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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 2001-02**

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EXECUTIVE SUMMARY

Hart, A.C.; McMillan, P.J.; Doonan, I.J. (2003). A summary of observer biological information on the New Zealand black oreo and smooth oreo fisheries from 1979–80 to 2001–02.

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1. Black oreo and smooth oreo biological (total length/sex) data collected mainly by observers from the Ministry of Fisheries Scientific Observer Programme (SOP) plus samples from the Orange Roughy Management Company (ORM) from 1979–80 to 2001–2002 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.
2. SOP and ORM 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 ORM data were from these smaller fisheries, so the data were reported separately as well as being combined with the SOP data.
3. 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 2001–02) combined.

The main results were as follows.

1. 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.
2. 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. In OEO 4 there were 7–21 black oreo tows per year and 32–90 smooth oreo tows sampled per year from 1999–2000 to 2001–02.
3. OEO 3A black oreo and smooth oreo scaled mean annual length appeared to decline over time (1979–80 to 2001–02) for males and females, but other studies showed that sampling had depth and area effects so care is required interpreting the data.
4. OEO 4 black oreo scaled mean annual length over time (1979–80 to 2001–02) was variable, perhaps due to the progressive discovery of new fishing areas along the south Chatham Rise. Smooth oreo scaled mean annual length appeared to decline over time (1979–80 to 2001–02) for males and females, but there are likely to be sampling depth and area effects so interpreting this trend is difficult.
5. Sampling of black oreo and smooth oreo in the smaller fisheries started in the early 1990s. Most of the data collected by the SOP was in the last 6 years (1996–97 to 2001–02) and most of the ORM sampling was in the last 4 years (1998–99 to 2001–02). Mean length data from each fishery should be interpreted with caution.

6. Female gonad stage data for black oreo from OEO 3A and OEO 4 for the years from 1990–91 to 2001–02 combined averaged less than 1500 samples per month. Most samples (2294–3892 per month) were taken by SOP 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.
7. Female gonad stage data for smooth oreo from OEO 3A and OEO 4 from 1990–91 to 2001–02 combined averaged about 3660 samples per month. Most samples taken by SOP observers were from April to June (2410–6666) and September to December (4298–8730). There was little evidence of a spawning period with only 2.1–3.2% running ripe in October to December.

1. INTRODUCTION

This report presents analyses for the following objectives for the Ministry of Fisheries funded research project "Oreo stock assessment" (OEO2002/02).

Overall objective

1. To carry out a stock assessment of black oreo and smooth oreo, including estimating biomass and sustainable yields.

Specific objective

3. To analyse length frequency, sex ratio, and reproductive condition data for black oreo and smooth oreo collected by the Scientific Observer Programme and other sources during the 2001/02 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 (SOP) or by the fishing industry (ORM). Data from the 2001–02 fishing year were analysed and data from 1979–80 to 2000–01 were also analysed and summarised 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 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). They 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. Interpretation of trends in mean length for the pooled data used in this report should therefore be treated with caution.

2. METHODS

Data sources

Total length and sex and gonad stage were extracted from the MFish Obs_lfs database for black oreo and smooth oreo, along with associated catch and position data from the 1979–80 to 2001–2002 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) decided 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 for the assessment of the quantity of data available in this study. 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 includes 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 ORM 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) because of 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.

Rest The remainder of OEO 4 south of 44° S.

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 few length samples from ORM observers for smooth oreo from the last two fishing years and they were combined with the SOP data in the analyses.

Samples from areas other than the south 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 SOP and ORM 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 SOP observers were selected and tabulated by stage for all years combined. 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.

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 (Table 1). Mean length appeared to decline from 1979–80 to 2000–01 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. This pattern is shown in our data (Table 2) where the annual total (sexes combined) mean is 32 cm or less (usually 29–30) in 10 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

There was a large increase in sample numbers in the last two years but previous years had an erratic sampling history and sampling declined again in 2001–02 (Table 3). Mean length appeared to decline from 1979–80 to 2001–02 by about 3 cm for males and about 4 cm females (Table 4, and 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 2001–02 (Table 3) and this presumably produced the very small 95% confidence interval for the mean estimates observed 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 (Tables 5 and 6). The total area mean length fluctuated for both sexes (Figures 7 and 8, Table 7) and there is 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 after 1994–95. Large fish would be expected from previously unfished or lightly fished seamounts and this is confirmed in Figures 7 and 8. 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 came from one area with a small sample size (228 fish). The increase in mean length in 2001–02 was driven by samples from the Andes hill complex (area 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 SOP sampling (1986 on) and numbers of samples increased from 1990–91 but were probably not adequate to describe the largest smooth oreo fishery in the EEZ (Tables 8 and 9). The total area mean length appeared to decline from 1986–87 to 2001–2002 by about 2 cm for both sexes (Figures 9 and 10, Table 10). 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 5 subsequent years (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 (Table 9). Sample sizes increased in the later fishing years, and in 2000–01 there were seven ORM observed tows available for these analyses. Annual length frequency distributions scaled to catch weight are shown in Appendix 5.

Other areas

Black oreo

There were few samples collected and only modest numbers of fish measured in most of the other areas. The areas where numbers of samples were acceptable included Southland, Pukaki (east), and Puysegur/Snares (Table 11). Sampling increased in some areas in the last 2–5 years (Tables 11 and 12). 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 Southland, Pukaki (east), Bounty Plateau, Auckland Island., and Puysegur (Table 14). Sampling increased in some areas in the last 2–5 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 but that is not surprising considering that 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/november (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/november (Annala et al. 2002).

4. SUMMARY

This analysis used Ministry of Fisheries observer-collected biological data from 1979–80 (mostly 1985–86 on) to 2001–02 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 was analysed for the south Chatham Rise and for the smaller oreo fisheries. Pooled female gonad stage data for the south Chatham Rise from 1990–90 to 2001–02 were summarised by month.

Mean length, OEO 3A

Annual data from the whole area were analysed. Previous analysis 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 2001–02 mean length decreased for males by about 3 cm and by about 4 cm for females. There were 17 years in the data series but only 11 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 (SOP data), but a decrease in samples from 2001–02.

Smooth oreo

From 1979–80 to 2001–02 mean length decreased for males by about 3 cm and by about 4 cm for females. There were 16 years in the data series but only 9 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 (SOP data), but a decrease in samples from 2001–02.

Mean length, OEO 4

Annual data from the whole area combined were analysed but analyses were also performed on 6 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 2001–02 no mean length trends were apparent for males and females for the whole area, and no trends by fishing area were apparent. There were only 13 years in the data series although the fishery was under way since the late 1970s. There were only 6 years when more than 1000 fish were measured (1990–91 to 1994–95, and 2001–02) (SOP data).

Smooth oreo

From 1986–87 to 2001–02 mean length for the whole area decreased by about 2 cm for males and by about 3 cm for females. No trends by fishing area were apparent but several areas were infrequently sampled. There were only 15 years in the data series with 13 years when more than 1000 fish were measured (mostly SOP data with 7 samples from ORM).

Length data – other areas

Black oreo. There were few SOP or ORM 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 2001–02; Auckland Island. 1998–99; Puysegur/Snares 1993–94, 1996–97 to 2000–01. ORM 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 SOP or ORM 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 2001–02; Bounty 1998–99 and 2000–01; Auckland Island 1997–98 to 2001–02; Puysegur 1997–98 to 2001–02. ORM 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; Auckland Island in 1998–99 and 2000–01 to 2001–02; and Puysegur in 1998–99 and 2000–01.

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 fish measured all SOP length/sex samples and numbers of tows (n) where length/sex samples were taken from all vessels, total includes unsexed.

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

Table 2: OEO 3A black oreo mean length (cm) for males, females and both sexes combined (Total) from all SOP samples from 1979-80 to 2001-02 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

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

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

Table 4: OEO 3A smooth oreo mean length (cm) for males, females, and both sexes combined (Total) from all SOP samples from 1979-80 to 2001-02 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

Table 5: OEO 4 black oreo. Numbers of tows where SOP and ORM observer length/sex samples were taken in OEO 4 from all vessels. See Table 6 for explanation of 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	1	7
1989-90	0	0	0	0	0	0	0
1990-91	2	0	21	0	0	0	23
1991-92	3	1	1	54	2	0	61
1992-93	0	0	16	9	0	0	25
1993-94	1	6	23	28	1	0	59
1994-95	1	4	3	30	0	1	39
1995-96	1	2	0	1	3	0	7
1996-97	0	0	1	1	0	0	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	1	7
2000-01	6	0	6	0	1	2	15
2001-02	3	2	2	13	1	0	21

Table 6: OEO 4 black oreo. Numbers of fish measured from SOP and ORM observers taken from all vessels, total includes unsexed. See Table 6 for explanation of 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	100	899
1989-90	0	0	0	0	0	0	0
1990-91	171	0	2 454	0	0	0	2 625
1991-92	220	57	100	5 298	193	0	5 868
1992-93	0	0	1 775	944	0	0	2 719
1993-94	144	441	1 903	2 791	102	0	5 381
1994-95	182	349	288	3 463	0	117	4 399
1995-96	128	193	0	102	308	0	731
1996-97	0	0	85	92	0	0	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

Table 7: OEO 4 black oreo mean length (cm) for males, females and both sexes combined (Total) from observer samples from 1988-89 to 2001-02 from all vessels, scaled to catch. See Table 7 for numbers of tows, and Table 8 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

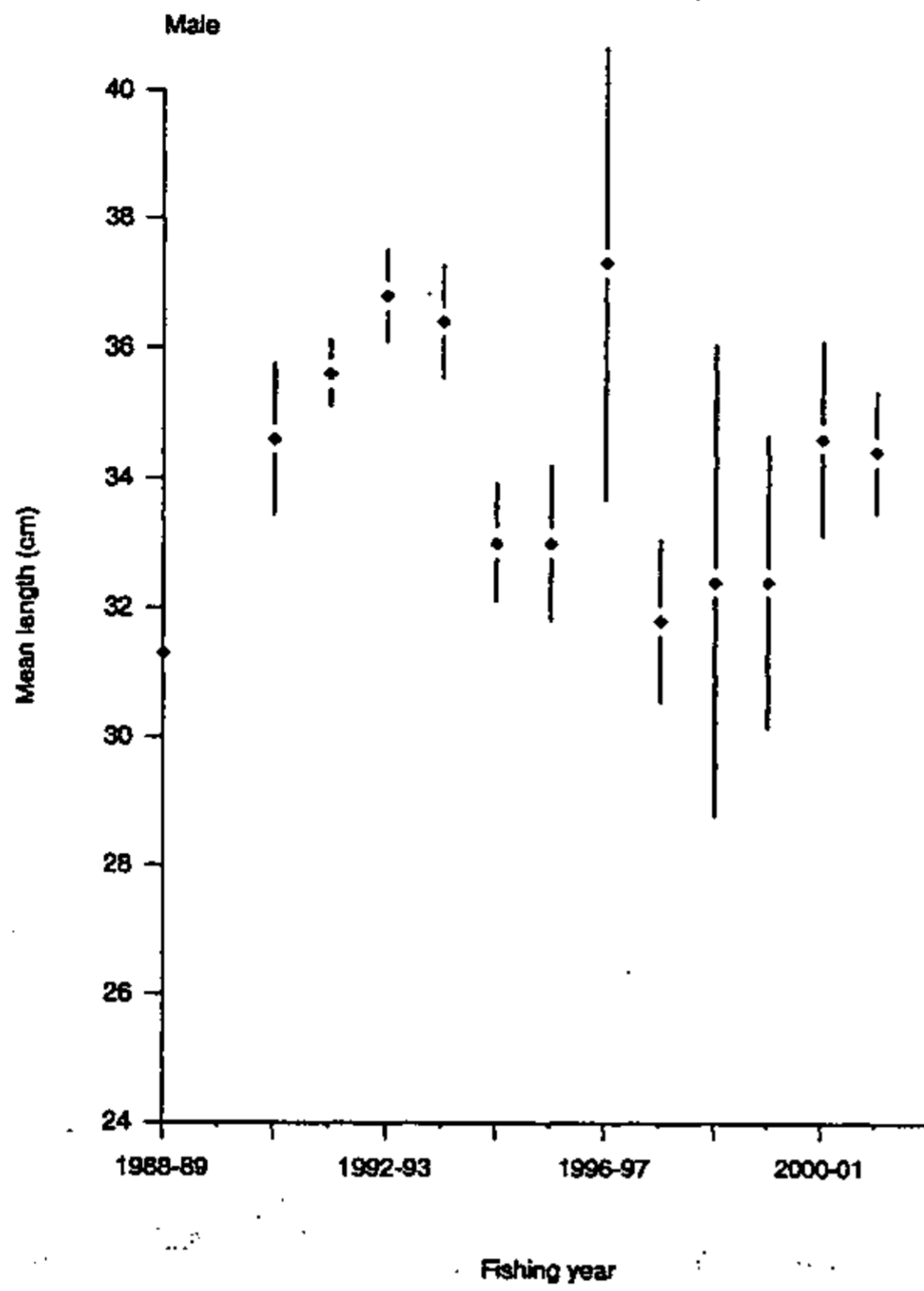


Figure 7: OEO 4 black oreo male SOP observer mean length from all samples combined for 1979-80 to 2000-01 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

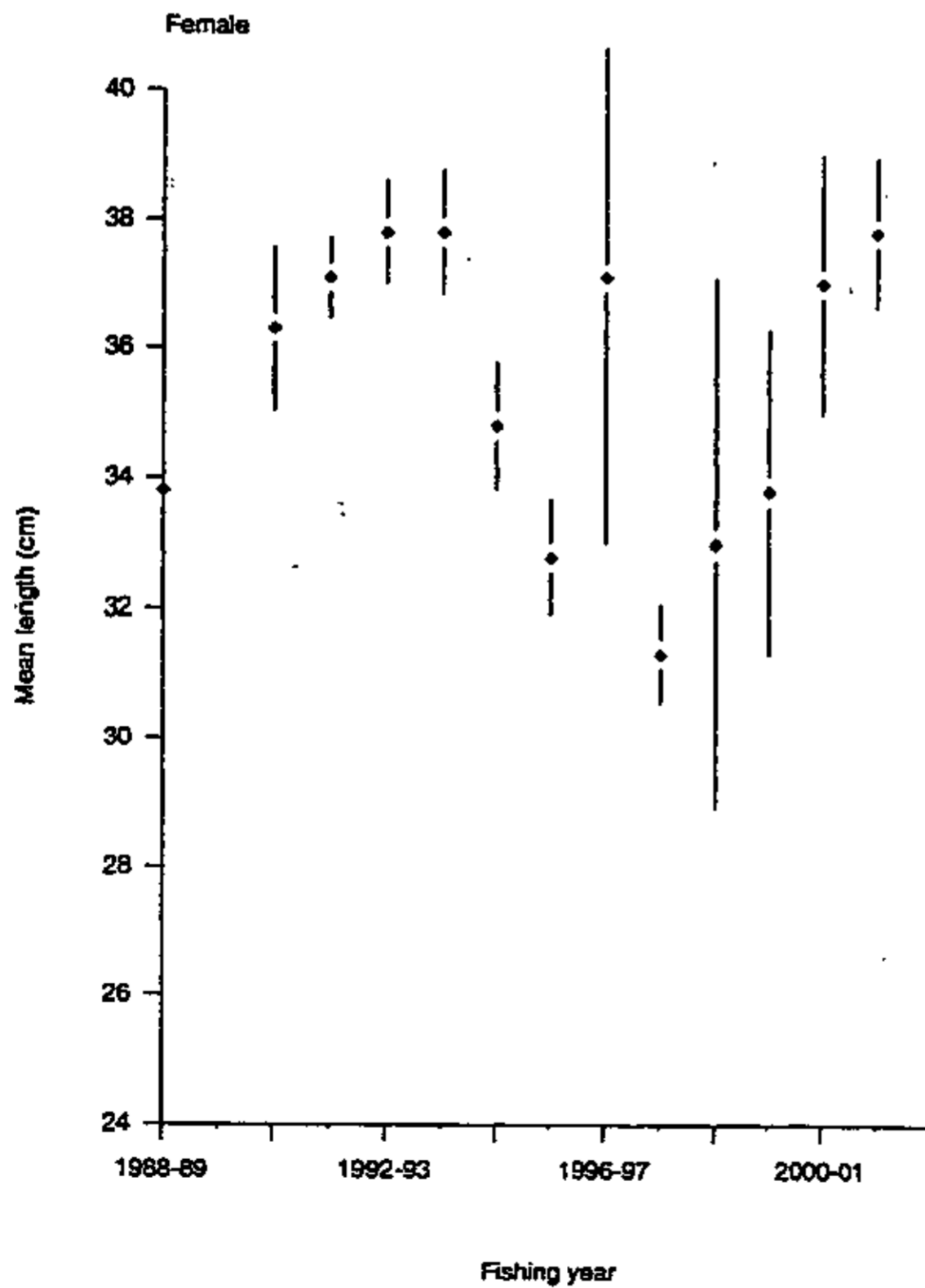
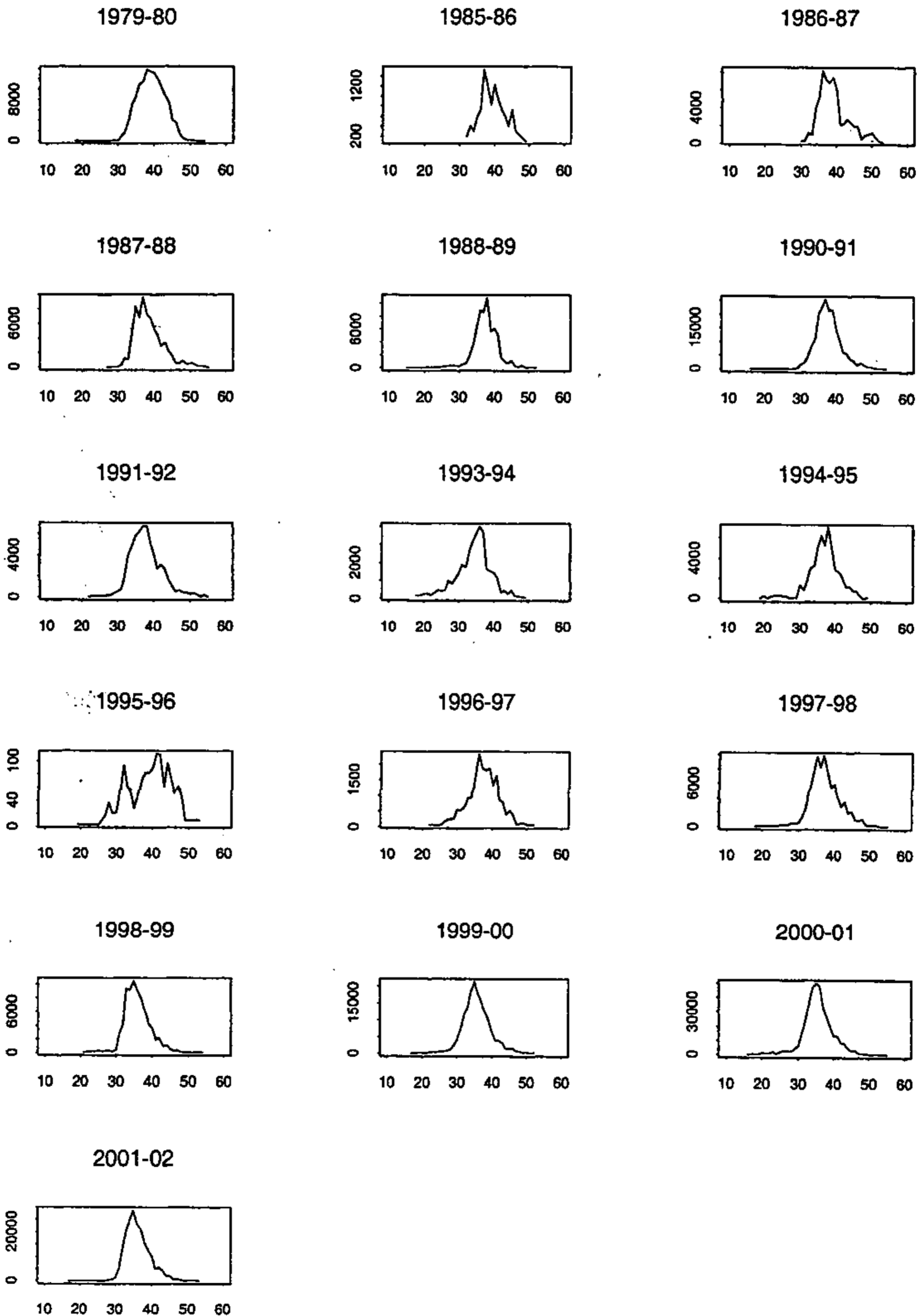


Figure 8: OEO 4 black oreo female SOP observer mean length from all samples combined for 1979-80 to 2001-02 scaled to catch. Mean length (◆). Vertical lines are ± 2 s.e.

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.

Appendix 3: OEO 3A (south of 44° S) smooth oreo observer length distributions by fishing year from all nations scaled by catch weight. Horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 6 for numbers of tows sampled and numbers of fish measured.



Appendix 5: OEO 4 (south of 44° S) smooth oreo observer length distributions by fishing year from all nations scaled by catch weight. Horizontal (x) axis is total length (cm) and vertical (y) axis is numbers of fish. See Table 12 for numbers of tows sampled and numbers of fish measured.

