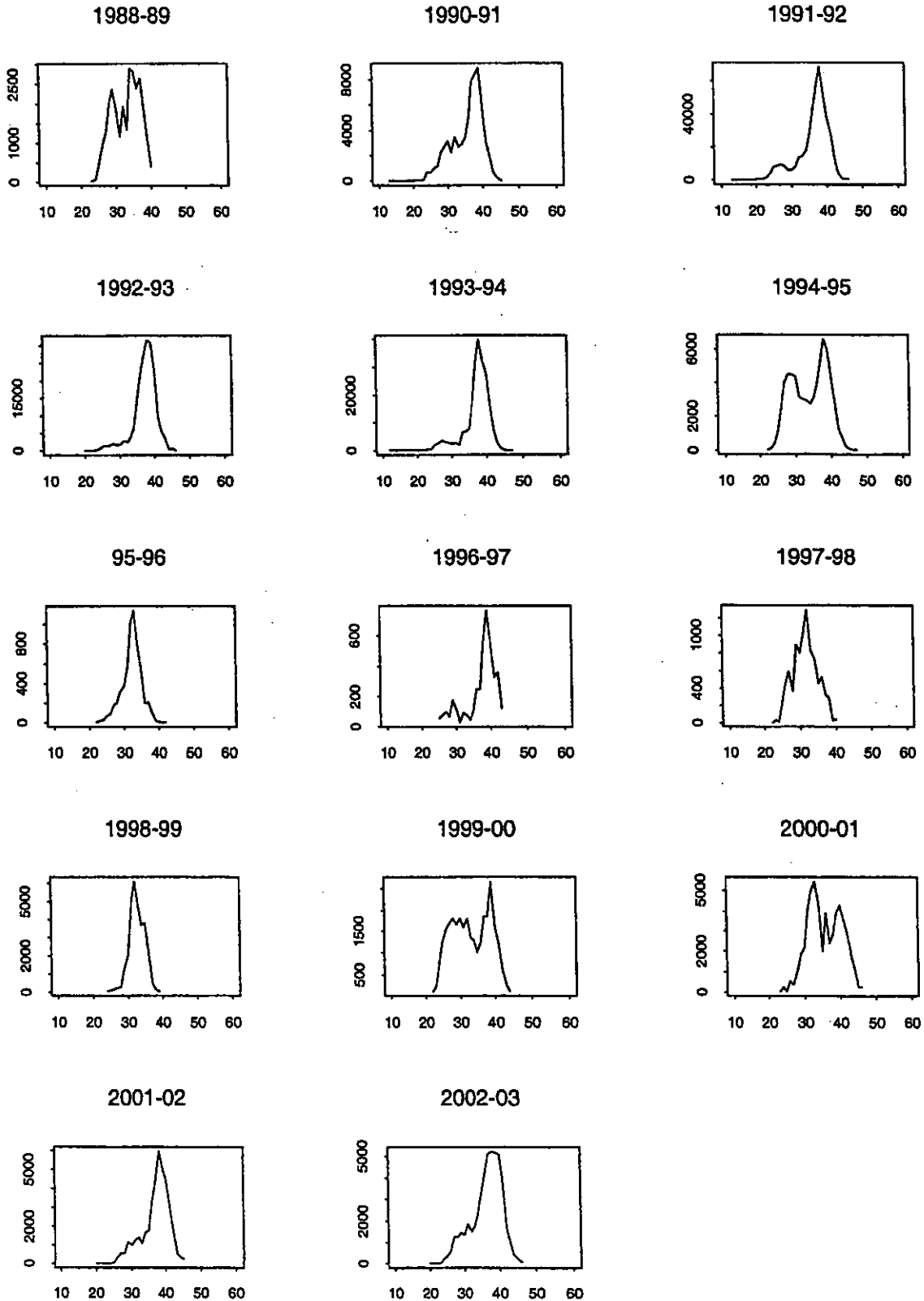
Appendix 2: OEO 3A (south of 44° S), black oreo observer length distributions by fishing year scaled by catch weight. The horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 1 for numbers of tows sampled and numbers of fish measured.



Appendix 3: OEO 3A (south of 44° S) smooth oreo observer length distributions by fishing year scaled by catch weight. The horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 3 for numbers of tows sampled and numbers of fish measured.



Appendix 4: OEO 4 (south of 44° S) black oreo observer length distributions by fishing year scaled by catch weight. The horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 5 for numbers of tows sampled and Table 6 for numbers of fish measured.



Appendix 5: OEO 4 (south of 44° S) smooth oreo observer length distributions by fishing year scaled by catch weight. Horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 8 for numbers of tows sampled and Table 9 for numbers of fish measured.

