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Assessment of black and smooth oreos for the 1991–92 fishing year

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1. INTRODUCTION

1.1 Overview

This document revises the information provided in the 1988 FARD (McMillan *et al.* 1988). Catch and effort data are updated and include an analysis by target species by tonnage class, plus data from catches where black (BOE) or smooth (SSO) oreo made up 25% or more of the total catch. Estimates of population parameters are made from preliminary unvalidated attempts at age estimation. New data from a trawl survey carried out in November 1990 are summarised and compared with results of the 1986 and 1987 trawl surveys. These data show few trends and are considered insufficient to warrant a stock reduction analysis. Consequently yields are estimated using catch history information as for previous assessments. A species split for black and smooth oreos is again suggested.

1.2 Description of the fishery

The largest oreo fishery is on the south slope of Chatham Rise. Other areas fished are off the Otago/Southland coast, on the north east slope of Pukaki Rise, and a fishery is developing in the Puysegur/Solander area. On the south Chatham Rise there has been a trend of exploratory fishing towards the east, probably caused by local depletion of fishing areas back to the west.

The south Chatham Rise fishery is a mixed species fishery with black and smooth oreo caught at the western end and the two oreos and orange roughy caught at the eastern end. The oreo quota may have limited the catch of orange roughy on the south Chatham Rise in the last few years.

1.3 Literature review

Earlier literature is listed in McMillan *et al.* (1988). New biological information on oreos is presented in Clark *et al.* (1989) and Conroy and Pankhurst (1989). Catch statistics, supplied principally by the former Fisheries Statistics Unit, for the time period 1972 to September 1988 have been compiled in Fincham *et al.* (in press).

2. REVIEW OF THE FISHERY

2.1 TACCs, catch, landings and effort data

2.1.1 TACCs

These have changed little from 1982 to 1991 (*see* Table 1) and were based on catch history. Black, smooth and spiky oreo are combined under one TACC. Problems associated with the management of oreos were discussed in the 1988 FARD and in the Reports from the 1989 and 1990 plenary (Annala 1989, 1990).

2.1.2 Catches

Combined oreo species reported catch from 1978-79 to 1989-90 are shown in Table 1. Catch from OEO 3A has been less than the TACC for each year except 1988-89. Catch from OEO 4 has exceeded the TACC for the last three years. The excess in 1987-88 and 1988-89 is probably due to fish allocated as a result of research charters.

Soviet catch data from 1972 to 1977 are presented in Table 2. Reported catches for each oreo species from the two Fishstocks on the Chatham Rise are presented in Table 3. Catch data prior to 1979–80 are not all available by species and area separately. Smooth oreo catches have been relatively high in the last 3-4 years whilst black oreo catches have declined in recent years compared to the high levels in 1980-82.

2.1.3 CPUE

(a) Target estimated catch by species by area by tonnage class 6 vessels (2000-2500 t) from 1981-82 to 1988-89 are listed in Tables 4 and 5. Tonnage class 6 vessels are mainly Soviet vessels, and were the main participants in the fishery in the late 1970's and early 1980's. They were chosen because they appeared to offer the best CPUE time series. These vessels have been leaving the fishery in recent years, with 9 present in 1983-84 but only 3 in 1988-89 and apparently none in 1989-90. Domestic vessels, which are mostly tonnage classes 3-5, have taken more of the oreo catch reported each year from about 1983-84 onwards, and took the majority of the oreo catch since 1987-88. There are few apparent trends in these data.

CPUE for black oreo (Figure 2) fluctuate but may have declined during the last two years. CPUE for smooth oreo (Figure 3) in OEO 3A increased up to 1985-86 then declined. CPUE in OEO 4 showed no apparent trend. See comments on CPUE data at the end of this section.

(b) Target estimated catch by species by area for all tonnage classes combined are presented in Tables 6 and 7 and Figures 4 and 5. The CPUE for black oreo in OEO 3A has shown a steady decline, with no trend in OEO 4. For smooth oreo CPUE increased in both Fishstocks up to 1988–89 and then declined.

(c) Total (not just target) estimated catch and effort by species by area for all tows containing oreos are shown in Tables 8-11 and Figures 6 and 7. These data will contain catches where orange roughy was also caught and therefore represent efforts to catch that species as well as oreos. Tonnes per day, t per tow and t per hour are presented in the tables and t per tow

in the figures. CPUE for black oreo declined, but this may simply indicate a decline in interest in the species and increased interest in orange roughy and smooth oreo. CPUE for smooth oreo showed no trend.

(d) Total (not just target) estimated catch by species by area selected from data where either smooth or black oreo makes up 25% or more of the catch are shown in Tables 12–15 and Figures 8 and 9. This criterion was chosen in an attempt to standardise CPUE. The trends in the data are closely similar to those for the total catch of each oreo above (Figures 6 and 7).

The use of CPUE data to monitor the oreo fishery is uncertain because of the following problems:

1. CPUE data for oreos are complex because of the diverse range of vessels involved in the fishery, from small ice vessels to large freezer trawlers, and because of the variable and sometimes unpredictable species mix, of the two oreo species and orange roughy.

2. The best effort variable for determining CPUE is uncertain. Catch per tow or catch per day may be better measures than catch per hour because of the difficulties of measuring the time that the net actually fished. Oreo trawling can be highly targeted with the effective fishing time being relatively short for some tows.

3. CPUE trends for oreos may be confounded by:

   (a) unmeasured changes in effective effort, i.e. learning by the fishers, new technology such as track plotters, Global Positioning System, sonar, etc. These changes effectively increase the effort in the fishery.

   (b) mis-reporting of catch statistics, e.g. discarding of black oreo, averaging of catches by Soviet trawlers.

   (c) regulation of catches by quotas since 1982–83.

2.2 Other information

There is only a modest amount of information available on the commercial fishery from the Scientific Observer Programme. The following number of observer trips have had catches of oreos exceeding 10 t per trip:

	1986	1987	1988	1989
BOE	8	8	11	4
SSO	8	10	12	7

Length frequency data collected by observers from 1986 to 1989 are presented in Figures 10 and 11 and may provide information on changing length distributions of oreos with time. Comparisons can be made with older "commercial" data, e.g. from the *Kalinovo* in 1981, and with the research trawl survey data from 1986, 1987 and 1990. The shift in fishing towards the east and the continual discovery of new areas may mask any changes to sizes of fish caught.

The main mode for black oreo decreased to 29 cm TL in 1988 and 1989 from 35–36 cm in 1986–87. The main mode for smooth oreo has increased from 37 to 39 cm during the period 1986–89.

2.3 Maori and recreational fishing patterns

There is no known Maori or recreational catch of oreos.

3. RESEARCH

3.1 Stock structure

Black and smooth oreos are different species and therefore are separate stocks. They have been managed as a combined Fishstock from 1982 to 1991. This is undesirable because it does not take into account any differences in stock size and productivity for the two species.

Hard data are lacking on the stock structure of each species of oreo. Because they do not appear to migrate to spawn, it is possible that they form localised discrete populations. Alternatively, if they have a pelagic juvenile phase they may be part of a larger stock which could include the populations on the continental slopes of the Bounty Platform and Campbell Plateau. Therefore, until more information becomes available, the most prudent approach would be to retain existing Fishstock areas.

3.2 Resource surveys

Stratified random trawl surveys were carried out on the south Chatham Rise (Fig. 12) at depths of 600-1200m in 1986, 1987 and again in 1990. In the 1990 survey the area covered was extended to the east (subarea 5) and the depth range was increased to 1500m in the eastern part of the area to cover the probable distribution of the oreo species. Strata were the same for each survey but additional strata to the east of 176° 20'W and between 1200 and 1500m were added in the 1990 survey.

There are problems with the comparability of the surveys because three different vessels were used. Some of the differences are as follows:

	Arrow	Amaltal Explorer	Cordella
vessel HP	1 800	2 700	3 500
length (m)	57	65	76
doors (m^2)	poly (6)	high asp. V (6.9)	super V (6.5)
net	6 panel wingless	6 panel wingless	6 panel wingless
groundrope length (m)	18.7	18.7	20.8
wingspread (m)	19.8	19.7	19?
doorspread (m)	86.7	87.0	89?

3.3 Other studies

Length frequency data from the surveys are presented in Figs. 13 and 14 and are summarised below:

	Survey		
	1986	1987	1990
Modal TL BOE	28 & 34	28 & 32	29 & 32
Modal TL SSO	37	34	35

There was no change in the modal length of black oreos. The modal length of smooth oreos decreased over the period of the surveys.

Comparison of length distributions of observer (Figures 10 and 11) and research survey data (Figures 13 and 14) shows that trends for the two series differ. The dominant mode for black oreo from the 1986 and 1987 survey data (28 cm) contrasts with that of the 1986 and 1987 observer data (35 cm). This is not unexpected because the survey covered depths and areas which are not normally fished by commercial vessels and which are known to contain small black oreo. A secondary mode at 32–34 cm was observed in the 1986, 1987, and 1990 survey data.

The slight decrease in modal size of smooth oreo from the surveys (37, 34 and 35 cm from 1986, 1987 and 1990) is in contrast to the increase in modal size observed in the observer data (37, 38 and 39 cm from 1986–1989). The increase in the latter may be attributed to the continual discovery of new areas while the decrease in the survey data may represent a trend for the south Chatham Rise population as a whole. Further surveys are required to test this hypothesis.

Preliminary unvalidated age estimates have been made using small samples of black and smooth oreos (8 and 10 fish respectively). Counts of translucent zones observed in whole otoliths using reflected light or in transverse sections of otoliths using transmitted light were made. Counts were included where two readers were in agreement. These data were fitted to a von Bertalanffy growth function and the resulting curves are presented in Figures 15 and 16. The curve for orange roughy, adjusted to total length (because standard length is normally measured with orange roughy) is also plotted for comparison.

Both species appear to be slow growing. Black oreo may have faster initial growth (perhaps due to a pelagic life) and then slow growth following metamorphosis to benthopelagic life. A pelagic early life for smooth oreo does not appear to result in initial growth that is as fast as that of black oreo. Smooth oreo settle to a benthopelagic habit at a smaller size than black oreo (16 c.f. 20–21 cm TL).

Estimated life history parameters for oreos are listed in Table 16. These estimates are preliminary pending a more intensive study of otolith sections and of micro-increments observed in otoliths of small oreos. Age validation also has to be considered.

3.4 Biomass estimates

Recruited biomass estimates for the three surveys are presented in Tables 17 and 18. Length at recruitment (cm TL) for the surveys are based on the 50% point on the left hand limb of the scaled length frequency distribution.

Two sets of biomass estimates are presented in an attempt to account for possible bias in the way that the surveys were carried out. No attempt has been made to adjust for the possible different fishing power of the three vessels.

The estimates for smooth oreo in Table 17 suggest that there has been a substantial decline in OEO 3A and a substantial increase in OEO 4. For black oreo, no trend in biomass estimates was observed in OEO 3A, while the estimate for OEO 4 for the 1990 survey is almost double those made for 1986 and 1987 (Table 17).

In Table 18 one station (#79) was removed from the 1986 data from OEO 3A because the station involved fishing on a fish mark seen beforehand. One station (#4) was removed from the 1990 data from OEO 3A for the same reason as given above. In addition, station 66 was removed from the 1990 survey data from OEO 4 because it was carried out more than 10 nautical miles from the random position.

Smooth oreo biomass estimates for OEO 3A show a less dramatic decline from 1986 to 1990 after the removal of one station from each of the 1986 and 1990 data sets (Table 18). Removal of station 66 from the 1990 data in OEO 4 reduces the 1990 biomass estimate considerably but the latter is still much higher than those made for 1986 and 1987. Black oreo biomass estimates are largely unchanged by removal of stations (Table 18).

3.5 Yield estimates

3.5.1 Estimation of Maximum Constant Yield (MCY)

MCY was estimated using the equation, MCY = cY_{av} (Method 5). Y_{av} is the average catch from 1981-82 to 1989-90, including April-September 1983, and c = 0.8 (moderate variability of catches; probably long lived species). MCY estimates for each species separately, for each Fishstock are as follows:

Estimates of MCY (t)

Fishstock	Black Oreo	Smooth Oreo
OEO1	400	700
OEO3A	3 800	3 000
OEO4	1 300	4 000
OEO6	800	200
OEO10	–	–

3.5.2 Estimation of Current Annual Yield (CAY)

No estimates can be made because of the lack of estimates of current biomass and life history parameters.

4. MANAGEMENT IMPLICATIONS

There is uncertainty about the sustainability of current catch levels and the current TAC. The TAC is based on historical catch and not biomass and productivity. There is increased uncertainty about sustainability due to the likelihood that oreos are slow growing species. Preliminary (unvalidated) age estimates for oreos indicates that smooth oreo has a similar growth rate to that of orange roughy. Black oreo appears to have an initial faster growth rate, perhaps due to a pelagic habit, but may have a slow growth with metamorphosis to a bottom living form.

The oreo fishery may therefore be based on accumulated stocks of slow growing fish. It is possible that the fishery has survived to date due to the periodic discovery of new fishing "hills" with associated unfished populations of oreos. There is a trend in recent years of fleet movements towards the east on the south Chatham Rise and of the discovery of new grounds.

There is some evidence of local depletion on the south Chatham Rise, some of it anecdotal. The fishery in OEO3A in the late 1970's and early 1980's, carried out mainly by Soviet trawlers, took about 38 540 t of oreo in the three years 1979–80 to 1981–82. The TAC of 10 000 t for the area, first introduced in 1982, has subsequently only been reported caught in one year, 1988–89.

It is recommended that the current TACCs for black and smooth oreos are split using the MCY values above as ratios to apportion the TACCs by management area. There has been an increase in reported catch of smooth oreo and a decrease in the reported catch of black oreo in the last few years, so the recommended species split has increased in favour of smooth oreo relative to black oreo.

Separate species catch limits are considered important to reduce the risk of one or other stock being damaged by the application of excessive catch levels based on two species. Smooth oreo is the favoured species and is being reported in increasing amounts, probably at the expense of black oreo.

5. REFERENCES

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Table 1: Total reported oreo catch (t) for all species combined and TACs (t) from 1978–79 to 1989–90.

	FISHSTOCK									
Fishing	OEO 1		OEO 3A		OEO 4		OEO 6			
year	Catch	TAC	Catch	TAC	Catch	TAC	Catch	TAC	Undefined	Totals
1978-79*	2808		1366		8041		17		–	12231
1979-80*	143		10958		680		18		–	11791
1980-81*	467		14832		10269		283		0	25851
1981-82*	21		12750		9296		4380		66	26514
1982-83*	162		8576	10000	3927	6750	765		251	13680
1983-83#	39		4409		3209		354		4	8015
1983-84+	3241		9190	10000	6104	6750	3568		7	22111
1984-85+	1480		8284	10000	6390	6750	2044		5	18204
1985-86+	5390		5331	10000	5883	6750	126		91	16820
1986-87+	532	4000	7222	10000	6830	6750	0	3000	508	15093
1987-88+	1193	4000	9049	10000	8674	7000	197	3000	46	19159
1988-89+	432	4233	10191	10000	8447	7000	7	3000	–	19077
1989-90+	2064	5033	9278	10000	7348	7000	38	3000	–	18728

Source: FSU from 1978–79 to 1987–88; QMS/FIC from 1988–89 to 1989–90.
* 1 April to 31 March
\# 1 April to 30 September
\+ 1 October to 30 September

Note: TAC for OEO10 (Kermadec) is 10 t but there has been no reported catch.
Totals do not always add up because of rounding to nearest tonne.

Table 2: USSR oreo catch 1972–1977 by FAO area

FAO area	81.4	81.5	Total
1972	121	6 879	7 000
1973	0	7 600	7 600
1974	0	10 200	10 200
1975	87	2 513	2 600
1976	242	7 758	8 000
1977	0	11 500	11 500

Note: *See* Figure 1 for a definition of FAO areas 81.4 and 81.5. 81.4 corresponds to west and 81.5 to the area east of New Zealand.

Table 3: Reported catch (t) of black (BOE) and smooth oreo (SSO) from OEO 3A and OEO 4 from 1979–80 to 1989–90. Source: FSU and FIC*.

	SSO		BOE	
	OEO 3A	OEO 4	OEO 3A	OEO 4
1979-80	5075	114	5588	566
1980-81	1522	849	8758	5224
1981-82	1283	3352	11419	5641
1982-83	2138	2796	6438	1088
1983-83	713	1861	3693	1340
1983-84	3594	4871	5524	1214
1984-85	4311	4729	3897	1651
1985-86	3135	4921	2184	961
1986-87	3186	5670	4026	1160
1987-88	5897	7771	3140	903
1988-89*	5786	6392	2724	1056
1989-90*	5257	5311	2306	479

Note: Differences in the totals by area between this table and Table 1 are due to reported catch of spiky oreo and unspecified oreo (OEO) which are included in Table 1. *See* Fincham *et al.* (in press).

Table 4: Black oreo target estimated catch, hours fished, and catch per unit of effort (CPUE) (t/hour) for charter and licensed class 6 vessels by fishing season. Source: FSU and FIC*. (Note that area C and area D are approximately equivalent to OEO 3A and OEO 4 respectively.)

EEZ Area		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89*
C	Catch (t)	7 856	5 319	2 092	904	418	1 815	928	417
	Hours	1 699	1 593	451	278	88	636	572	301
	CPUE	4.6	3.3	4.6	3.3	4.8	2.9	1.6	1.4
D	Catch (t)	2 791	995	618	187	263	691	16	20
	Hours	1 042	315	252	132	126	335	142	22
	CPUE	2.7	3.2	2.5	1.4	2.1	2.1	0.1	0.9

Table 5: Smooth oreo target estimated catch, hours fished, and catch per unit of effort (CPUE) (t/hour) for charter and licensed class 6 vessels by fishing season. Source: FSU and FIC*.

EEZ Area		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988-89*
C	Catch (t)	134	867	1 071	1 833	1 688	786	537	2
	Hours	24	137	219	242	204	201	233	14
	CPUE	5.6	6.3	4.9	7.6	8.3	3.9	2.3	0.1
D	Catch (t)	865	1 580	924	883	633	188	90	0
	Hours	142	333	141	240	96	130	20	0
	CPUE	6.1	4.7	6.6	3.7	6.6	1.4	4.5	–

Table 6: Black oreo target estimated catch, hours and catch per unit of effort (CPUE) for charter, large domestic and licensed vessels of all tonnage classes combined by fishing season. Source: FSU and FIC*.

EEZ Area		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89
C	Catch (t)	8 678	5 605	4 823	2 129	921	2 638	1 815	1053
	Hours	2 398	3 384	2 221	626	383	1 186	1 513	847
	CPUE	3.6	4.0	2.2	3.4	2.4	2.2	1.2	1.2
D	Catch (t)	2 832	1 286	829	474	504	694	355	541
	Hours	1 247	169	321	441	247	342	338	239
	CPUE	2.3	1.7	2.5	1.1	2.0	2.0	1.1	2.3

Table 7: Smooth oreo target estimated catch, hours and catch per unit of effort (CPUE) for charter, large domestic and licensed vessels of all tonnage classes combined by fishing season. Source: FSU and FIC*.

EEZ Area		1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88	1988–89*	1989–90*
C	Catch (t)	134	1 117	1 519	2 602	2 317	1 735	3 581	3990	3373
	Hours	24	267	436	457	564	390	581	471	644
	CPUE	5.6	4.2	3.5	5.7	4.1	4.4	6.2	8.5	5.4
D	Catch (t)	1 011	2 066	2 207	2 187	1 697	2 253	3 363	1355	1942
	Hours	281	740	650	811	485	787	1 120	246	952
	CPUE	3.6	2.8	3.4	2.7	3.5	2.9	3.0	5.5	2.0

Table 8: Catch, effort, and CPUE data for **black oreo**, for all reported estimated catch (not just target), for all vessels, **for area OEO3A only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	3728	264	14.1	742	5.1	1972	1.9
83-84	5469	474	11.5	1269	4.3	1980	2.8
84-85	2879	306	9.4	748	3.8	1066	2.7
85-86	2084	368	5.7	805	2.6	1177	1.8
86-87	3988	432	9.2	1237	3.2	1856	2.1
87-88	3043	440	6.9	1185	2.6	2014	1.5
88-89	2650	361	7.3	1046	2.5	2123	1.2
89-90	2306	341	6.8	959	2.4	1235	1.9

* December to September only.

Table 9: Catch, effort, and CPUE data for **black oreo**, for all reported estimated catch (not just target), for all vessels, **for area OEO4 only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	1805	203	8.9	494	3.7	862	2.1
83-84	1280	164	7.8	434	2.9	735	1.7
84-85	1653	284	5.8	860	1.9	1359	1.2
85-86	979	245	4.0	744	1.3	1131	0.9
86-87	1156	315	3.7	882	1.3	1390	0.8
87-88	893	371	2.4	1032	0.9	1655	0.5
88-89	1049	354	3.0	1090	1.0	1709	0.6
89-90	478	248	1.9	611	0.8	586	0.8

* December to September only.

Table 10: Catch, effort, and CPUE data for **smooth oreo**, for all reported estimated catch (not just target), for all vessels, **for area OEO3A only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	881	205	4.3	358	2.5	1012	0.9
83-84	3527	467	7.6	1131	3.1	1683	2.1
84-85	3822	363	10.5	865	4.4	1312	2.9
85-86	2641	521	5.1	1150	2.3	1837	1.4
86-87	3122	494	6.3	1286	2.4	1933	1.6
87-88	5898	553	10.7	1435	4.1	2292	2.6
88-89	5703	421	13.5	1213	4.7	2195	2.6
89-90	5362	477	11.2	1389	3.9	1566	3.4

* December to September only.

Table 11: Catch, effort, and CPUE data for **smooth oreo**, for all reported estimated catch (not just target), for all vessels, **for area OEO4 only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	2231	233	9.6	585	3.8	1159	1.9
83-84	4862	325	15.0	1020	4.8	1672	2.9
84-85	4759	487	9.8	1468	3.2	2806	1.7
85-86	4821	527	9.1	1655	2.9	2978	1.6
86-87	5656	613	9.2	1898	3.0	3395	1.7
87-88	7577	705	10.7	2284	3.3	3851	2.0
88-89	5968	674	8.9	2401	2.5	4219	1.4
89-90	5253	607	8.7	1920	2.7	2905	1.8

* December to September only.

Table 12: Catch, effort, and CPUE data for **black oreo** where it is more than 25% of the estimated catch, for all vessels, **for area OEO3A only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	3688	256	14.4	708	5.2	1883	2.0
83-84	5388	451	11.9	1199	4.5	1826	3.0
84-85	2724	257	10.6	598	4.6	784	3.5
85-86	1865	242	7.7	481	3.9	701	2.7
86-87	3845	318	12.1	951	4.0	1394	2.8
87-88	2798	328	8.5	823	3.4	1497	1.9
88-89	2512	272	9.2	763	3.3	1723	1.5
89-90	2026	271	7.5	640	3.2	975	2.1

* December to September only.

Table 13: Catch, effort, and CPUE data for **black oreo** where it is more than 25% of the estimated catch, for all vessels, **for area OEO4 only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	1508	130	11.6	287	5.3	441	3.4
83-84	1102	94	11.7	216	5.1	326	3.4
84-85	1274	162	7.9	378	3.4	587	2.2
85-86	767	116	6.6	281	2.7	422	1.8
86-87	913	150	6.1	378	2.4	540	1.7
87-88	559	115	4.9	220	2.5	364	1.5
88-89	874	120	7.3	261	3.3	568	1.5
89-90	250	83	3.0	132	1.9	68	3.7

* December to September only.

Table 14: Catch, effort, and CPUE data for **smooth oreo** where it is more than 25% of the estimated catch, for all vessels, **for area OEO3A only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	762	58	13.1	102	7.5	216	3.5
83-84	3195	239	13.4	640	5.0	707	4.5
84-85	3608	229	15.8	562	6.4	636	5.7
85-86	2402	280	8.6	585	4.1	852	2.8
86-87	2837	326	8.7	750	3.8	932	3.0
87-88	5643	360	15.7	850	6.6	1010	5.6
88-89	5520	293	18.8	778	7.1	1200	4.6
89-90	5264	365	14.4	1035	5.1	902	5.8

* December to September only.

Table 15: Catch, effort, and CPUE data for **smooth oreo** where it is more than 25% of the estimated catch, for all vessels, **for area OEO4 only**. Source: FIC.

Year	Catch	Days	t/day	Tows	t/tow	Hours	t/hour
82-83*	2042	155	13.2	390	5.2	688	3.0
83-84	4569	253	18.1	762	6.0	1077	4.2
84-85	4290	307	14.0	841	5.1	1340	3.2
85-86	4366	311	14.0	889	4.9	1208	3.6
86-87	5296	365	14.5	1114	4.8	1542	3.4
87-88	7076	493	14.4	1532	4.6	2182	3.2
88-89	5495	519	10.6	1708	3.2	2852	1.9
89-90	4703	463	10.2	1312	3.6	1921	2.4

* December to September only.

Table 16: Estimated life history parameters for oreos.

		BOE	SSO
age at recruitment	(A_r)	8	20
age at maturity	(A_m)	8	20
L_{inf}		35	40 cm TL
k		0.188	0.0676
t_0		0.353	-2.28
a		0.0154	0.0293
b		3.09	2.91

Note: L_{inf}, k and t_0 are parameters of the von Bertalanffy equation and a and b are parameters of the length-weight relationship $W = aL^b$.

Table 17: Recruited biomass estimates (t) from the trawl surveys using all stations.

		OEO 3A			OEO 4		
	Size (cm TL)	Biomass (t)	CV (%)	No. Stns	Biomass (t)	CV (%)	No. Stns
SMOOTH OREO							
1986	33–51	116 197	62	82	91 921	33	105
1987	31–47	35 199	59	87	76 828	25	105
1990	30–51	39 643	55	45	192 105	35	103
BLACK OREO							
1986	27–44	64 659	17	82	41 312	17	105
1987	27–44	44 198	20	87	44 751	26	105
1990	27–45	62 321	24	45	77 941	31	103

Table 18: Recruited biomass estimates from the trawl surveys using only those stations which where considered to be unaffected by observed fish marks or by manipulation of the station to mirror a known commercial tow.

		OEO 3A			OEO 4		
	Size (cm TL)	Biomass (t)	CV (%)	No. Stns	Biomass (t)	CV (%)	No. Stns
SMOOTH OREO							
1986#1	33–51	49 699	53	81	91 921	33	105
1987	31–47	35 199	59	87	76 828	25	105
1990#2	30–51	17 355	52	44	150 548	35	102
BLACK OREO							
1986#1	27–44	64 759	17	81	41 312	17	105
1987	27–44	44 198	20	87	44 751	26	105
1990#2	27–45	61 331	24	44	77 742	32	102

#1 Station 79 removed from area OEO 3A because a fish mark was observed.

#2 Station 4 was removed from area OEO3A because a fish mark was observed before the station was carried out. Station 66 was removed from area OEO4 because it was over 10 n.m from the random station.

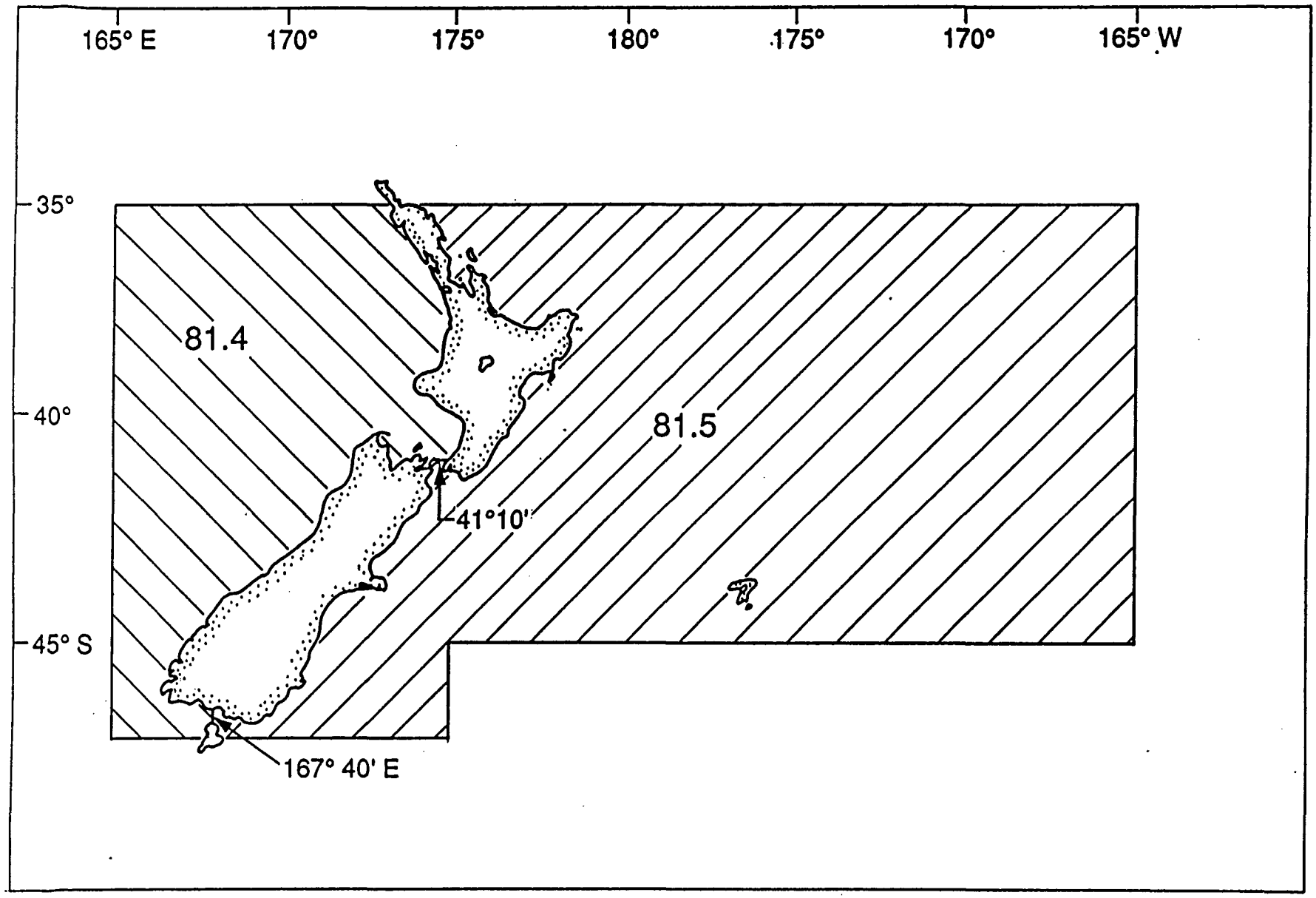

Figure 1: FAO statistical areas for the New Zealand region *see* Table 2.

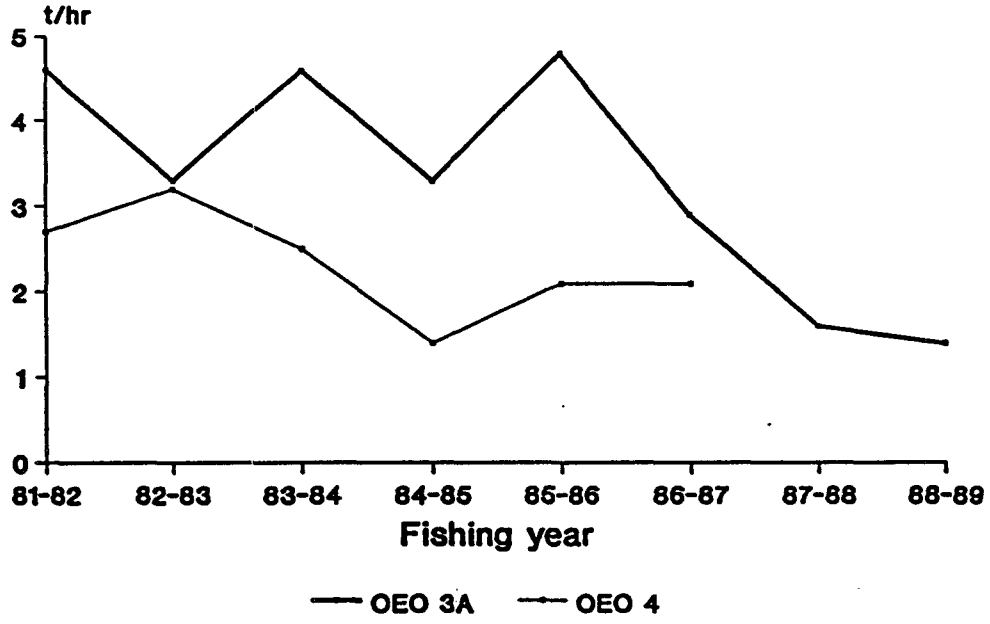

Figure 2: Black oreo estimated CPUE for charter and licensed tonnage class 6 vessels.

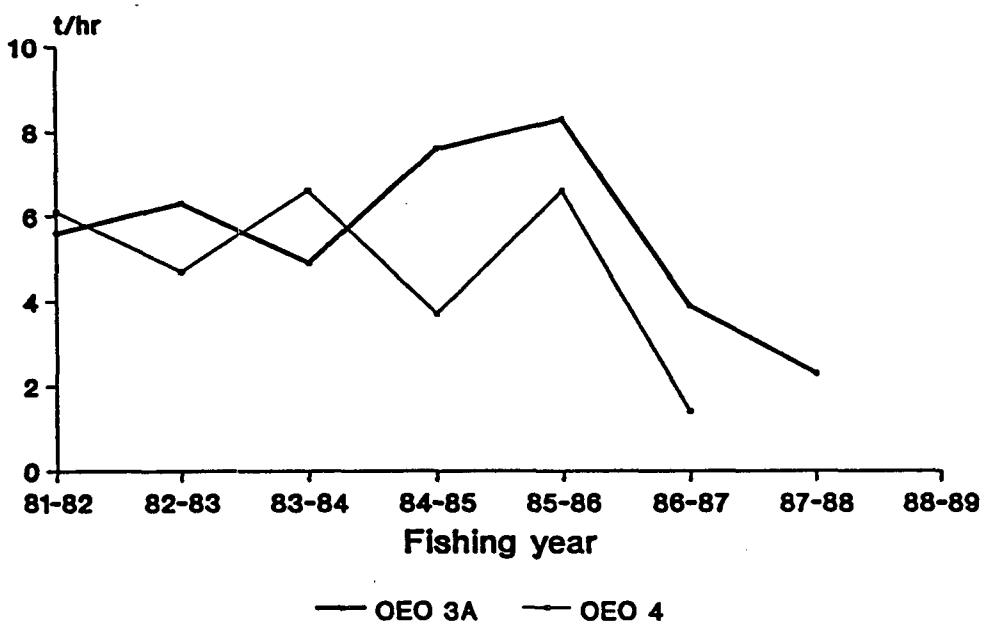

Figure 3: Smooth oreo estimated CPUE for charter and licensed tonnage class 6 vessels.

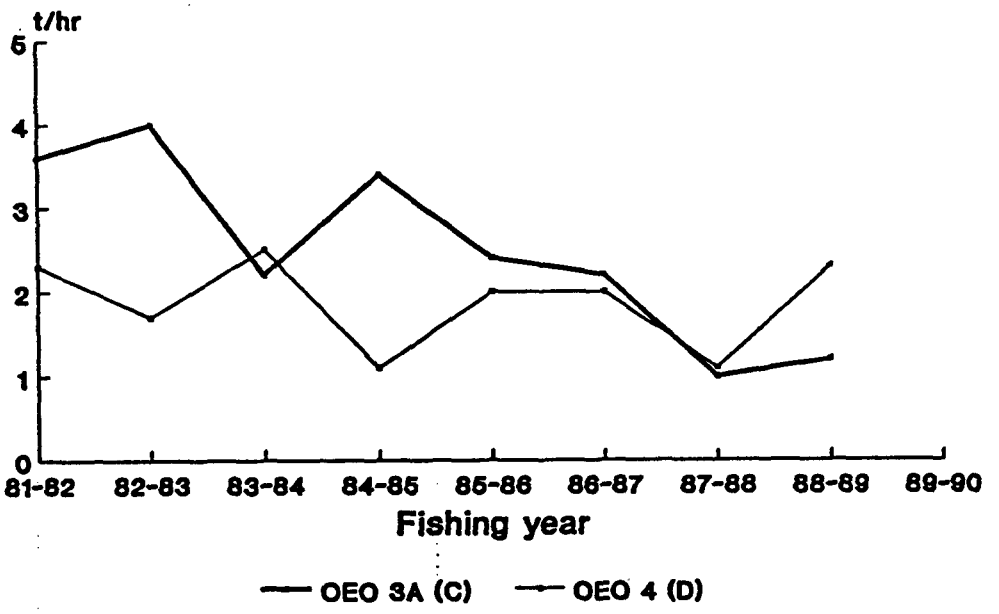

Figure 4: Black oreo target estimated CPUE for charter, licensed and large domestic vessels.

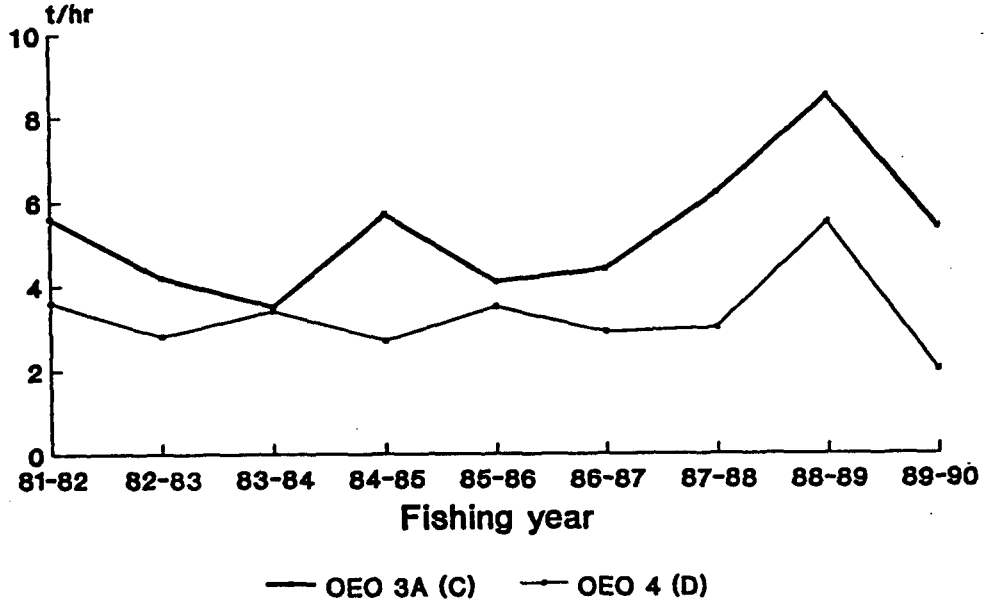

Figure 5: Smooth oreo target estimated CPUE for charter, licensed and large domestic vessels.

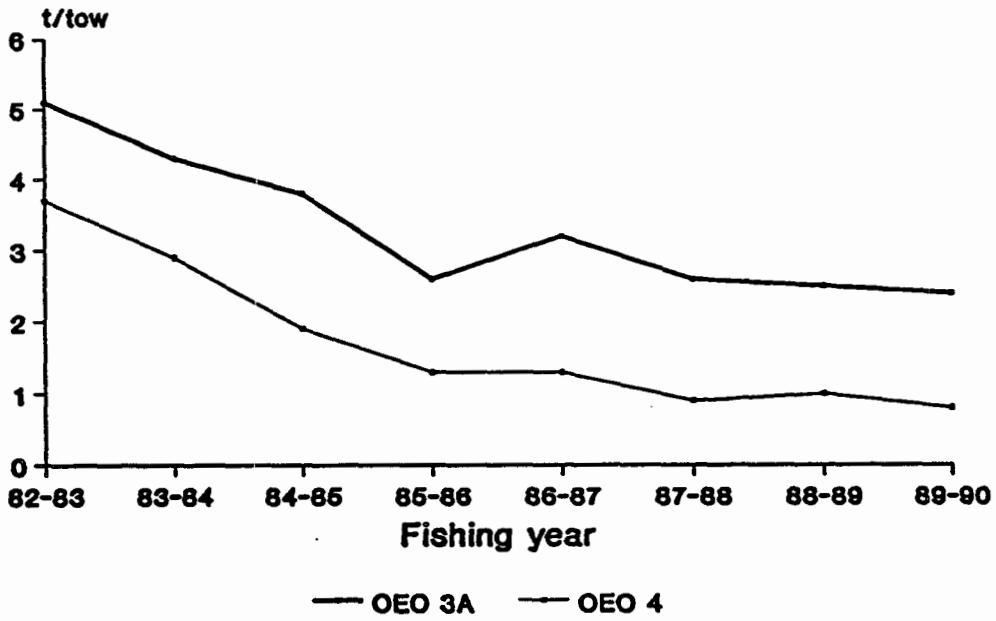

Figure 6: Black oreo CPUE for total catch (not just target).

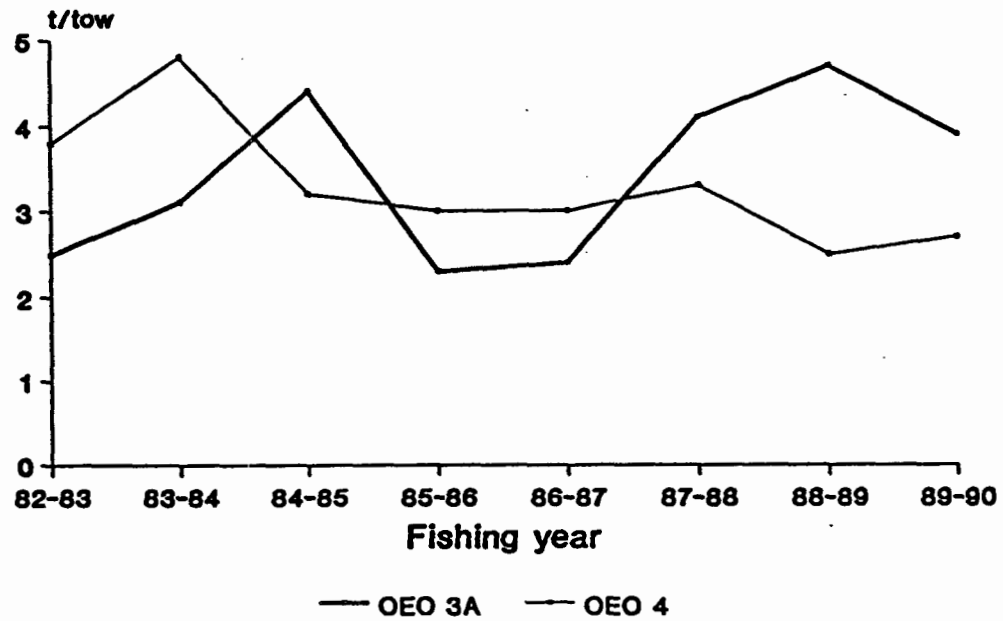

Figure 7: Smooth oreo CPUE for total catch (not just target).

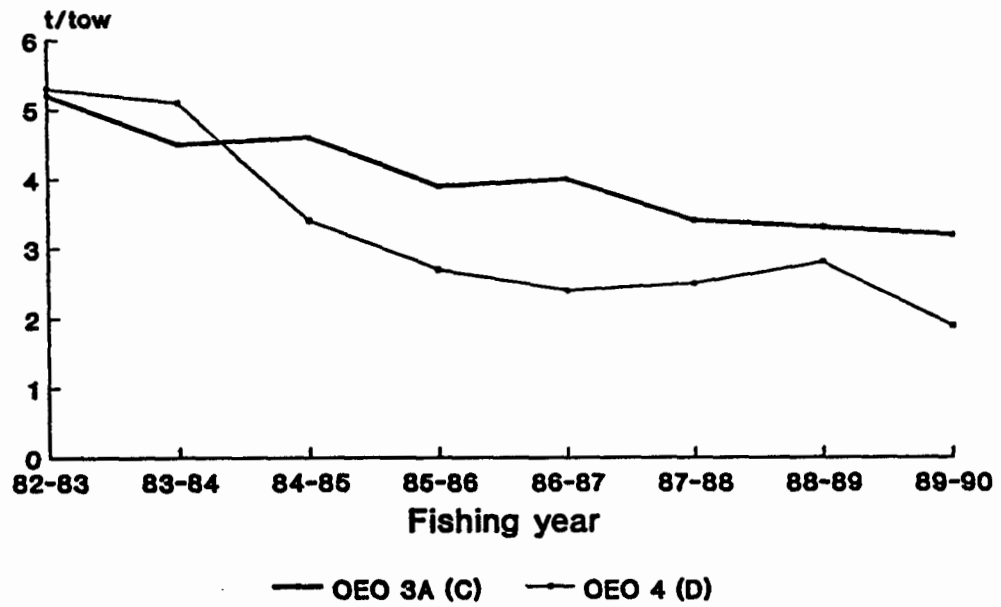

Figure 8: Black oreo CPUE where >25% of estimated catch from each tow is black oreo, for all vessels.

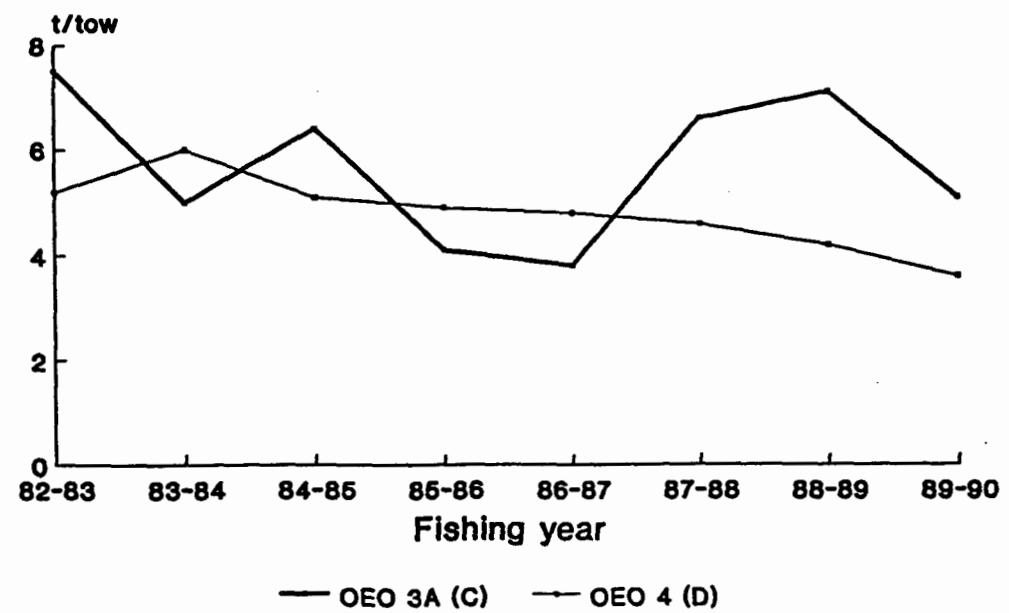

Figure 9: Smooth oreo CPUE where >25% of estimated catch from each tow is smooth oreo, for all vessels.

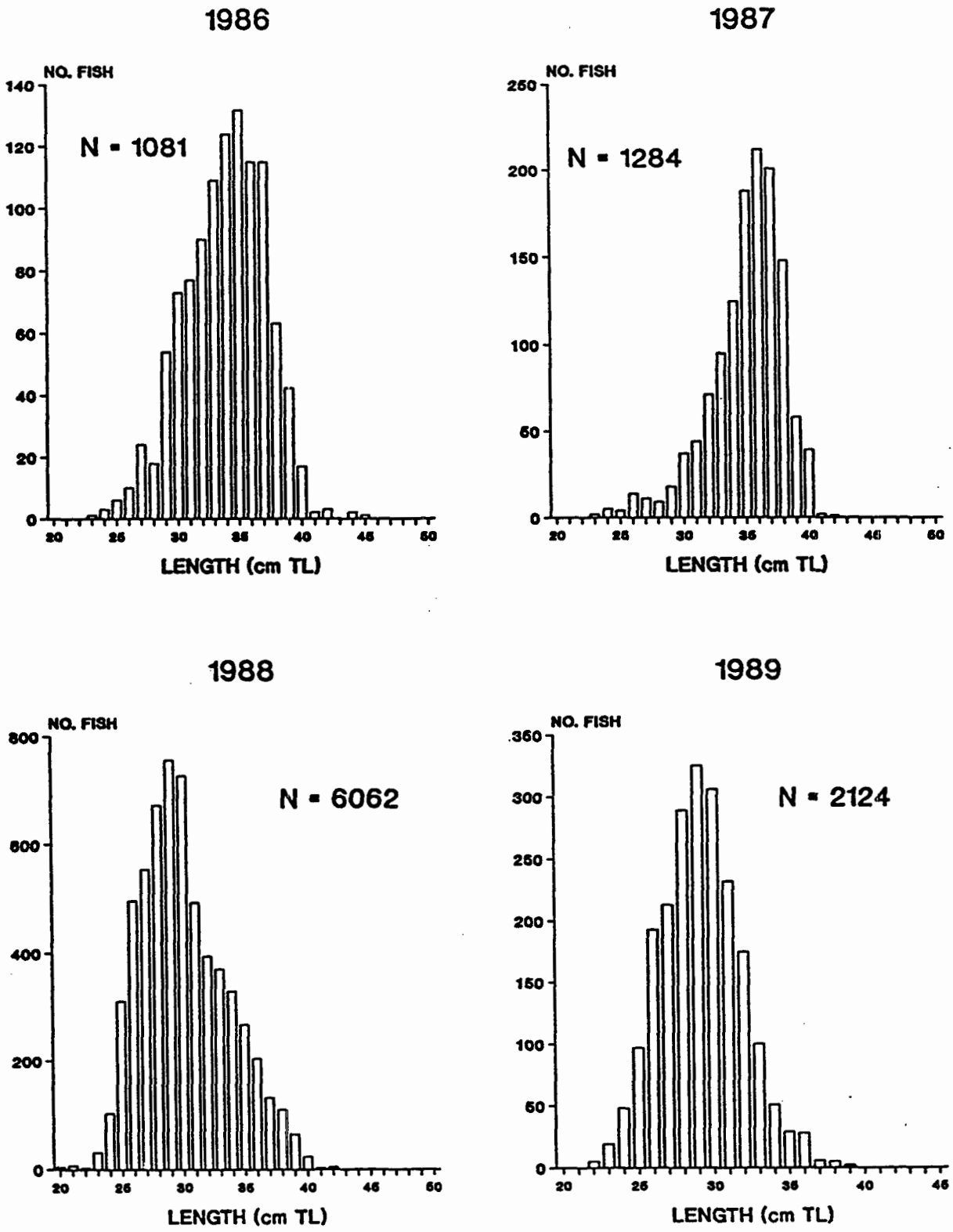

Figure 10: Black oreo length samples collected by observers, 1986–1989.

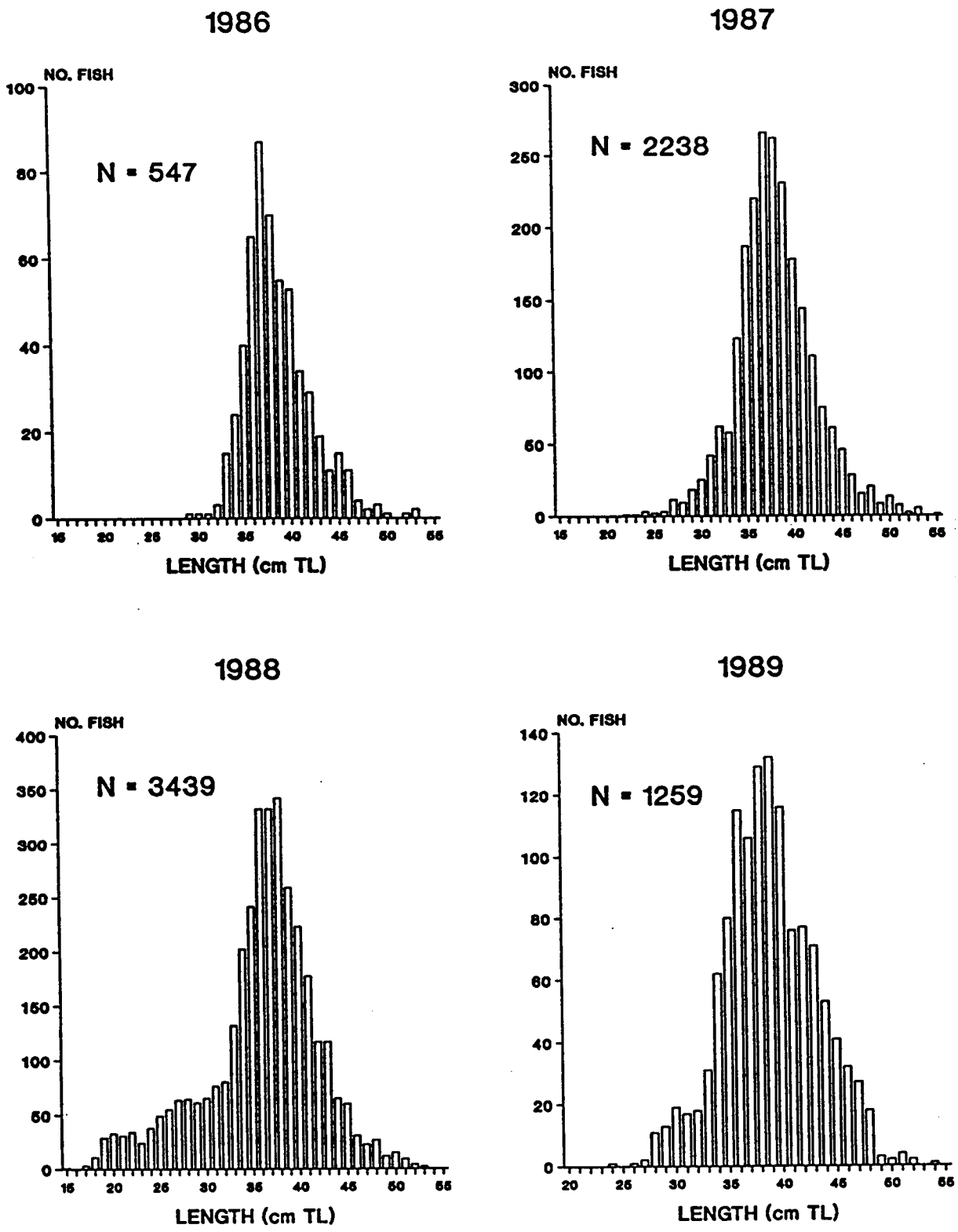

Figure 11: Smooth oreo length samples collected by observers, 1986–1989.

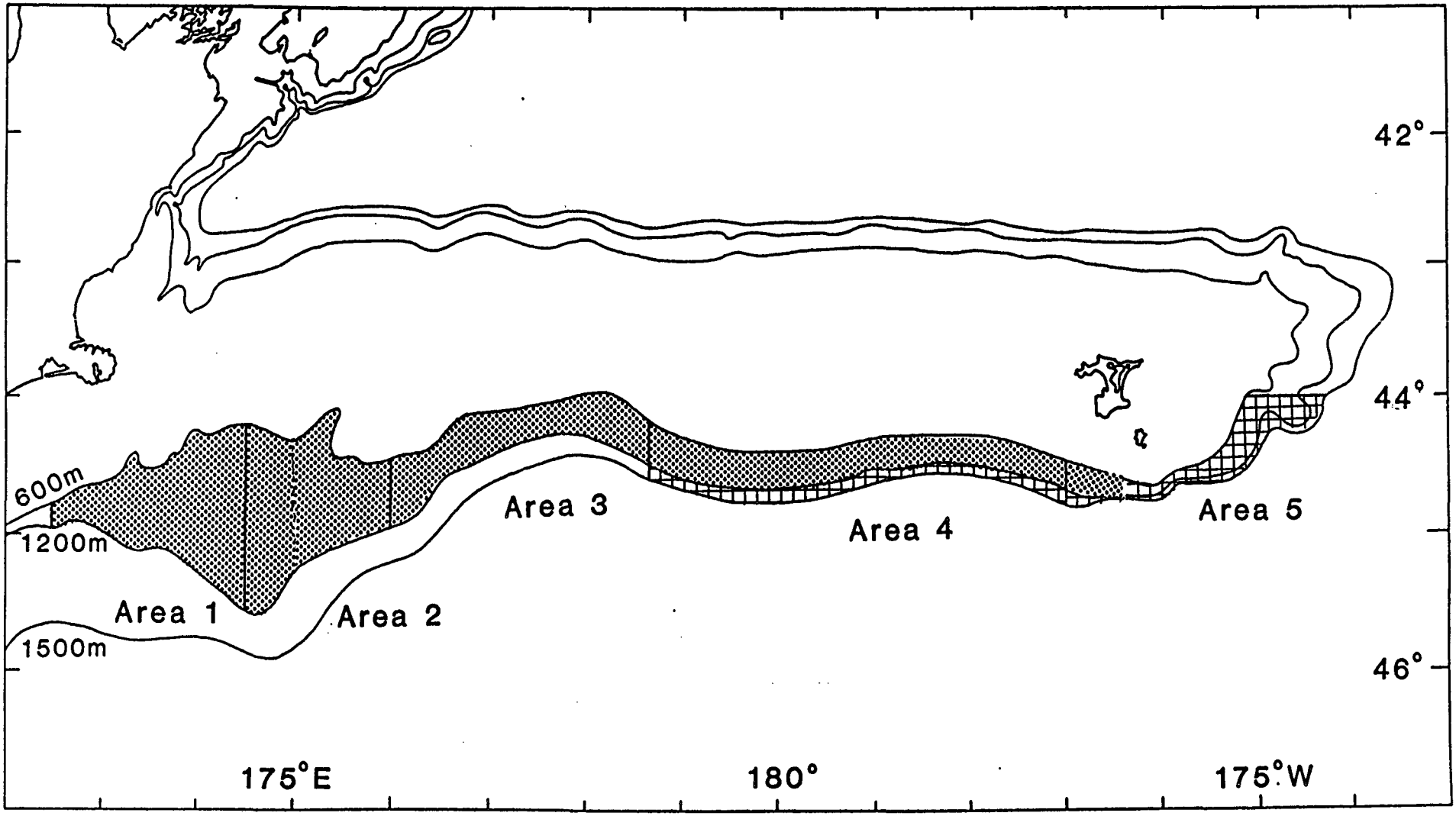

Figure 12: Areas for the 1986, 1987 (subareas 1–4, stippled) and 1990 (subareas 1–5, stippled and squares) south Chatham Rise surveys.

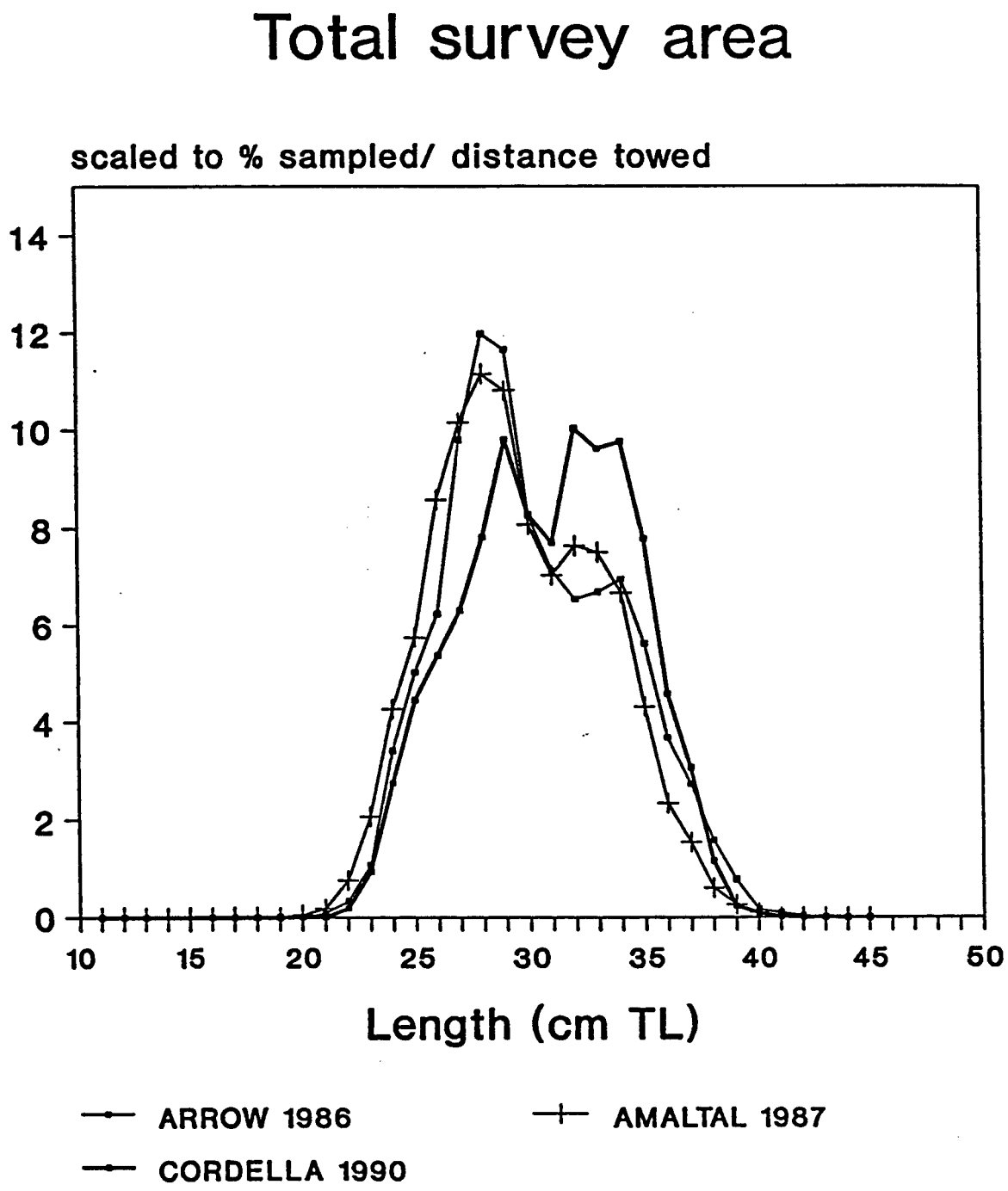

Figure 13: Scaled length distributions for black oreo collected during the 1986, 1987 and 1990 south Chatham Rise surveys.

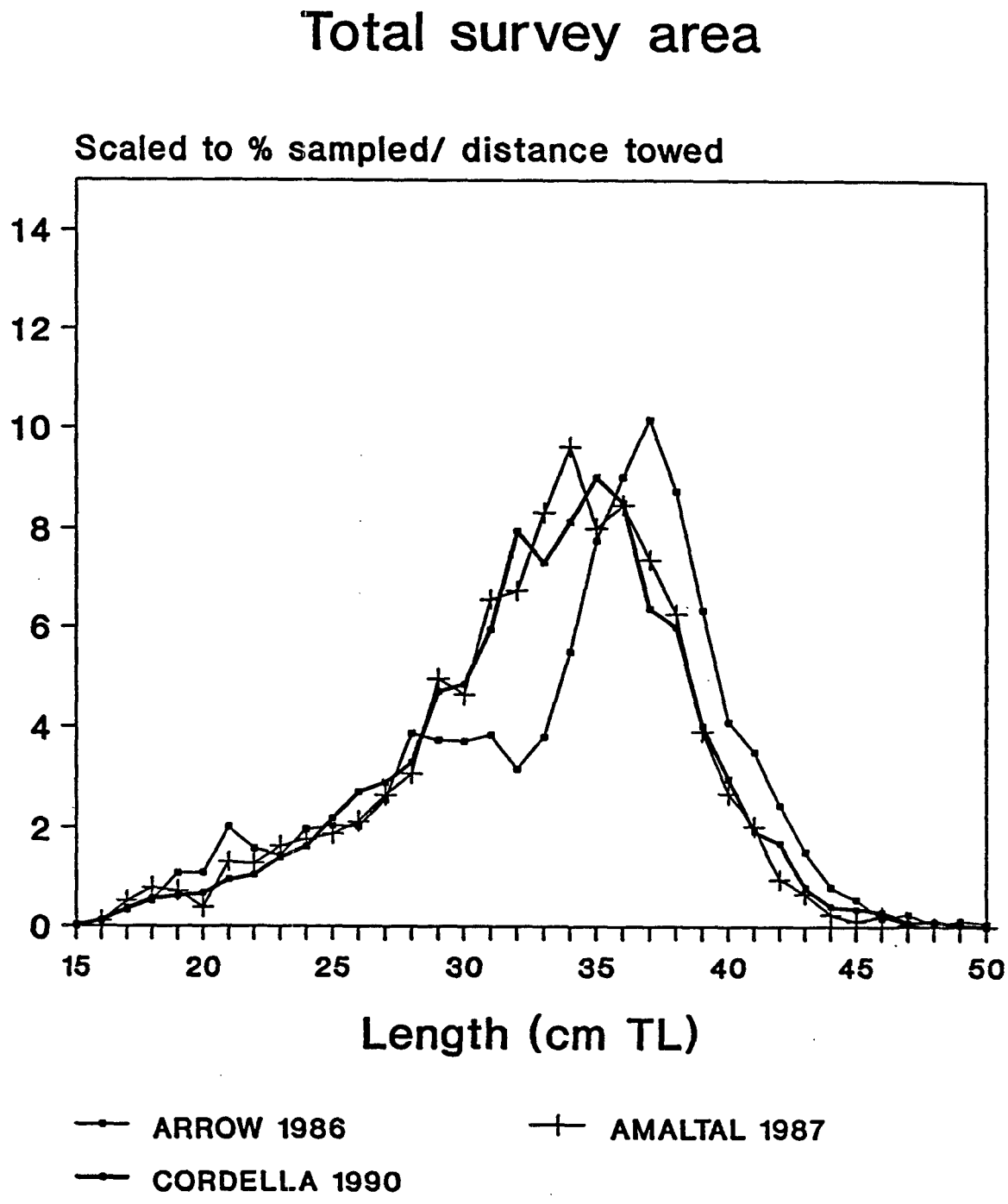

Figure 14: Scaled length distributions for smooth oreo collected during the 1986, 1987 and 1990 south Chatham Rise surveys.

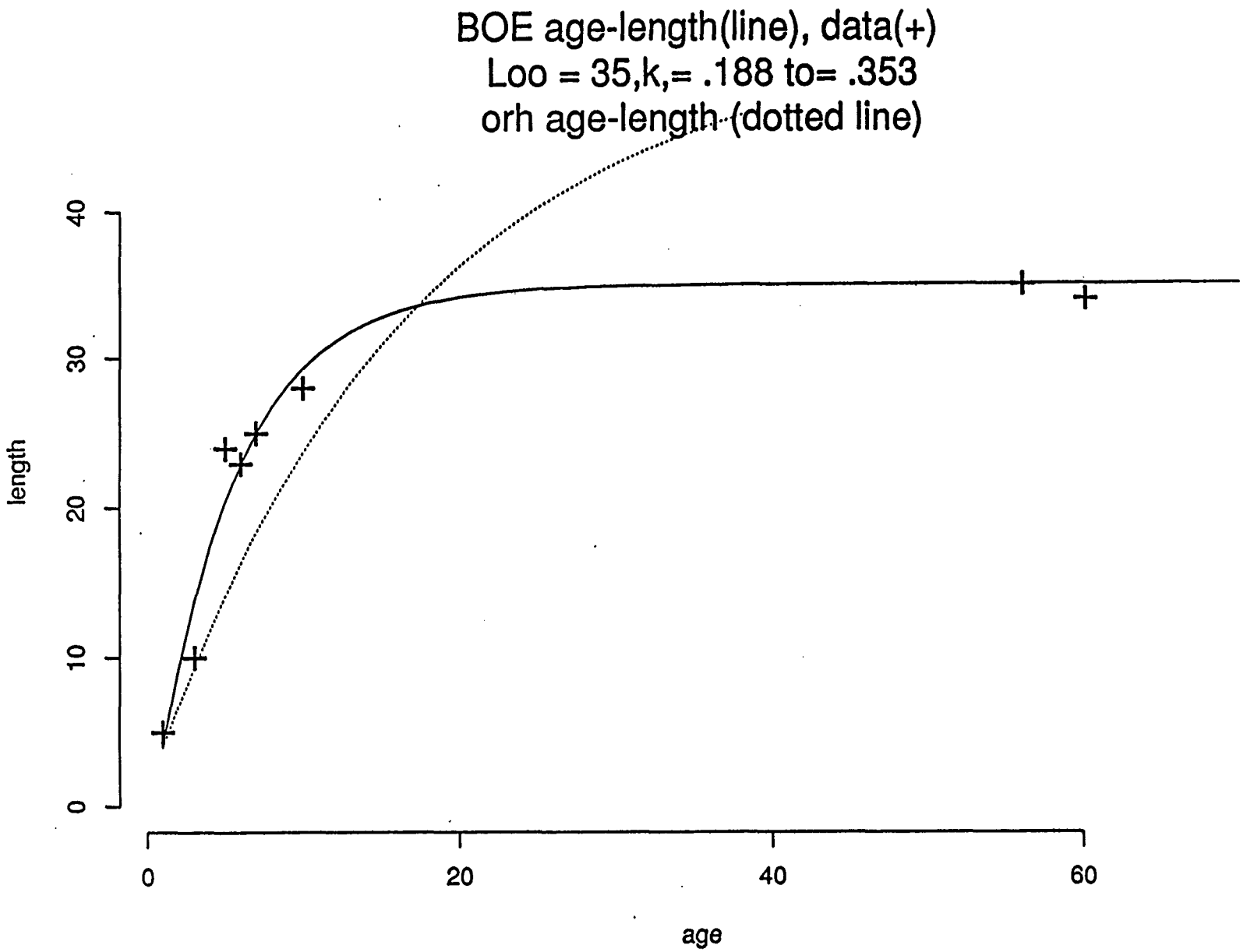

Figure 15: von Bertalanffy curve fitted to preliminary unvalidated otolith age estimation data (solid line) for black oreo from the south Chatham Rise. Orange roughy data, converted from standard to total length for comparison is the dotted line.

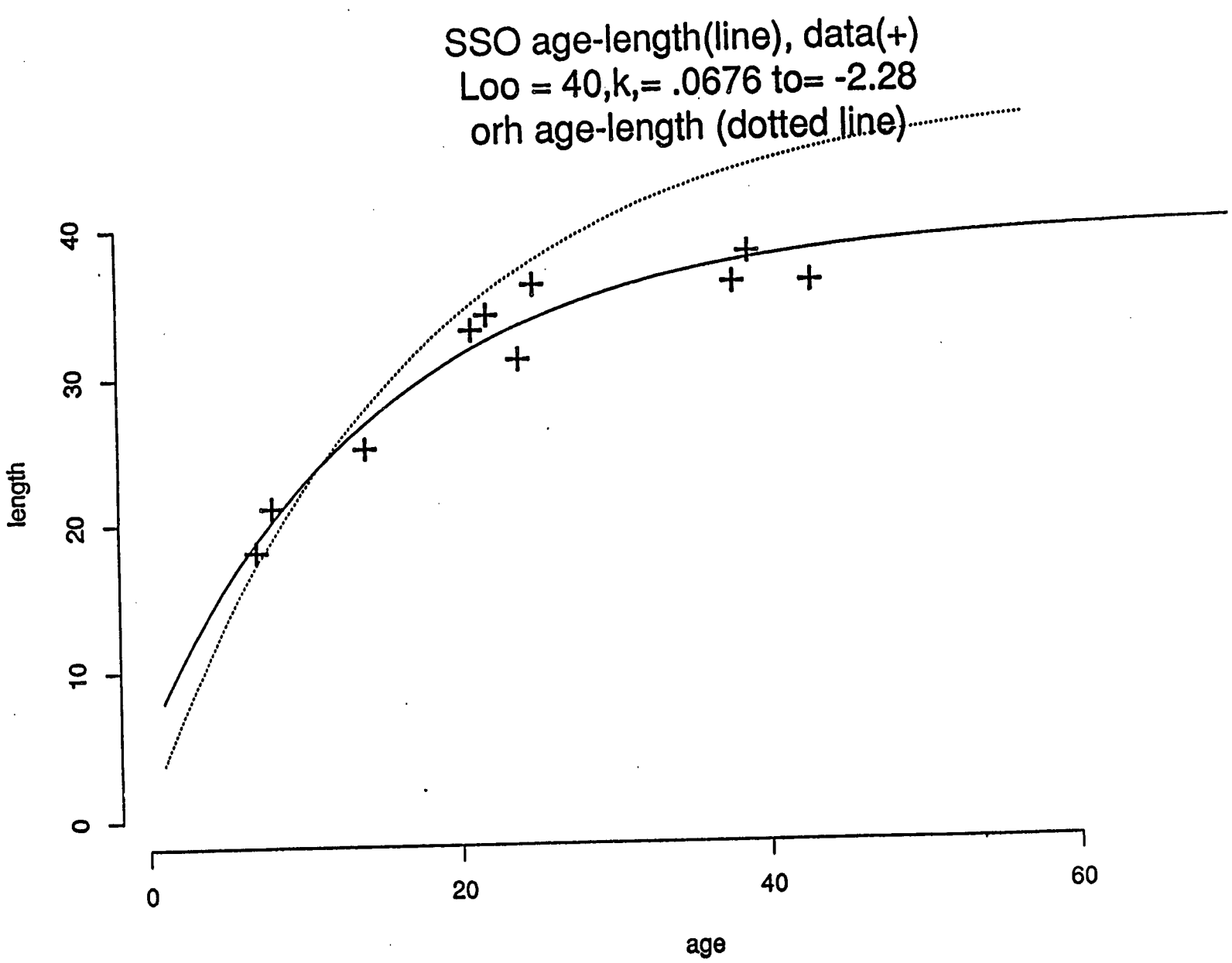

Figure 16: von Bertalanffy curve fitted to preliminary unvalidated otolith age estimation data (solid line) for smooth oreo from the south Chatham Rise. Orange roughy data, converted to total length, is the dotted line.