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Te Tautiaki i nga tini a Tangaroa

**Summary of black oreo, smooth oreo, and orange roughy biological data
collected from the OEO 3A fishery during the 1999–2000 fishing year**

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**Fisheries Information Systems Ltd.
43B Anglesea Street
Freemans Bay
Auckland 1**

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EXECUTIVE SUMMARY

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During 1999–2000, a high level of at-sea monitoring of the OEO 3A fishery was achieved by MFish scientific observers and observers contracted by the fishing industry. The presence of the observers in the fishery was principally to monitor the catch of black and smooth oreo, including the collection of length, sex, and gonad condition data from the catch of both species.

Biological data were collected from the catch of 359 trawls within the OEO 3A fishery: 254 and 194 samples were collected from the catches of black oreo and smooth oreo, respectively. Forty samples were also collected from the orange roughy catch, principally taken as a bycatch of the target oreo fishery.

In previous years, observer coverage in the OEO 3A fishery has generally been low and, consequently, limited biological data were collected from the black and smooth oreo catch. In contrast, the large number of samples collected from the fishery in 1999–2000 has enabled the length compositions of the catch of the two oreo species to be determined with a high level of precision.

For black oreo, the length composition of the catch comprised a single mode occupying the 24–40 cm total length (T.L.) range with a modal peak at 31–32 cm T.L.. The smooth oreo catch comprised a broader length mode, occupying the 20–50 cm T.L. length range, with a modal peak between 33 and 36 cm. For both species, female fish accounted for about 55% of the catch (by number).

Ovarian staging data were collected from a relatively limited period and were not adequate to reliably determine the seasonal trend in the ovarian development cycle for either black oreo or smooth oreo.

1. INTRODUCTION

The OEO 3A fishstock supports an important deepwater trawl fishery for both smooth oreo and black oreo (Annala et al. 2000). The fishery is currently managed under a combined TACC for three oreo species, specifically smooth (SSO), black (BOE), and spiky (SOR) oreo.

For the 1999–2000 fishing year, the TACC for OEO 3A was 5900 tonnes. In addition, for 1999–2000, a further catch limit was set to restrict the catch of smooth oreo within OEO 3A to 1900 t. This catch limit was implemented through a formal agreement between The Orange Roughy Management Company Ltd (ORMC), representing the OEO 3A quota owners, and the Minister of Fisheries.

During 1999–2000, a monitoring regime was instigated in the OEO 3A fishery to support the introduction of the smooth oreo catch limit. The monitoring programme included a high level of observer coverage in the fishery using both the MFish Scientific Observer Programme (SOP) and observers contracted by the fishing industry. The observers were required to monitor the species composition of the OEO 3A catch and to undertake biological sampling of the main species caught.

This report summarises the results of catch sampling conducted by observers in the OEO 3A fishery during 1999–2000.

2. METHODS

2.1 Sampling protocol

Biological sampling was conducted by Ministry of Fisheries scientific observers and by fisheries observers contracted by individual fishing companies. The industry contracted observers were provided by Fisheries Audit Services Ltd and by Fisheries Management Services Ltd.

The MFish scientific observers and the industry contracted observers were issued with slightly different instructions for conducting sampling of the oreo catch. The instructions for scientific observers are documented in the Biological Data Collection Manual compiled by the Ministry of Fisheries Observer Programme. Industry contracted observers were issued with the Deepwater Biological Sampling Manual that was developed for use on board commercial vessels conducting sampling in the deepwater exploratory fisheries. The latter document was largely based on the instructions issued to scientific observers, although there are some differences regarding the protocol for selecting the catch to be sampled and the data collected.

A copy of the sampling instructions issued to the MFish scientific observers is given in Appendix A.

2.1.1 Scientific observers

Scientific observers were instructed to sample the oreo catch from at least one trawl per day. The instructions are not explicit as to whether the catches of one or both oreo species are to be sampled from the trawl, although for 75% of trawls sampled by the SOP the catch of only one species was measured. Overall, the SOP sampled an average of 1.8 trawls per day and collected an average of 2.2 samples of the two oreo species per day.

Samples of 100–200 fish per species were selected at random from the unsorted catch of the trawl. The weight of sampled component of the catch was determined (to the nearest kilogram). Fish were measured to the nearest centimetre below the actual fish length (total length for oreo, standard length for orange roughy) and sexed. Scientific observers were instructed not to determine the gonad developmental stage of the oreos sampled.

For each trawl, detailed catch and effort data, including the date, time, location, and weight of the catch of each species, were recorded in the observer's logbook.

In addition to sampling the oreo catch, a few samples were collected from the catch of orange roughy taken during the fishing trip.

2.1.2 Industry contracted observers

The sampling instructions issued to the industry contracted observers were those developed for at-sea catch sampling by trained vessel personnel. These instructions specify the collection of length and biological data from the catch of smooth and black oreo from only one trawl for each day of fishing. The sampled trawl was selected by allocation of a random time to the day of fishing.

However, since the observers involved in the current programme were employed specifically to monitor the catch, there was sufficient time available to sample the catch from more than one trawl per day. Consequently, the daily random selection of the sampled trawl was frequently augmented by the opportunistic sampling of additional trawl catches. In practice, the industry contracted observers sampled an average of 1.4 trawls per day of fishing and collected 2.3 samples from daily catch of the two oreo species.

For each species (SSO and BOE), a sub-sample of 100 fish was selected at random from the entire catch of a trawl. Fish were measured to the nearest centimetre below the actual fish length (total length [T.L]), sex was determined, and female fish were staged using a five-stage ovarian development scale (Table 1).

Details of the sampled trawl were recorded on the Ministry of Fisheries Trawl, Catch, Effort, and Processing Return (TCEPR), including the location of the trawl, time of the trawl and estimated catch of each of the main species caught. A small number of trawls were sampled by observers on board vessels recording catch and effort data on MFish CELR forms. Details of the precise location of these trawls were not available.

Table 1: Female gonad maturity stages used during the sampling programme.

Stage	Definition
1	Immature/Resting
2	Maturing
3	Ripe
4	Running Ripe
5	Spent

2.2 Data analysis

The weight of the fish making up the length samples was available from trawls sampled by the SOP. However, for the trawls sampled by industry contracted observers, the weight of fish included in each sample was determined using the length-weight relationships for each species given in Annala et al. (2000) (Table 2). For each species, the proportion of the total

catch sampled from each trawl was determined from the ratio of the sample weight to the estimated weight of the species catch.

Table 2: Variables of the length-weight relationships used to determine the weight of the catch sampled. Individual fish weight is estimated by the equation $a \cdot \text{length}^b$, where weight is grams and length centimetres (source: Annala et al. 2000, table 5, p. 295).

	Sex	a	b
Black oreo	Males	0.016	3.06
	Females	0.008	3.28
Smooth oreo	Males	0.032	2.87
	Females	0.029	2.90

Length frequency distributions were determined for the three species sampled from trawls within the OEO 3A fishstock area. To determine a cumulative length composition, individual length samples were combined, weighted by the relative size of the catch sampled.

The coefficient of variation of the estimates of proportions at length was calculated for the length frequency distributions following Gavaris & Gavaris (1983).

Gonad staging data were summarised by month to investigate seasonal trends in the ovarian development of each of the three species sampled.

3. RESULTS

3.1 Distribution of sampling effort

The MFish Scientific Observer Programme covered a total of nine fishing trips within OEO 3A between October 1999 and February 2000. Biological data were collected from 196 trawls with a total of 222 samples collected from the catch of the three species.

A further 163 trawls were sampled by the industry contracted observers resulting in the collection of 288 samples from the catch of the three species. Of the samples collected, 22 were not included in the calculation of the combined length frequency distributions as no corresponding catch data were available for these records.

Most of the sampled trawls were from the main OEO 3A fishing grounds along the south-western edge of the Chatham Rise (Figure 1) (Coburn et al. 1999).

A few samples were also collected from trawls off the Kaikoura coast and along the north-western edge of the Chatham Rise (Figure 1). These trawls were targeting orange roughy and samples were collected from both the orange roughy catch and the oreo bycatch of these trawls.

A total of 254 samples was collected from the OEO 3A black oreo catch representing the measurement of about 26 000 fish (Table 3). Sampling was conducted from the October 1999 to May 2000, although only limited sampling was conducted in October, December, and March (Table 4).

A total of 194 samples was collected from the OEO 3A smooth oreo catch (Table 3) and the monthly distribution of sampling effort was comparable to that of black oreo (Table 4).

A few samples of the orange roughy catch from within OEO 3A were also collected. Most of the sampled orange roughy catches were small (less than 500 kg), with the total weight of the catch sampled accounting for only 21 t (Table 3). The SOP collected all orange roughy samples and, consequently, sampling effort was limited to the October 1999–February 2000 period (Table 4).

Table 3: Summary of catch sampling of the black oreo, smooth oreo, and orange roughy catches from the OEO 3A fishery during 1999–2000. Reported estimated catch from Annala et al. (2001) ;-, not available.

	Black oreo	Smooth oreo	Orange roughy
Number of samples	254	194	40
Number of fish measured	26 393	19 061	1 354
Total weight of catch sampled (t)	1 176.9	474.0	20.9
Sampled catch as percentage of total reported estimated catch.	29	27	-

Table 4: Percentage distribution of samples collected by species and month from the OEO 3A fishery during the 1999–2000 fishing year.

	Month								Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Black oreo	6	31	1	17	16	4	12	12	254
Smooth oreo	5	21	2	19	18	6	13	16	194
Orange roughy	3	13	10	33	43	0	0	0	40

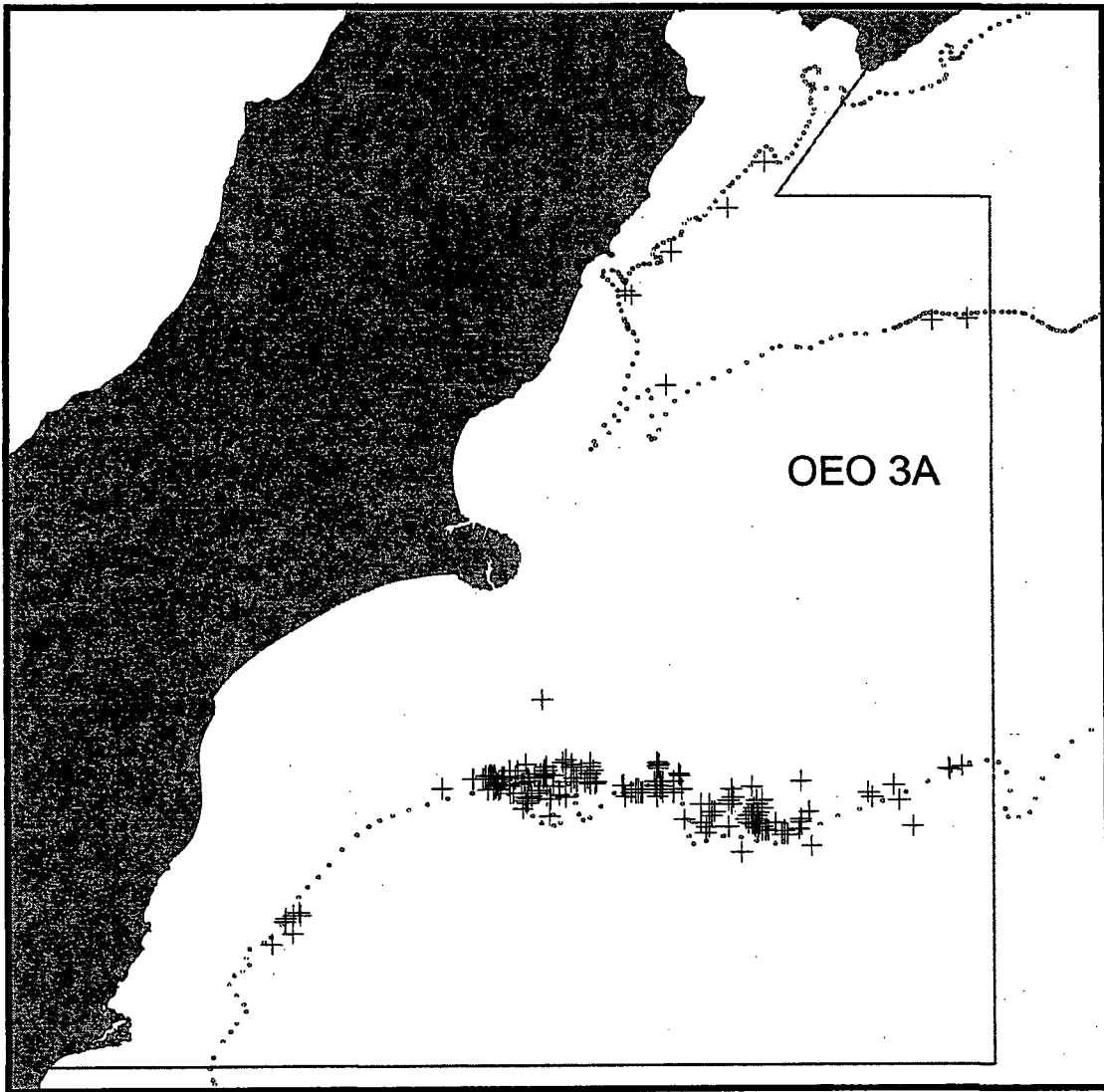


Figure 1: Distribution of trawls sampled from the OEO 3A fishery during the 1999–2000 fishing year (crosses). The solid line represents the boundary of the OEO 3A fishstock area. The dotted line represents the 1000 m depth contour.

3.2 Length compositions

3.2.1 Black oreo

The length composition of black oreo catches from OEO 3A comprised a single mode occupying the 24–40 cm T.L. range and was dominated by a strong modal peak at 31–32 cm T.L. (Figure 2). Estimates of proportion at length for the main length classes were determined with a high level of precision, with coefficients of variation of 4–7%.

Female fish were generally larger and attained a higher maximum length than males (Figure 3). Sampled catches were slightly skewed to females, accounting for 56% of the sampled catch (by number).

3.2.2 Smooth oreo

The smooth oreo catch comprised a broader length mode occupying the 20–52 cm T.L. range and a strong modal peak at 34–35 cm T.L. (Figure 4). The length composition was determined with high precision, with coefficients of variation of 5–8% for the main length classes.

The catch composition was slightly skewed to females which accounted for 55% of the sampled catch by number. Similar to black oreo, female smooth oreo attain a larger maximum length than males (Figure 5).

3.2.3 Orange roughy

The length composition of orange roughy sampled from catches in the OEO 3A area comprised fish within the 23–49 cm S.L. range (Figure 6). The distribution is characterised by two poorly defined length modes, at 27–32 cm and 33–40 cm, and a declining proportion of fish in the larger length classes. The moderate-high coefficients of variation (20–40%) associated with the main length classes indicate that the length composition is poorly determined.

The sex ratio of the sampled catch was skewed to male fish, which accounted for 60% of the catch (by number). However, the relatively small sample size means that the length compositions of both male and female fish are poorly determined (Figure 7).

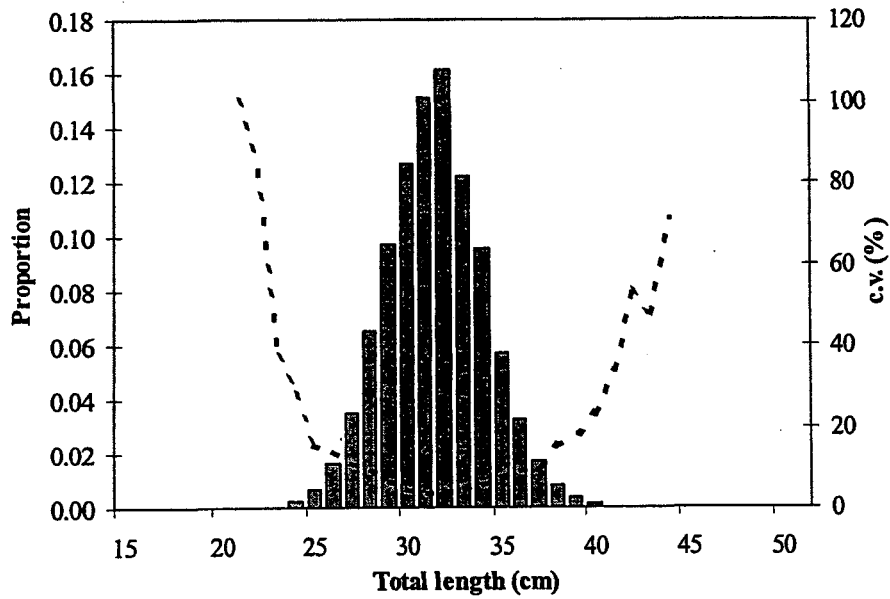


Figure 2: Length frequency distribution for black oreo (sexes combined) sampled from the OEO 3A fishery during 1999–2000. The dashed line represents the coefficient of variation associated with the estimate of proportion at length.

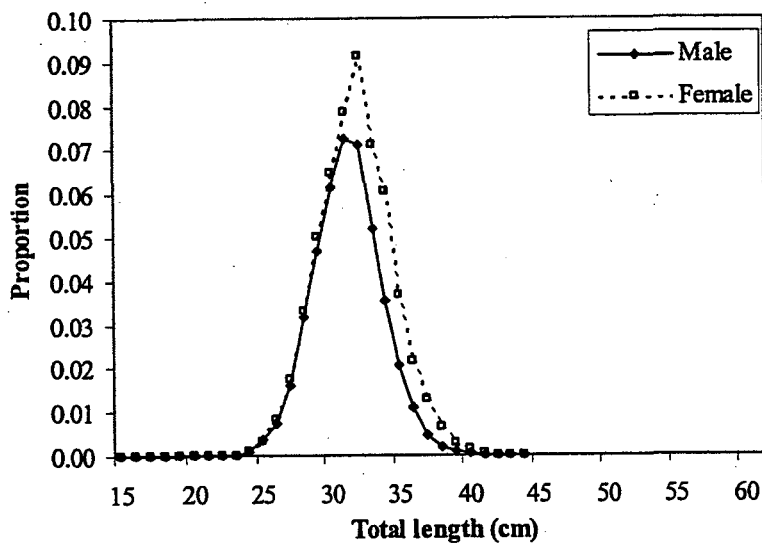


Figure 3: Length frequency distribution for male and female black oreo sampled from the OEO 3A fishery during 1999–2000.

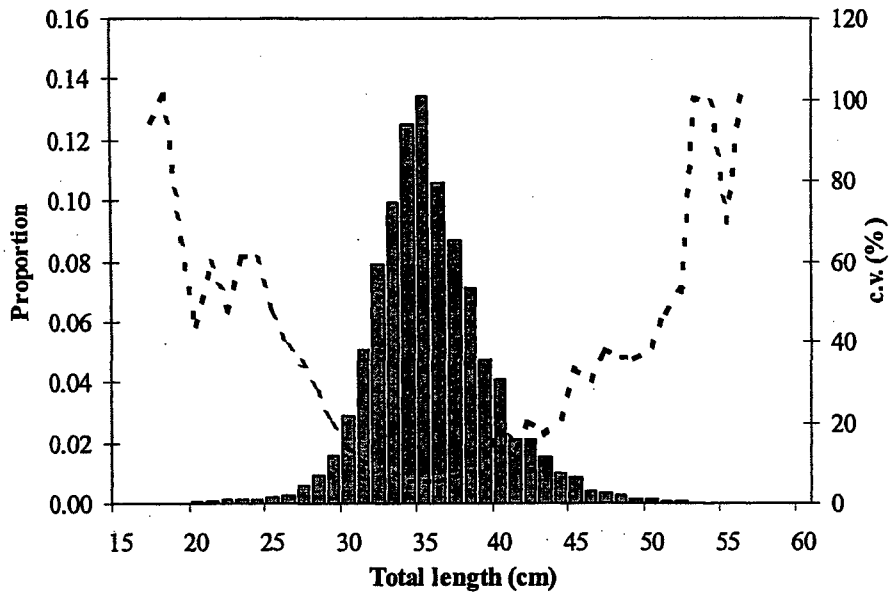


Figure 4: Length frequency distribution for smooth oreo (sexes combined) sampled from the OEO 3A fishery during 1999–2000. The dashed line represents the coefficient of variation associated with the estimate of proportion at length.

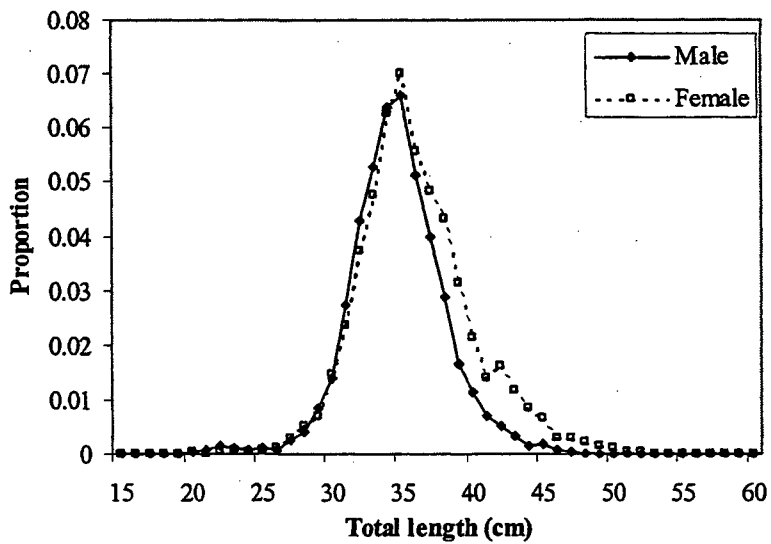


Figure 5: Length frequency distribution for male and female smooth oreo sampled from the OEO 3A fishery during 1999–2000.

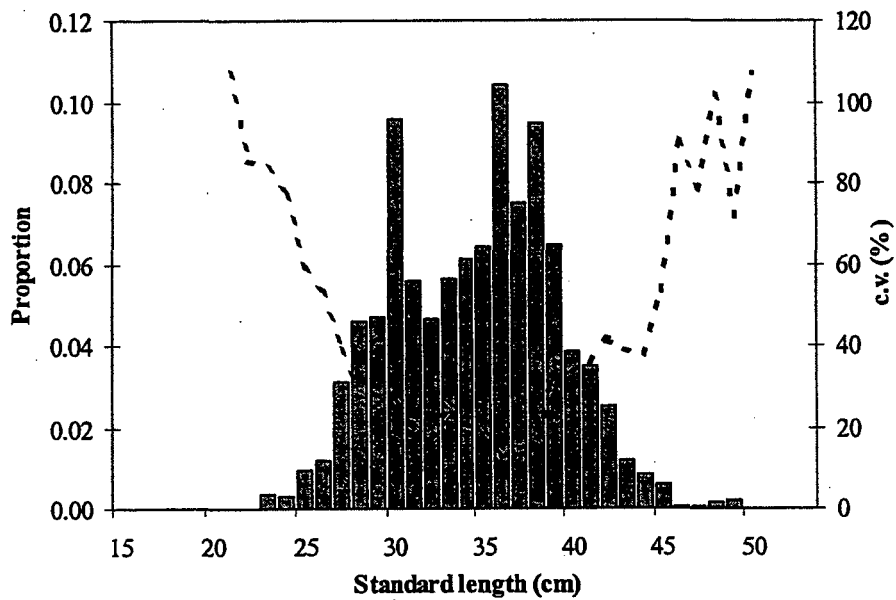


Figure 6: Length frequency distribution for orange roughy (sexes combined) sampled from the OEO 3A fishery during 1999–2000. The dashed line represents the coefficient of variation associated with the estimate of proportion at length.

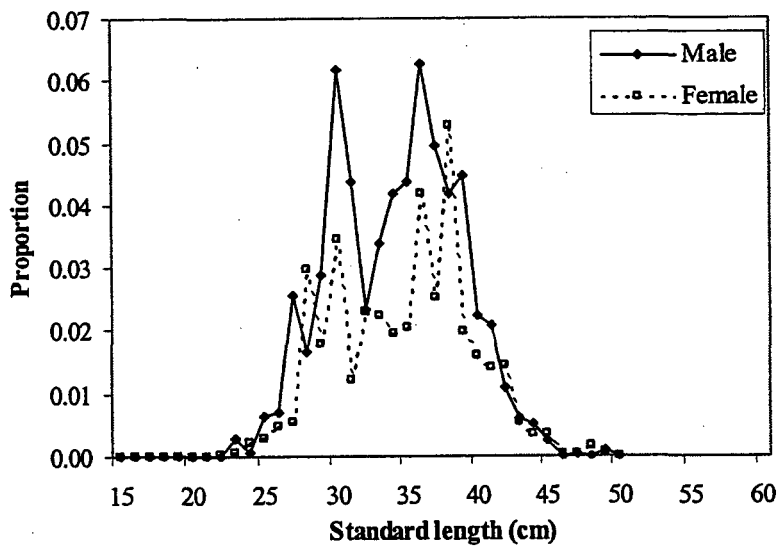


Figure 7: Length frequency distribution for male and female orange roughy sampled from the OEO 3A fishery during 1999–2000.

3.3 Ovarian development

Gonad staging data were examined to investigate seasonal trends in ovarian development for each of the three species sampled. Most of the samples were collected from the fishery during the first half of the 1999–2000 fishing year. The few samples collected during the remainder of the year provide limited data to define trends in ovarian condition during this period.

3.3.1 Black oreo

Ovarian staging data were collected from the sampled black oreo catch during November 1999 and monthly from January to May 2000 (Table 5). Most of the fish sampled were in the immature/resting (stage 1) and maturing (stage 2) stages of ovarian development.

The relative proportion of stage 1 and stage 2 fish was variable from October to May, although there was a general decline in the proportion of stage 2 fish between January and May (Figure 8). The decline in the proportion of stage 1 and stage 2 female fish in April corresponded to a substantial increase in the proportion of ripe (stage 3) fish in the sampled catch.

Ripe female fish were present in the catch between January and May, but were most prevalent during April, accounting for about 40% of fish sampled. Running ripe (stage 4) black oreo were sampled in the catch during April, albeit in small numbers, and were negligible during the other months sampled (Figure 8).

Spent fish were virtually absent from the catch during the sampling period (Table 5).

3.3.2 Smooth oreo

Ovarian staging data were collected from the sampled smooth oreo catch from each month between October 1999 and May 2000, except December (Table 6). Most of the fish sampled were in the stage 1 and stage 2 of ovarian development. During January to May, there was a general decline in the combined proportion of fish in these stages of gonad development, with a corresponding increase in the proportion of stage 3 fish in the catch (Figure 9).

Stage 4 fish accounted for a small proportion of the female smooth oreo sampled in November, March, and April, and spent fish were virtually absent from the sampled catch (Table 6).

3.3.3 Orange roughy

The collection of gonad sampling data from the orange roughy catch was restricted to a few samples collected between October and February. Catches of orange roughy sampled were almost entirely dominated by stage 1 and stage 2 fish (Table 7).

Table 5: Proportion of female black oreo at each gonad stage by month from catches sampled during the 1999–2000 fishing year.

Month	Percentage at stage					No. of fish
	1	2	3	4	5	
Oct						0
Nov	66.3	28.1	5.1	0.4	0.0	1 132
Dec						0
Jan	17.1	66.8	14.5	0.6	1.0	627
Feb	44.6	46.6	8.7	0.0	0.0	789
Mar	47.8	48.0	4.0	0.0	0.2	500
Apr	18.1	42.0	36.6	2.9	0.4	1 294
May	54.1	22.9	4.2	0.4	0.0	1 389

Table 6: Proportion of female smooth oreo at each gonad stage by month from catches sampled during the 1999–2000 fishing year.

Month	Percentage at stage					No. of fish
	1	2	3	4	5	
Oct	55.6	44.4	0.0	0.0	0.0	36
Nov	79.2	14.0	5.0	1.9	0.0	808
Dec						0
Jan	35.2	60.5	4.1	0.0	0.2	463
Feb	46.3	42.0	11.6	0.0	0.0	723
Mar	51.6	38.6	8.9	1.0	0.0	508
Apr	44.2	35.0	18.4	2.3	0.1	1 355
May	31.9	51.4	16.7	0.0	0.0	1 286

Table 7: Proportion of female orange roughy at each gonad stage by month from catches sampled during the 1999–2000 fishing year.

Month	Percentage at stage					No. of fish
	1	2	3	4	5	
Oct	100.0	0.0	0.0	0.0	0.0	70
Nov	7.7	92.3	0.0	0.0	0.0	26
Dec	17.9	92.0	0.0	0.0	0.0	28
Jan	23.0	75.7	1.4	0.0	0.0	148
Feb	3.7	95.4	0.0	0.4	0.4	241
Mar						0
Apr						0
May						0

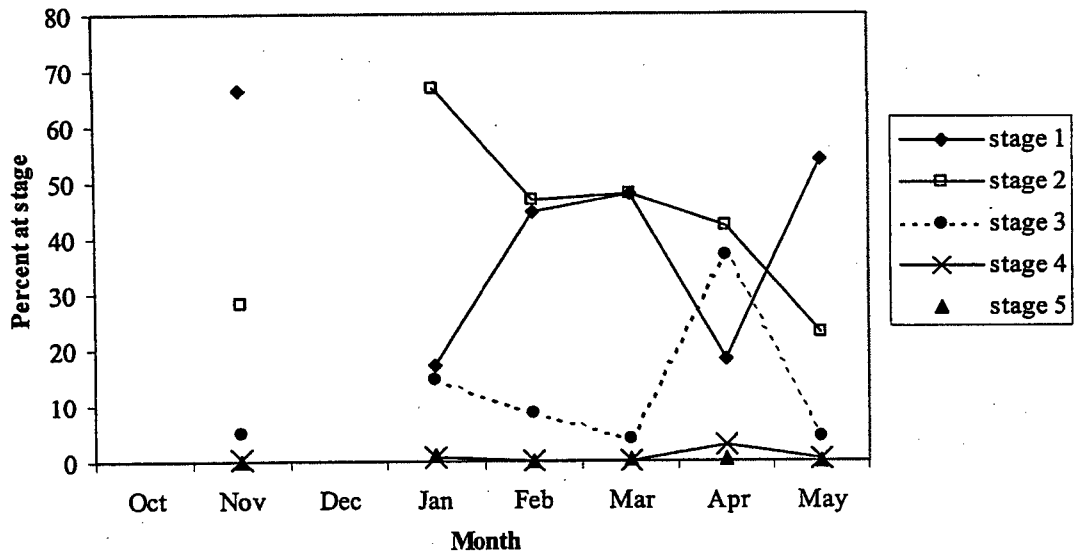


Figure 8: Seasonal trends in the proportion of female black oreo by gonad stage from catches sampled from the OEO 3A fishery.

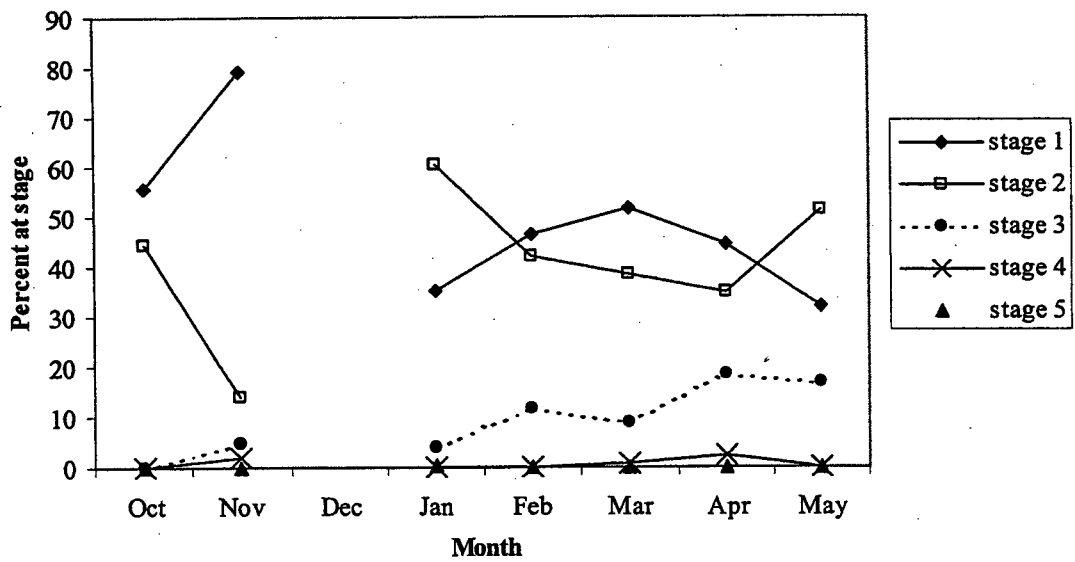


Figure 9: Seasonal trends in the proportion of female smooth oreo by gonad stage from catches sampled from the OEO 3A fishery.

4. DISCUSSION

During the 1999–2000 fishing year, a high proportion of the fishing activity in the OEO 3A fishery was monitored by the MFish Scientific Observer Programme and industry contracted observers. One of the roles of the observers was to collect biological data (length, sex, and ovarian state) from the catch from the fishery. The high level of observer coverage in 1999–2000 resulted in the collection of the most comprehensive set of data available from the OEO 3A commercial fishery. These data enabled the length composition of the catch of black and smooth oreo from the OEO 3A fishery to be determined with a high level of precision. This information has direct application in the ongoing monitoring of the catch composition of the OEO 3A fishery and incorporation in the relevant species stock assessments.

The gonad staging data collected from the fishery was less equivocal. Sampling was conducted between October and May only, and the lack of data from the remainder of the fishing year prevents the determination of the entire ovarian maturation cycle.

For both black and smooth oreo, there was no strong seasonal trend in gonad development, usually characterised by an increase in the prevalence of pre-spawning fish, followed by a peak in the proportion of actively spawning fish, and a subsequent increase in the prevalence of spent fish. This may be attributable to the high proportion of the sampled female fish that were immature, given the high proportion of fish below the mean length of sexual maturity; 34 cm T.L. for black oreo and 40 cm T.L. for smooth oreo (Annala et al. 2000). This is evident from the high proportion of immature/resting fish sampled from the catch throughout the year. The high proportion of immature fish in the sampled catch may obscure any significant seasonal trends in ovarian development of mature fish in the sampled catch.

Nevertheless, for both oreo species there was an increase in the proportion of ripe female fish in the sampled catch during March–May, particularly evident in the high proportion of ripe female black oreo sampled during April 2000. These trends persisted, and were exaggerated, when only fish larger than the mean length of sexual maturity were included in the analysis. This observation may indicate the occurrence of a prolonged period of gonad development, the occurrence of spawning during autumn, or problems in the accurate staging of black and smooth oreo.

Further, very few active spawning fish were sampled from the catch between early spring and summer. This observation is inconsistent with the accepted premise that both species spawn from late October to at least December (Annala et al. 2000). In 1999–2000, sampling was relatively limited during this period, and ongoing sampling during 2000–01 may improve the definition of the spawning season for both black and smooth oreo.

5. ACKNOWLEDGMENTS

This work was commissioned and funded by The Orange Roughy Management Company Limited, representing quota owners in the OEO 3A fishery. ORMC managed the collection of biological data by industry contracted observers. Data collected by the Scientific Observer Programme were provided by the Ministry of Fisheries. George Clement (ORMC) provided comment on a draft version of the report.

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Appendix A. Excerpt from Biological Data Collection Manual, Ministry of Fisheries Observer Programme

OREO SAMPLING PROGRAMME

SAMPLING POINT

On each vessel a sampling point or points should be determined where samples can be obtained. Record this point at the start of the trip with a brief description of the method used to take samples. This point should not change from day to day, but remain fixed for the whole trip. The essential feature of the sampling point chosen is that the BOE/SSO **must not be sorted** by size before reaching the sampling point. Fish should all be from one trawl shot. All fish coming aboard should pass the sampling point **before sorting** occurs; e.g., fish pond, conveyor belt. Where there are several fish ponds or conveyor belts in use, an equivalent sampling point may be used on the alternative line. The selection of random samples from the catch should be such that all fish coming aboard have an equal chance of being chosen in the sample.

Sampling should be convenient for observer and vessel personnel, easily completed in a short time frame and unambiguous; i.e., sampling point should be pre-determined.

DATA RECORDING

Each observer will be provided with a supply of length frequency forms, and otolith envelopes. The data should be recorded directly onto these forms; no transcribing is required. The following information should be recorded for each sample taken:

(a) **Tow Information**

Record the date, trip code, time sample was taken, initials of sampler and the tow number from which the sample came. The tow number should correspond to the station number recorded in the observer catch effort log book. Take sample weight. Record all this information on the length frequency form.

(b) **Fish Measurements**

Fish should be measured and sexed (criteria for determining the sex of oreo are described in the guide provided: Figure 2). **Do not stage the gonads.** For both males and females use a stroke to denote one fish. A completed example of an oreo length frequency form is provided.

If time does not permit the whole sample to be sexed, **do not** record any data for those fish you do not process fully. Either sample a smaller number of fish, or do not take any sample.

Each length frequency sample should be between 100 and 200 fish per species. The entire sample of fish should be drawn at one time, and it may be convenient to case up the sample into fish boxes before measuring and sexing.

Fish should be measured to the nearest 1 cm below the actual length of the fish; e.g., 32.8 cm is recorded as 32 cm. **Total length** (code as 2) is required; i.e., measured from

the tip of the closed jaw to the end of the tail. Damaged fish should not be recorded if their total length cannot be measured.

(c) Collection of otoliths

No otoliths are required unless specifically requested.

SAMPLE FREQUENCY

At least one sample should be taken from the oreo catch by each observer each day, and where present of either species. Efforts should be made to sample the oreo even when caught as by-catch with orange roughy. Please attempt to measure at least one of the oreo species as well as the ORH if you have time. Record details of catch accurately in the observer catch effort log book, especially any details about discards.

Collection of small oreo: please collect any BOE < 18 cm Total Length and SSO < 16 cm Total Length (see diagram page 3 in this section and Appendix 2).

CHECKLIST

BLACK AND SMOOTH OREOS	
Species codes	BOE SSO
Measurement method : code	TL : 2
Sample Size	100-200
Otoliths	0 (unless specifically requested)

- Select sampling point.
- Begin sampling at selected time.
- Record date, time, trip, tow number, and initials on length frequency form.
- Draw sample of either BOE or SSO all at one time; get a weight of the total sample for that species, and record details on the length frequency form.
- Measure and sex each fish in the sample, and record.
- Ensure length frequency form is correctly filled out.