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A summary of biological information on the New Zealand fisheries for orange roughy (*Hoplostethus atlanticus*) for the 1996–97 fishing year

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This series documents the scientific basis for stock assessments and fisheries management advice in New Zealand. It addresses the issues of the day in current legislative context and in the time frames required. The documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

A summary of biological information on the New Zealand fisheries for orange roughy (*Hoplostethus atlanticus*) for the 1996–97 fishing year

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N.Z. Fisheries Assessment Research Document 98/18. 25 p.

1. EXECUTIVE SUMMARY

1. Size and reproductive data on orange roughy collected by observers on New Zealand fishing vessels from 247 tows inside and outside the EEZ during the 1996–97 fishing year were examined and summarised by fishery. Research survey biological data collected during this year were also summarised.
2. Size frequency distributions were strongly unimodal in all areas examined, but mean length was variable ranging from 29.5 to 38.7 cm for male and 30.3 to 40.5 cm for female fish.
3. Sex ratios showed no general trend with most fisheries within 10 percentage points of a 50:50 ratio. Where strong biases were detected (Arrow 71.2% male, Lord Howe 39.5% male) sample sizes were relatively small, except in the Mercury-Colville fishery (ORH 1) which was 68.9% male and had a relatively large sample size.
4. Reproductive data showed strong seasonal trends with spawning in June and July. For the Challenger and Mercury-Colville fisheries there were sufficient data to pinpoint the spawning period with some confidence.

2. INTRODUCTION

This document presents the first summary of biological information on orange roughy collected directly from the fishery by observers of the Ministry of Fisheries (MFish) Scientific Observer Programme (SOP). Biological data collected by observers can be important inputs to stock assessment, particularly for areas where there are no independent estimates of biological parameters, such as age at recruitment or age at maturity, available from research surveys. These parameters can be estimated by derivation from observer-collected size and reproductive stage information, combined with an age-length key. Reproductive stage data collected by observers are also important for examining trends in fisheries, such as changes in timing and location of spawning activity. Changes in mean length over time can sometimes help to identify areas suffering heavy exploitation and give clues to recruitment patterns. Examination of sex ratio information can be used to indicate a selectivity bias in the fishery.

Data were available from most of the orange roughy fisheries currently being fished by New Zealand vessels, the most significant exception being the fishery on the Louisville Ridge to the east of New Zealand. In this report we present data on size and reproductive state collected from samples from trawls made throughout the EEZ between 1 October 1996 and 30 September 1997.

3. DATA SOURCES

Data were collected by SOP observers hosted aboard commercial fishing vessels. Observers took measurements from random samples of about 100 fish from up to five trawls a day. The standard length (SL) and sex of these fish, as well as reproductive condition of female fish, were collected along with the weight of both the sample and of the entire orange roughy catch. These data are managed by staff at NIWA, Greta Point, and held on the EMPRESS *obs_ifs* database (Mackay 1993). Tow by tow catch data from the entire commercial fishery was also used to show the distribution of the fishery. These data came from extracts from MFish databases held on the EMPRESS database *dw_cdb* at NIWA, Greta Point. Biological data from the *Tangaroa* research survey in June–July 1997 (TAN9708) are also presented.

4. METHODS

Although the SOP sampling regime was designed around broad areas (the old Fisheries Management Areas (FMAs), Figure 1) the fisheries are mostly managed on finer scales. In this summary we have analysed the data according to recognised fisheries within each SOP and QMA area, as well as those fisheries outside the EEZ (see Figures 2 and 3).

Data were to error checked before being added to the databases, and again before any analyses were begun. Tow positions were plotted to identify any outliers or impossible tow sequences caused by misrecording of position, and length and catch data were checked for irregularities. An error in one of the extracts received from MFish, where for July 1997 the catch of smooth oreo (*Pseudocyttus maculatus*) per tow was mistakenly added to that of orange roughy, has been corrected in the results presented here.

4.1 Size structure

Size distributions were prepared for fisheries where more than two or three tows were sampled. Samples were combined where they were entirely outside of, or entirely within, the winter months (June, July, August) to approximate spawning season and non-spawning season sampling. Size frequencies were scaled according to the fraction of the catch sampled for that tow in order to more fairly represent larger catches. Occasionally, where sample weight was not recorded, an estimate was made by applying a length-

weight function to the size frequency from the sample. Sex ratios (percentage male) and mean lengths were calculated from the scaled data.

Size frequency data from the *Tangaroa* survey were scaled by the percentage of fish sampled per tow, the area swept by the wings, and the biomass calculated from the catch weights (*see* Vignaux 1994).

4.2 Reproduction

All female fish examined by observers were checked for reproductive state and assigned to one of the following (macroscopic) categories.

- F1 Immature to early maturation
- F2 Maturing
- F3 Ripe
- F4 Running ripe
- F5 Spent

Note that these categories are different to those used for orange roughy by NIWA research staff, who use eight categories.

The reproductive state of female fish was examined for areas with sufficient observer data. Where time series data through the spawning period were available, plots were created to examine the progression of spawning with a curve (Distance Weighted Least Squares, Wilkinson 1987) fitted to the data points. In addition, reproductive data for both male and female fish collected on TAN9708 were examined.

5. RESULTS

5.1 Distribution of samples

Observers examined 247 samples collected during 16 voyages with the number of samples per voyage ranging between 3 and 31. The positions of tows from which samples were collected are shown in Figures 2 and 3. Monthly totals arranged by SOP area, ORH 3B fisheries, and other fisheries are shown in Table 1, and station details are summarised in Appendix 1.

To determine how well the observed tows represented the entire fishery, catch rate per tow for all tows (from QMS data) was compared with that from all observed tows (Figure 4). Coverage on the Chatham Rise (ORH 3B) was good, particularly in the NW Rise and East Rise. The Challenger fishery (ORH 7A) also had good coverage. The distribution and number of tows in other orange roughy fisheries was more variable (e.g., Puysegur (ORH 3B), ORH 2A). There was no coverage of the Louisville Ridge (ET) or

Cook Canyon (ORH 7B) grounds, and only a few samples from Lord Howe and NW Challenger (ET) and some of the southern (ORH 3B) fisheries (e.g. Auckland, Antipodes). Moderate coverage was achieved in the Snares (ORH 3B), Westpac (ORH 7A), Mercury-Colville and ORH1other (ORH 1), East Cape (hills) (ORH 2A), and Kaikoura (ORH 3A) fisheries. Sample weights, the weight of catch observed, and total catch are summarised by fishery in Table 2.

5.2 Size structure and sex ratios

Length frequency distributions by sex are given in Figure 5.

Strong unimodal distributions by sex, typical for orange roughy size structures, were found for most areas. Fish sampled from Challenger and Kaikoura were smaller than those from other areas, with mean lengths of 31.5 and 29.5 cm for males and 33.9 and 30.3 for females respectively. The Arrow and Snares fisheries had the largest fish, with mean lengths of 38.3 and 38.7 cm for males and 40.1 and 40.5 for females respectively (Table 3). Size structure of fish sampled before and during spawning on the East Rise showed little difference with mean sizes being almost identical (Figure 5d, e). Size distributions of fish from Lord Howe and NW Challenger (Figure 5m, n) suffer from small sample sizes but are included because they are the only data collected from outside the EEZ. Fish appear to be of average size compared with other areas examined.

Sex ratios were also calculated for each of these areas with values ranging from 39.5% (Lord Howe) to 71.2% (Arrow) male, with 6 of the 13 areas showing a male dominance and 7 areas a female dominance. Sex ratio and mean length data are summarised by area in Table 3.

Additional length frequency distributions are presented from the research trawl survey (TAN9708) carried out in the East Cape and NW Chatham Rise ("Graveyard") areas (Figure 6).

5.3 Reproduction

Areas examined were the Spawning Box, South Rise, NW Rise, and East Rise in ORH 3B, Mercury-Colville and ORH1other in ORH 1, Challenger in ORH 7A, East Cape ORH 2A, and NW Challenger (ET). A summary of gonad stages by area and date is given in Table 4 and research survey data for male and female fish collected on TAN9708 are presented in Table 5.

An indication of timing of spawning can be determined for Challenger and Mercury-Colville using plots of fractions of fish spawning (Figure 7). An indication of spawning period was also available from East Cape and NW Challenger data.

- Data from Challenger indicate spawning from mid June through to mid July with a peak (20% spent fish) at about 1 July. This is a week or so earlier than in the period 1984 to 1990 (Clark & Tracey 1994) when peak spawning ranged between 9 and 15 July (Figure 7a).
- Spawning in Mercury-Colville appeared to peak at about 20 June with ripe fish still present in samples taken in late July (Figure 7b). This is similar timing to that observed in a 1995 survey (Clark & Field 1998).
- In East Cape running ripe and spent fish were found on 5 June and 19 June suggesting that spawning covered this period. Research data collected shortly afterwards (21 June) confirms this.
- Observer sampling in NW Challenger also covered only two days (26 and 28 June), but the data indicate that this was close to peak spawning.

6. ACKNOWLEDGMENTS

We thank the scientific observers of the Ministry of Fisheries who collected the data and members of the deepwater working group and Paul Grimes (NIWA) for providing constructive comments on previous drafts. Thanks also to the Orange Roughy Management Company for permission to present some of the 1997 East Cape survey data. This work was funded through the Ministry of Fisheries (project ORH9702).

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Table 1: Number by month of observer orange roughy biological samples for 1996–97

Summary by SOP area (see Figure 1 for area boundaries)

Area	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Voyages
AKE	0	0	0	0	0	0	0	0	9	14	4	0	27	3
CEE	0	0	0	0	0	3	4	0	12	0	0	0	19	3
CET	5	0	0	0	0	0	0	0	4	0	0	0	9	3
CHA	0	0	0	0	0	0	0	0	35	13	0	0	48	3
SEC	0	2	1	0	0	0	15	0	0	0	0	0	18	2
SOE	0	9	17	10	14	10	6	0	23	0	5	0	94	5
SOI	0	0	0	0	1	0	0	0	1	0	0	0	2	2
SOU	0	0	0	8	8	0	1	0	0	4	0	0	21	3
SUB	0	0	0	0	1	0	5	0	3	0	0	0	9	3
ALL	5	11	18	18	24	13	31	0	87	31	9	0	247	

Summary by sub-area of ORH 3B

Area	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Voyages
Spawning box	0	0	0	0	0	0	1	0	14	0	0	0	15	2
NW rise	0	11	11	0	4	0	0	0	0	0	0	0	26	2
East rise	0	0	3	5	8	8	0	0	9	0	0	0	33	4
South rise	0	0	4	5	2	2	5	0	0	0	0	0	18	3
Arrow	0	0	0	0	0	0	0	0	0	0	5	0	5	1
Puysegur	0	0	0	2	1	0	1	0	0	3	0	0	7	2
Snares	0	0	0	6	7	0	0	0	0	0	0	0	13	1
Antipodes	0	0	0	0	0	0	3	0	3	0	0	0	6	2
Auckland	0	0	0	0	1	0	0	0	1	0	0	0	2	2
Macquarie	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Pukaki	0	0	0	0	0	0	2	0	0	0	0	0	2	1
Subantarctic	0	0	0	0	1	0	0	0	0	0	0	0	1	1
ALL	0	11	18	18	24	10	12	0	27	4	5	0	129	

Summary for other areas

Area	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Voyages
Challenger	0	0	0	0	0	0	0	0	30	5	0	0	35	3
Westpac	0	0	0	0	0	0	0	0	5	8	0	0	13	1
NW Challenger	0	0	0	0	0	0	0	0	4	0	0	0	4	2
Lord Howe	5	0	0	0	0	0	0	0	0	0	0	0	5	1
Mercury-Colville	0	0	0	0	0	0	0	0	9	3	2	0	14	2
ORH10ther	0	0	0	0	0	0	0	0	0	11	2	0	13	3
East Cape (hills)	0	0	0	0	0	2	1	0	8	0	0	0	11	3
East Cape (other)	0	0	0	0	0	1	0	0	0	0	0	0	1	1
Tolaga	0	0	0	0	0	0	1	0	1	0	0	0	2	2
Ritchie	0	0	0	0	0	0	1	0	3	0	0	0	4	2
Kaikoura	0	0	0	0	0	0	15	0	0	0	0	0	15	1
Wairarapa	0	0	0	0	0	0	1	0	0	0	0	0	1	1
ALL	5	0	0	0	0	3	19	0	60	27	4	0	118	

Table 2: Summary of number and weight (kg) of samples taken by scientific observers relative to the observed catch (t) and estimated total catch (t) in the fishery, 1996–97 (+ indicates catch totals are not available separately but are less than 20 t; some catch (fishery) totals based on tow by tow data are incomplete)

Area	No. tows sampled	Weight of samples	Catch (observed)	Catch (fishery)
ORH 1				
Mercury-Colville	14	1 507	72	500
ORH1other	13	1 941	39	550
ORH 2A				
East Cape (hills)	11	1 567	60	2 000
East Cape (other)	1	40	<1	500
Tolaga	2	274	7	60
Ritchie	4	542	36	1 100
ORH 2B				
Wairarapa	1	131	3	270
ORH 3A				
Kaikoura	15	1 188	50	600
ORH 3B				
Chatham Rise				
Spawning Box	15	1 854	159	1 500
NW Rise	26	2 694	141	1 900
East Rise	33	3 995	339	1 600
South Rise	18	2 252	123	1 300
Arrow	5	500	45	200
Southern				
Puysegur	7	911	37	320
Snares	13	2 583	49	55
Antipodes	6	612	20	790
Auckland	2	242	6	90
Macquarie	1	70	<1	20
Pukaki	2	37	<1	+
Subantarctic	1	154	2	+
ORH 7A				
Challenger	35	3 572	168	1 050
Westpac	13	1 638	109	250
ORH ET				
Lord Howe	5	131	<1	130
NW Challenger	4	331	10	340

Table 3: Summary of mean length data and sex ratio (% male) by fishery and month, and total catch (t) from which length data were selected.

Area	Month	<u>Number measured</u>			Sex ratio (% male) (scaled)	Total Catch (t)	<u>Scaled Mean length</u>	
		Male	Female	Total			Male	Female
Spawning Box	June	666	656	1323	47.8	146	33.3	34.9
South Rise	Dec/Apr	636	999	1635	42.8	123	34.2	35.7
NW Rise	Nov/Feb	1013	1170	2188	47.3	141	32.7	34.4
East Rise	Dec/Mar	1047	1064	2113	46.4	220	34.9	35.6
East Rise	June	363	460	823	41.7	119	34.7	35.9
Arrow	August	200	83	283	71.2	45	38.3	40.1
Snares	Jan/Feb	600	561	1161	52.8	49	38.7	40.5
Mercury-Colville	Jun/Aug	794	453	1247	68.9	72	37.3	39.5
ORH1other	July	576	400	976	58.2	39	35.5	36.3
East Cape	June	405	238	643	53.7	58	34.0	35.4
Kaikoura	April	456	490	946	46.9	26	29.5	30.3
Challenger	Jun/Jul	2269	2337	4614	54.5	168	31.5	33.9
Lord Howe	Oct	45	54	100	39.5	0.5	33.1	34.6
NW Challenger	Jun	137	158	297	45.9	9.8	32.1	35.1
East Cape*	June	109	371	480	19.7	4	32.8	36.3
NW Chat. Rise (Graveyard)*	June	947	1085	2033	52.5	16	32.6	34.0

* Research data TAN9708

Table 4: Female gonad stage summaries from selected areas

F1	Immature to early maturation
F2	Maturing
F3	Ripe
F4	Running ripe
F5	Spent

Spawning box

Month	F1	F2	F3	F4	F5
Apr	2	16	0	0	0
Jun	125	453	76	2	0

South Rise

Month	F1	F2	F3	F4	F5
Dec	13	176	28	0	0
Jan	73	149	12	0	0
Feb	54	40	0	0	0
Mar	43	76	0	0	0
Apr	172	163	0	0	0

NW Rise

Month	F1	F2	F3	F4	F5
Nov	100	453	2	0	0
Dec	99	329	1	0	0
Feb	61	87	0	0	0
Apr	62	8	0	0	0

East Rise

Month	F1	F2	F3	F4	F5
Dec	24	110	1	0	0
Jan	100	128	0	0	0
Feb	97	239	0	0	0
Mar	128	234	3	0	0
Jun	135	265	60	0	0

Mercury - Colville

Month	F1	F2	F3	F4	F5
Jun	0	33	58	184	13
Jul	0	0	0	17	65
Aug	0	0	0	2	81

ORH1other

Month	F1	F2	F3	F4	F5
Jul	17	231	8	12	131

East Cape

Month	F1	F2	F3	F4	F5
Mar	40	44	0	0	0
Apr	1	26	0	0	0
Jun	48	32	79	65	19

Challenger

Month	F1	F2	F3	F4	F5
Jun	19	220	742	462	64
Jul	27	9	22	94	95

NW Challenger

Month	F1	F2	F3	F4	F5
Jun	3	9	31	87	28

Table 5: Percentage gonad stage data from research survey (TAN9708), East Cape and Graveyard areas (Female stages 1 and 2, immature or resting; 3, maturing; 4, ripe; 5, running ripe; 6 and 8, spent. Male stages 1 and 2 immature or resting/maturing; 3, ripe; 4, running ripe; 5 and 8, spent)

East Cape - 21/6/97

Males (n = 109)

Stage	1/2	3	4	5/8
%	13	26	43	18

Females (n = 368)

1/2	3	4	5	6/8
8	9	43	14	26

NW Chatham Rise (Graveyard) 23/6 to 1/7 1997

Males (n = 979)

Stage	1/2	3	4	5/8
%	29	14	44	13

Females (n = 1,154)

1/2	3	4	5	6/8
28	10	41	8	13

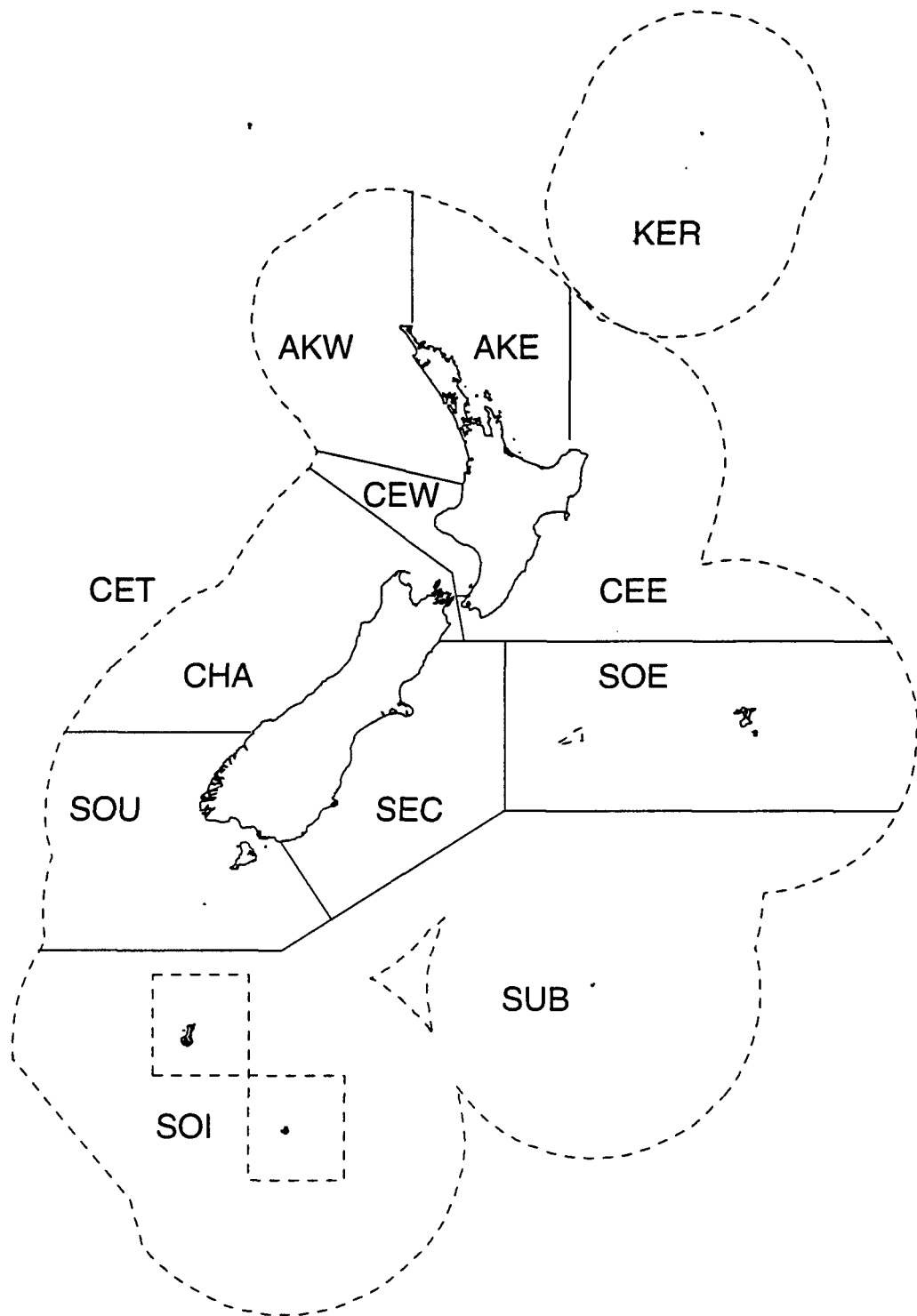


Figure 1: Scientific Observer Programme Management Areas.

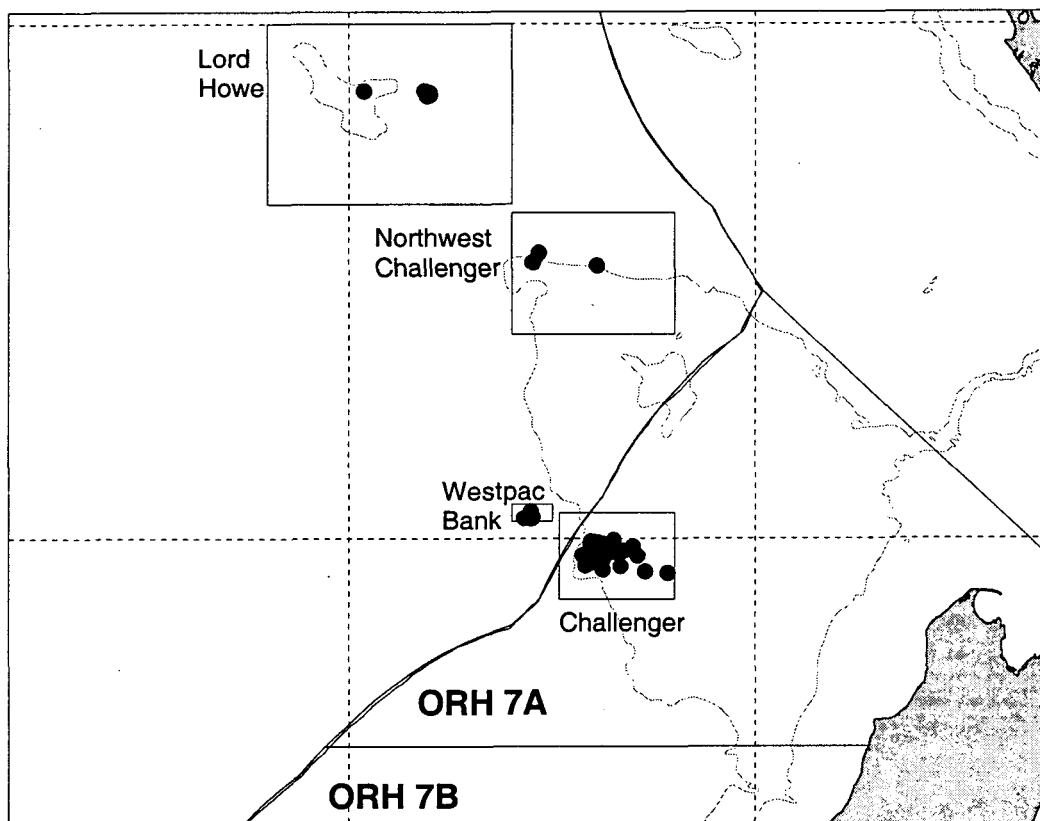
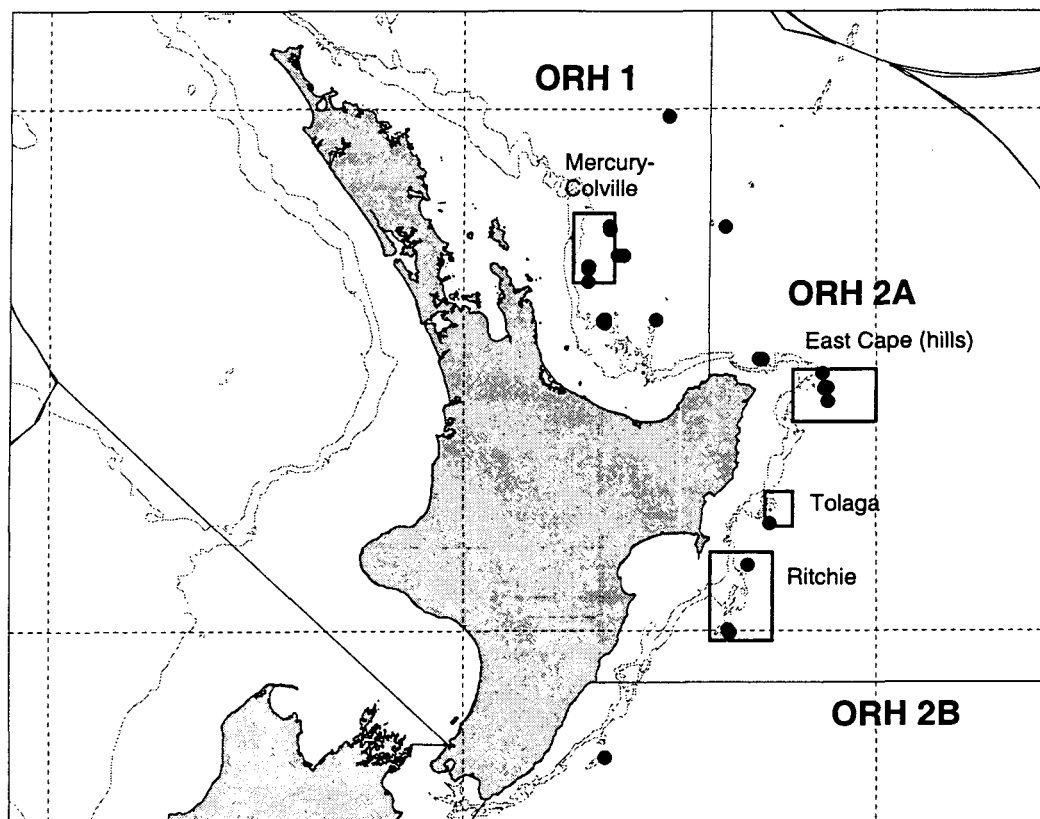


Figure 2: Location of fisheries used in analyses of biological data, and the location of samples of orange roughy taken by the MFish Scientific Observer Programme during the 1996–97 fishing year.

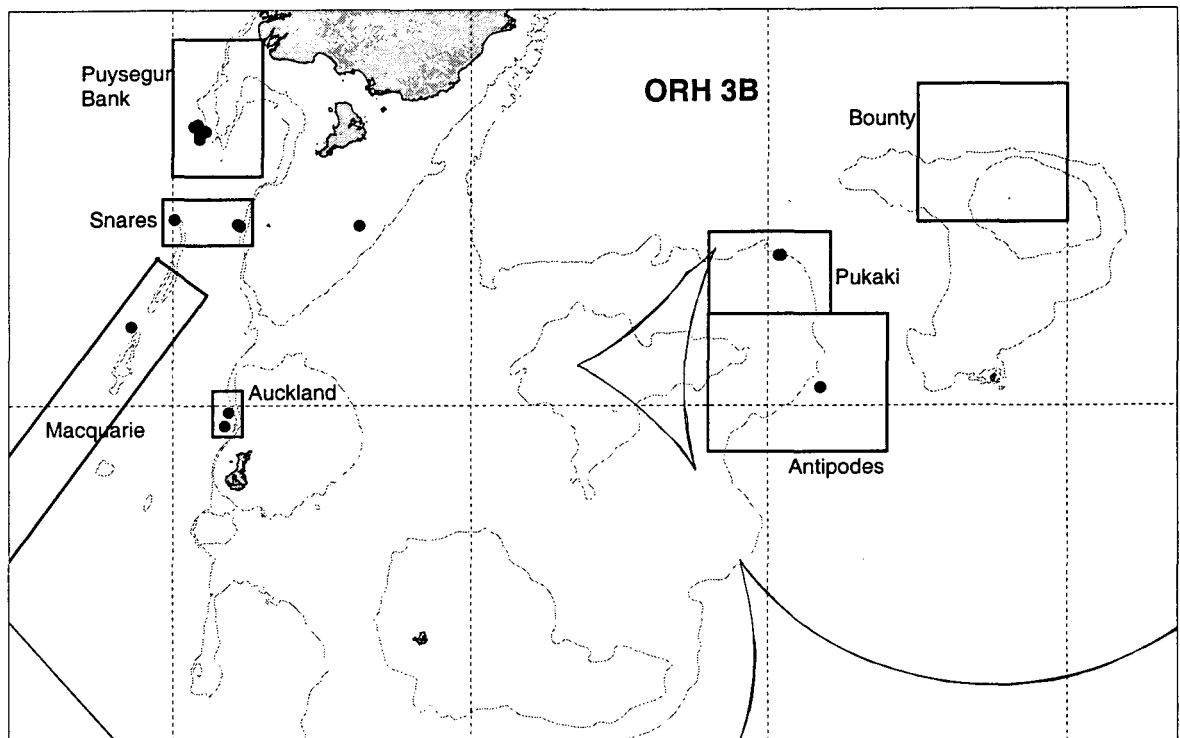
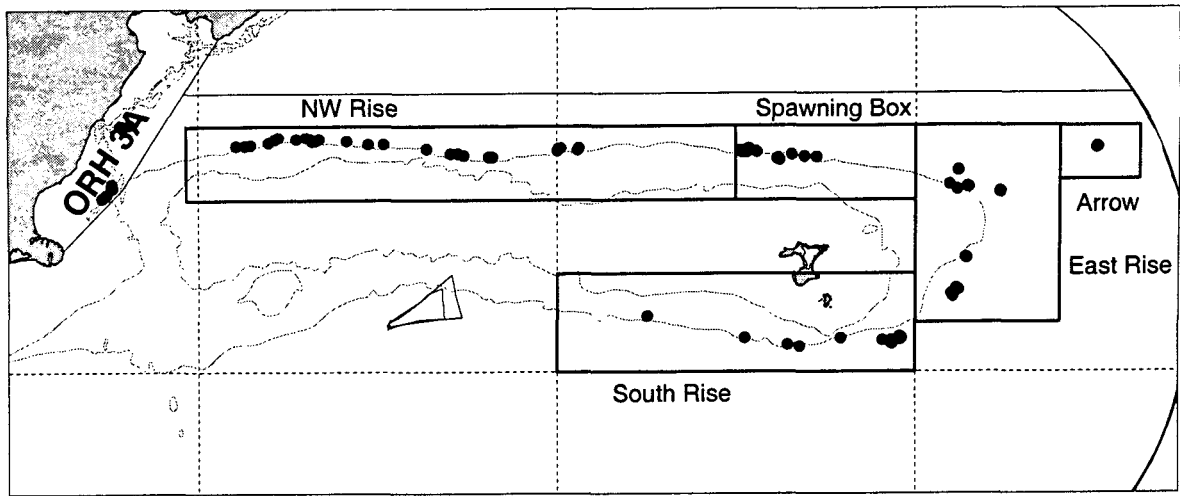


Figure 3: Location of fisheries used in analyses of biological data, and the location of samples of orange roughy taken by the MFish Scientific Observer Programme during the 1996–97 fishing year.

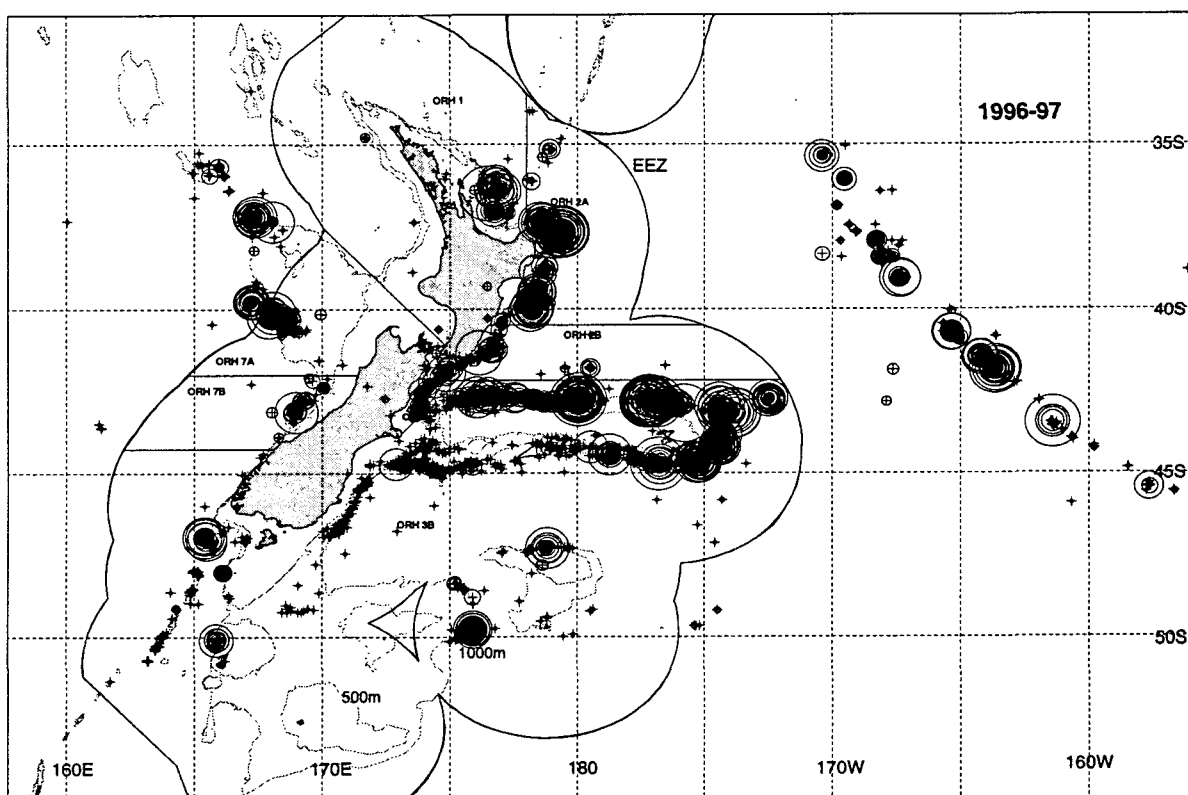
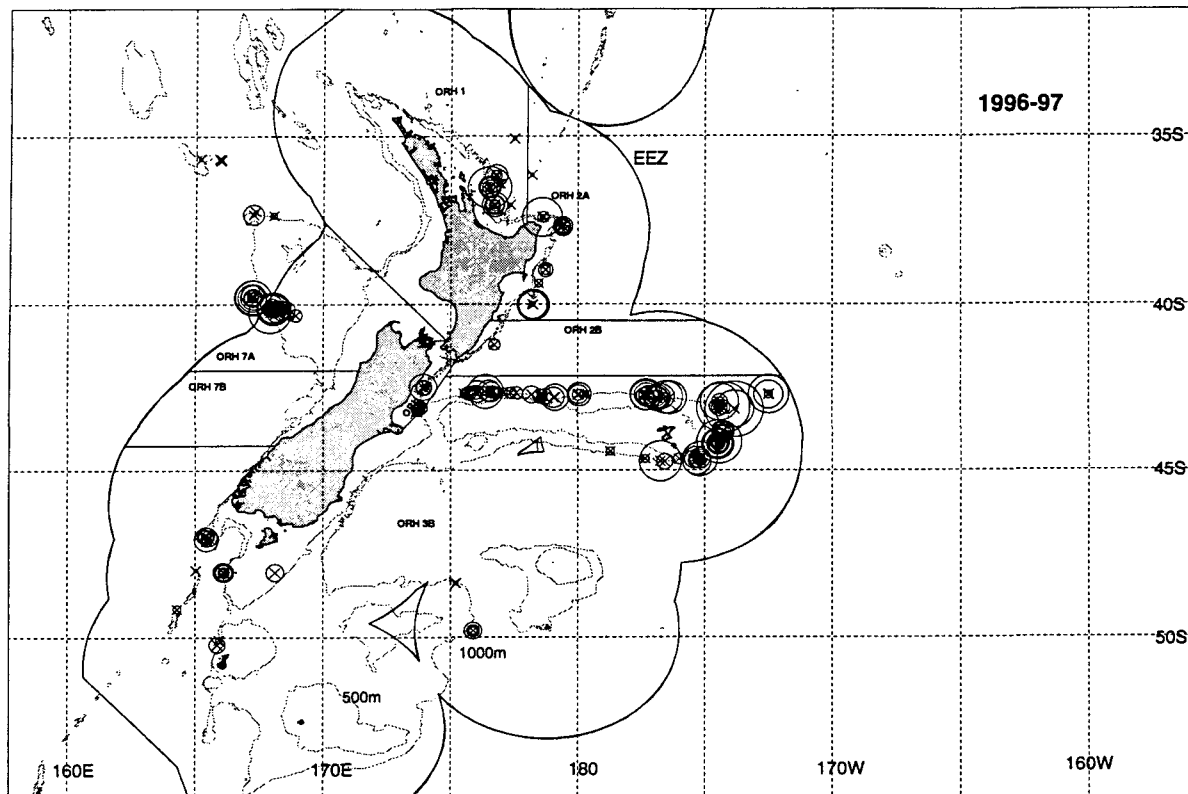


Figure 4: Catch per tow of orange roughy in trawls sampled by MFish scientific observers during 1996-97 (top), and catch rate in trawls by the commercial fishery (bottom) (circle size is proportional to catch rate, maximum = 50 t, all trawl positions are marked x or +).

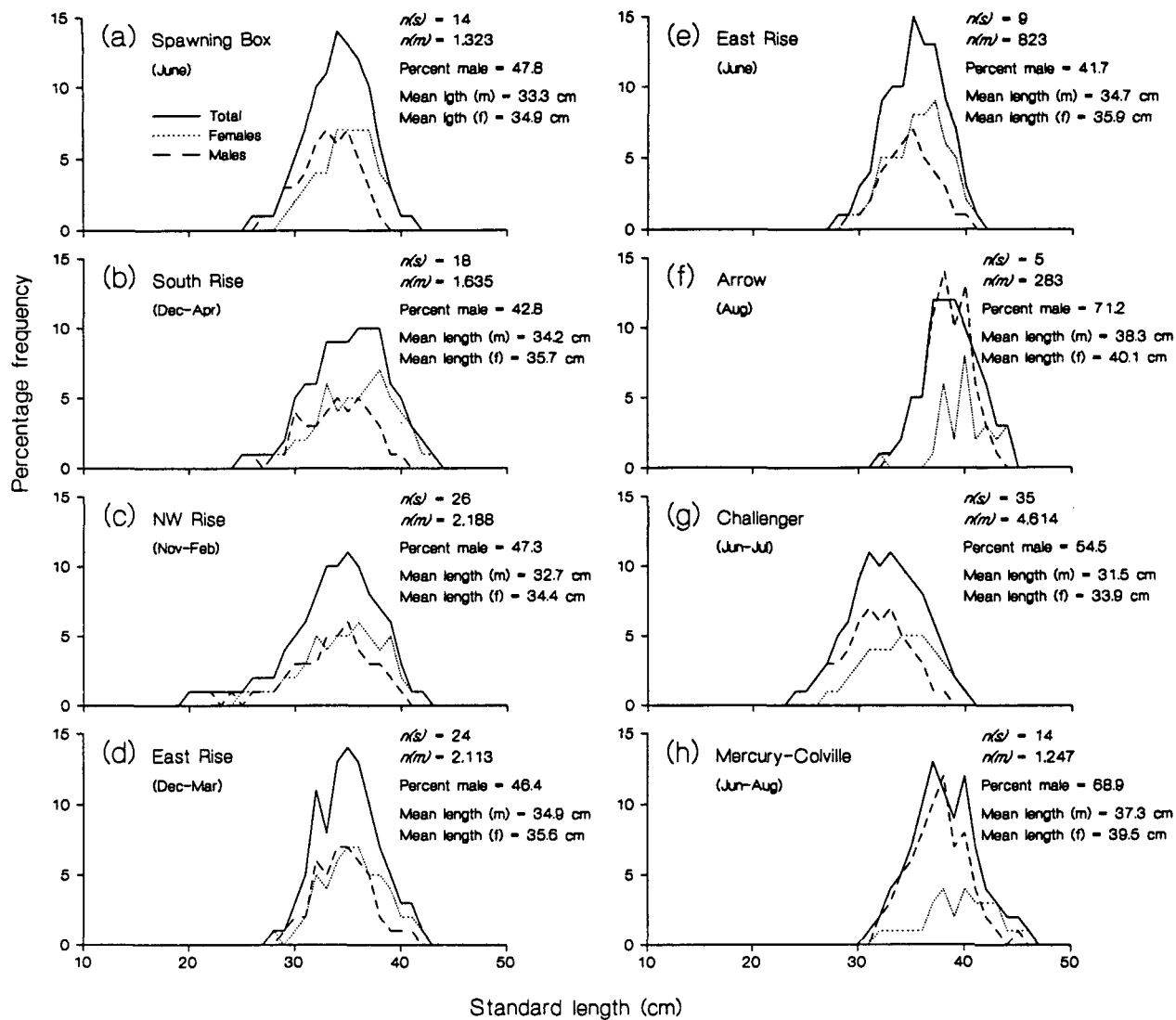


Figure 5: Observer length frequency distributions (scaled by catch) of orange roughy by area, $n(s)$, number of samples; $n(m)$, number of fish measured.

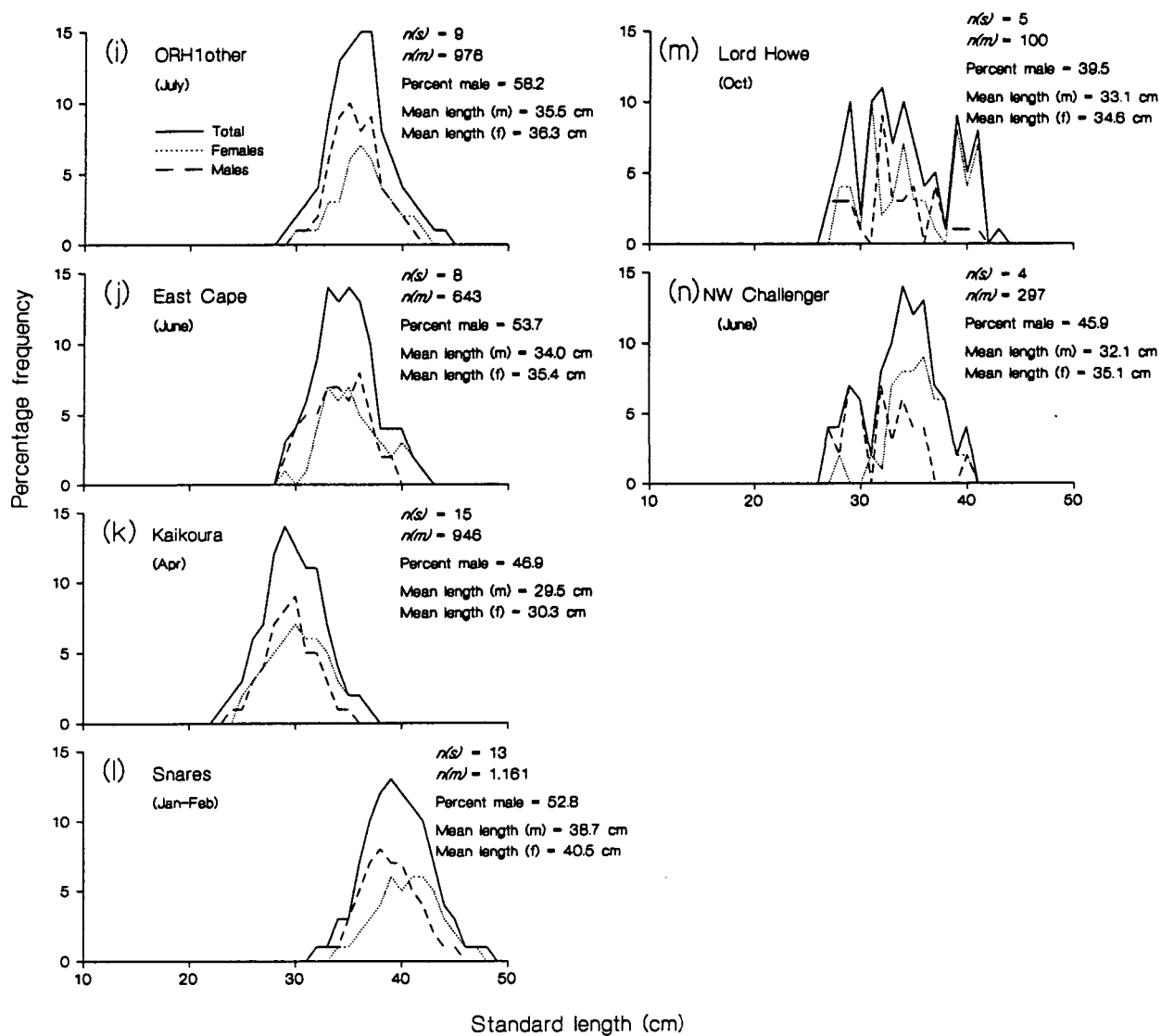


Figure 5 – continued.

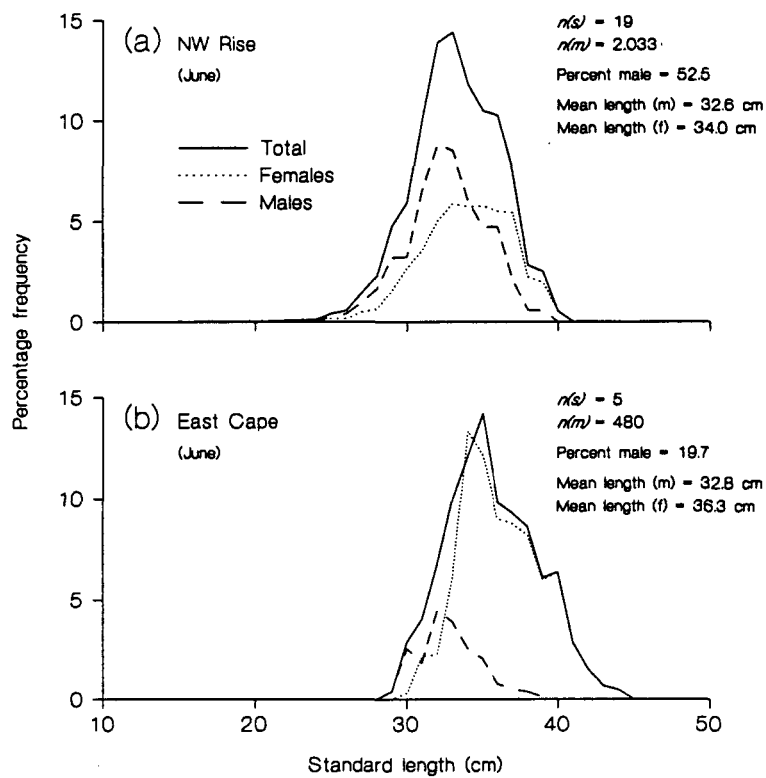


Figure 6: Research length frequency distributions (scaled, *see text*) of orange roughy from 1997 surveys carried out in northwest Chatham Rise and East Cape, $n(s)$, number of samples; $n(m)$, number of fish measured.

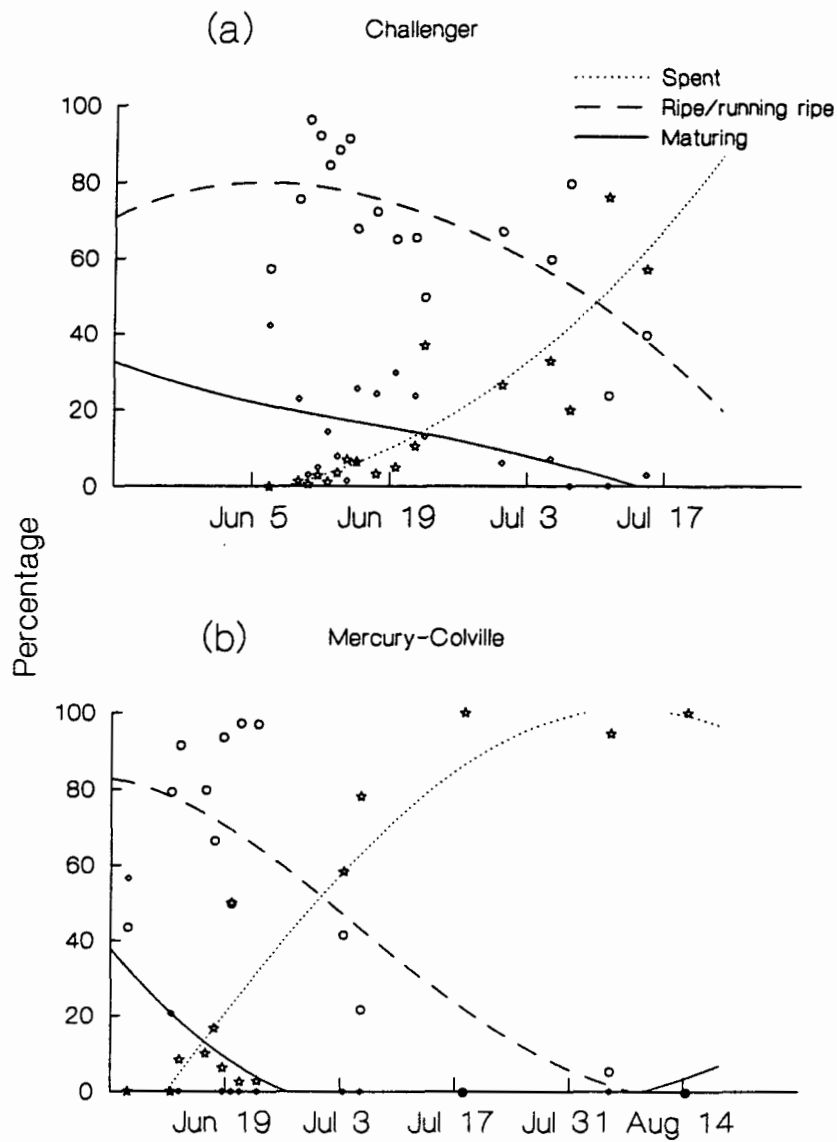


Figure 7: Daily changes in female orange roughy gonad stage proportions during the spawning season.

Appendix 1: Station data for samples of orange roughy taken by observers in 1996/97

Area	Trip number	Tow number	Date	Longitude (0°–360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
Antipodes	983	100	09-Apr-97	175.883	49.800	165.6	3503
Antipodes	983	116	10-Apr-97	175.883	49.800	34.0	2333
Antipodes	983	117	11-Apr-97	175.883	49.800	74.2	1663
Antipodes	1012	100	22-Jun-97	175.890	49.800	116.0	3712
Antipodes	1012	103	23-Jun-97	175.885	49.800	111.0	5983
Antipodes	1012	107	24-Jun-97	175.888	49.800	111.0	2910
Arrow	1027	11	01-Aug-97	187.517	42.717	243.0	27136
Arrow	1027	12	02-Aug-97	187.530	42.723	41.0	120
Arrow	1027	15	02-Aug-97	187.512	42.732	36.0	1470
Arrow	1027	17	03-Aug-97	187.510	42.730	135.0	14760
Arrow	1027	28	07-Aug-97	187.510	42.730	45.0	1422
Auckland	963	88	03-Feb-97	165.872	50.222	123.0	5184
Auckland	1012	120	30-Jun-97	165.935	50.077	119.0	1231
Challenger	1014	16	07-Jun-97	167.908	40.185	107.5	2674
Challenger	1009	13	10-Jun-97	168.233	40.133	88.6	1700
Challenger	1009	14	10-Jun-97	168.017	40.032	90.7	4800
Challenger	1014	33	10-Jun-97	167.915	40.187	100.5	1380
Challenger	1009	15	11-Jun-97	167.912	40.187	84.5	2600
Challenger	1009	16	11-Jun-97	168.013	40.043	92.0	2400
Challenger	1009	17	11-Jun-97	168.000	40.227	87.9	1500
Challenger	1009	18	11-Jun-97	168.052	40.035	86.9	2000
Challenger	1009	19	12-Jun-97	167.870	40.160	93.7	2400
Challenger	1009	20	12-Jun-97	168.250	40.013	96.0	900
Challenger	1009	22	12-Jun-97	168.013	40.200	97.3	1732
Challenger	1009	23	13-Jun-97	168.128	40.148	90.2	4200
Challenger	1009	24	13-Jun-97	168.377	40.117	93.3	4000
Challenger	1009	25	13-Jun-97	168.015	40.135	99.6	3000
Challenger	1009	26	13-Jun-97	168.335	40.122	95.7	5600
Challenger	1014	53	13-Jun-97	167.880	40.160	106.7	2000
Challenger	1014	54	13-Jun-97	168.120	40.203	102.5	2260
Challenger	1009	27	14-Jun-97	168.373	40.123	98.9	3200
Challenger	1009	28	14-Jun-97	168.055	40.138	94.9	18800
Challenger	1014	57	14-Jun-97	168.065	40.102	103.5	18000
Challenger	1009	29	15-Jun-97	168.097	40.115	91.2	5600
Challenger	1009	31	15-Jun-97	168.112	40.052	92.4	1700
Challenger	1009	32	15-Jun-97	167.938	40.207	93.4	2800
Challenger	1014	64	16-Jun-97	167.973	40.028	109.5	9130
Challenger	1014	72	18-Jun-97	168.180	40.085	109.0	4441
Challenger	1014	86	20-Jun-97	167.980	40.073	103.0	3624

Area	Trip number	Tow number	Date	Longitude (0°–360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
Challenger	1014	88	20-Jun-97	168.118	40.302	113.0	5043
Challenger	1014	95	22-Jun-97	168.337	40.267	111.5	4093
Challenger	1014	96	22-Jun-97	168.545	40.167	109.0	6017
Challenger	1014	102	23-Jun-97	167.978	40.048	120.0	5240
Challenger	1014	162	01-Jul-97	168.490	40.077	107.0	949
Challenger	1014	195	06-Jul-97	168.917	40.333	112.0	3821
Challenger	1013	51	08-Jul-97	167.905	40.260	125.0	28320
Challenger	1014	243	12-Jul-97	167.967	40.050	134.5	365
Challenger	1014	267	16-Jul-97	168.640	40.320	130.5	2100
East Cape (hills)	986	4	31-Mar-97	178.588	37.398	88.0	600
East Cape (hills)	986	7	31-Mar-97	179.353	37.538	90.0	1001
East Cape (hills)	986	22	04-Apr-97	179.383	37.673	95.9	92
East Cape (hills)	1009	6	02-Jun-97	178.632	37.403	100.1	3160
East Cape (hills)	1009	8	03-Jun-97	178.588	37.398	122.8	26070
East Cape (hills)	1013	10	05-Jun-97	179.422	37.803	180.0	2700
East Cape (hills)	1013	12	06-Jun-97	179.415	37.675	180.0	4680
East Cape (hills)	1013	16	07-Jun-97	179.397	37.678	180.0	7450
East Cape (hills)	1013	21	13-Jun-97	179.390	37.682	180.0	4245
East Cape (hills)	1013	22	14-Jun-97	179.378	37.683	170.0	4245
East Cape (hills)	1013	25	14-Jun-97	179.383	37.685	180.0	5750
East Cape (other)	986	2	30-Mar-97	178.183	36.133	40.0	40
East Rise	956	97	04-Dec-96	185.517	44.200	100.0	4396
East Rise	956	100	04-Dec-96	185.600	44.167	111.0	7045
East Rise	956	112	06-Dec-96	185.517	44.200	104.5	3043
East Rise	967	11	27-Jan-97	185.592	42.953	109.1	2200
East Rise	967	15	28-Jan-97	185.708	43.845	115.0	9000
East Rise	967	17	28-Jan-97	185.710	43.843	137.7	5400
East Rise	967	29	30-Jan-97	185.502	44.207	130.7	7120
East Rise	967	31	31-Jan-97	185.507	44.210	124.4	17250
East Rise	967	36	07-Feb-97	185.593	42.955	127.3	5472
East Rise	967	38	07-Feb-97	185.698	43.837	120.2	2622
East Rise	967	41	08-Feb-97	185.510	44.208	122.8	912
East Rise	967	42	08-Feb-97	185.507	44.210	111.8	7904
East Rise	967	43	08-Feb-97	185.503	44.212	140.8	9614
East Rise	967	45	08-Feb-97	185.710	43.843	124.6	7068
East Rise	967	46	08-Feb-97	185.710	43.842	115.6	4446
East Rise	967	50	09-Feb-97	185.518	44.212	114.1	836
East Rise	967	90	02-Mar-97	185.503	44.212	122.7	3306
East Rise	967	91	02-Mar-97	185.503	44.212	130.8	3724
East Rise	967	92	02-Mar-97	185.708	43.845	128.3	4712

Area	Trip number	Tow number	Date	Longitude (0°–360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
East Rise	983	25	27-Mar-97	185.503	44.208	89.4	2426
East Rise	983	27	27-Mar-97	185.520	44.233	76.6	6401
East Rise	983	32	28-Mar-97	185.567	44.150	133.7	31331
East Rise	983	43	29-Mar-97	186.177	43.167	135.0	24400
East Rise	983	44	29-Mar-97	186.173	43.177	133.1	49489
East Rise	1012	45	10-Jun-97	185.475	43.097	111.0	4369
East Rise	1012	46	10-Jun-97	185.718	43.120	117.0	4396
East Rise	1012	48	11-Jun-97	185.577	43.147	118.0	5431
East Rise	1012	53	11-Jun-97	185.735	43.123	223.0	42656
East Rise	1012	61	13-Jun-97	185.720	43.118	115.0	4179
East Rise	1012	69	13-Jun-97	185.508	44.205	112.0	16525
East Rise	1012	73	14-Jun-97	185.497	44.205	111.0	15165
East Rise	1012	75	14-Jun-97	185.497	44.205	118.0	2140
East Rise	1012	80	15-Jun-97	185.593	42.953	111.0	24575
Kaikoura	994	6	12-Apr-97	173.800	43.083	75.6	2200
Kaikoura	994	7	12-Apr-97	173.725	43.190	78.9	3400
Kaikoura	994	8	12-Apr-97	173.795	43.115	72.3	3200
Kaikoura	994	9	13-Apr-97	173.713	43.193	78.2	1200
Kaikoura	994	10	13-Apr-97	173.793	43.113	71.5	2800
Kaikoura	994	12	13-Apr-97	173.793	43.102	71.9	2400
Kaikoura	994	13	14-Apr-97	173.662	43.225	75.4	1000
Kaikoura	994	14	14-Apr-97	173.805	43.100	74.4	2400
Kaikoura	994	15	14-Apr-97	173.672	43.223	70.1	1400
Kaikoura	994	22	16-Apr-97	173.805	43.117	73.3	4800
Kaikoura	994	23	16-Apr-97	173.807	43.125	72.5	1200
Kaikoura	994	3	11-Apr-97	174.053	42.480	89.0	1200
Kaikoura	994	25	17-Apr-97	173.952	42.513	104.0	5600
Kaikoura	994	26	17-Apr-97	173.952	42.513	106.3	4000
Kaikoura	994	28	17-Apr-97	173.925	42.492	74.4	13600
Lord Howe	955	2	21-Oct-96	165.955	35.702	13.3	NA
Lord Howe	955	3	22-Oct-96	165.988	35.690	17.5	50
Lord Howe	955	9	24-Oct-96	165.985	35.668	42.2	90
Lord Howe	955	15	24-Oct-96	165.922	35.652	30.3	315
Lord Howe	955	19	25-Oct-96	165.180	35.653	27.3	35
Mercury-Colville	1015	1	11-Jun-97	176.515	36.517	108.0	30000
Mercury-Colville	1015	7	16-Jun-97	176.515	36.508	100.0	500
Mercury-Colville	1015	11	17-Jun-97	176.517	36.508	101.0	4500
Mercury-Colville	1015	14	20-Jun-97	176.517	36.508	90.0	500
Mercury-Colville	1015	19	21-Jun-97	176.517	36.507	100.0	9000
Mercury-Colville	1015	21	22-Jun-97	176.515	36.507	120.0	7000

Area	Trip number	Tow number	Date	Longitude (0°-360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
Mercury-Colville	1015	25	23-Jun-97	176.515	36.657	100.0	5000
Mercury-Colville	1015	27	24-Jun-97	176.770	36.123	145.0	1500
Mercury-Colville	1015	28	26-Jun-97	176.775	36.157	160.0	9000
Mercury-Colville	1015	44	06-Jul-97	176.515	36.507	115.0	2000
Mercury-Colville	1015	49	08-Jul-97	176.777	36.158	120.0	2500
Mercury-Colville	1015	59	20-Jul-97	176.777	36.158	40.0	40
Mercury-Colville	1032	18	06-Aug-97	176.515	36.538	110.0	110
Mercury-Colville	1032	32	15-Aug-97	176.515	36.510	98.0	200
Macquarie	963	113	07-Feb-97	164.302	49.137	154.0	1566
NW Challenger	1014	126	26-Jun-97	168.048	37.345	135.5	1148
NW Challenger	1019	5	28-Jun-97	167.333	37.222	28.0	40
NW Challenger	1019	6	28-Jun-97	167.255	37.313	58.0	8500
NW Challenger	1019	7	28-Jun-97	167.262	37.313	109.5	150
NW Rise	956	4	07-Nov-96	175.728	42.695	117.0	4074
NW Rise	956	7	08-Nov-96	176.067	42.637	103.0	9887
NW Rise	956	10	08-Nov-96	176.367	42.633	124.0	20981
NW Rise	956	11	09-Nov-96	176.585	42.655	111.0	8728
NW Rise	956	15	10-Nov-96	175.650	42.700	117.0	2847
NW Rise	956	19	11-Nov-96	176.633	42.650	102.0	3570
NW Rise	956	21	13-Nov-96	176.117	42.617	105.0	2400
NW Rise	956	22	13-Nov-96	176.500	42.617	122.0	9021
NW Rise	956	24	14-Nov-96	176.567	42.633	91.0	1503
NW Rise	956	27	15-Nov-96	176.683	42.633	118.5	3000
NW Rise	956	29	15-Nov-96	177.367	42.683	103.0	3079
NW Rise	956	134	10-Dec-96	180.300	42.743	103.6	28
NW Rise	956	137	11-Dec-96	179.050	42.817	85.0	8779
NW Rise	956	138	11-Dec-96	178.700	42.800	95.5	5123
NW Rise	956	140	12-Dec-96	179.100	42.817	58.2	12978
NW Rise	956	143	13-Dec-96	178.617	42.783	75.5	1778
NW Rise	956	144	13-Dec-96	178.517	42.783	88.0	4571
NW Rise	956	145	13-Dec-96	178.183	42.733	79.5	5925
NW Rise	956	147	14-Dec-96	177.583	42.683	79.0	3228
NW Rise	956	149	15-Dec-96	177.067	42.650	106.0	1473
NW Rise	956	153	16-Dec-96	175.533	42.700	115.0	1841
NW Rise	956	155	16-Dec-96	175.983	42.667	106.0	4191
NW Rise	967	32	05-Feb-97	180.027	42.728	130.9	6992
NW Rise	967	34	06-Feb-97	180.008	42.752	115.3	2850
NW Rise	967	77	26-Feb-97	180.053	42.725	135.6	10868
NW Rise	967	83	27-Feb-97	180.318	42.723	107.5	1026
ORH1other	1015	35	03-Jul-97	176.870	36.403	110.0	30

Area	Trip number	Tow number	Date	Longitude (0°–360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
ORHlother	1024	2	13-Jul-97	176.717	37.022	140.0	6000
ORHlother	1024	3	13-Jul-97	176.698	37.045	135.0	7000
ORHlother	1024	5	14-Jul-97	176.717	37.018	142.0	1500
ORHlother	1024	7	14-Jul-97	176.717	37.020	146.0	2000
ORHlother	1024	10	16-Jul-97	176.717	37.053	142.0	3000
ORHlother	1024	13	17-Jul-97	176.717	37.022	152.0	7000
ORHlother	1024	14	17-Jul-97	176.717	37.022	170.0	12000
ORHlother	1024	22	25-Jul-97	176.692	37.038	173.0	180
ORHlother	1024	28	27-Jul-97	176.717	37.020	192.0	210
ORHlother	1024	40	30-Jul-97	177.337	37.025	134.0	134
ORHlother	1032	2	02-Aug-97	176.945	36.405	145.0	150
ORHlother	1032	24	08-Aug-97	177.497	35.072	160.0	180
Pukaki	983	118	11-Apr-97	175.183	48.367	28.8	25
Pukaki	983	119	11-Apr-97	175.217	48.367	8.4	50
Puysegur	963	67	30-Jan-97	165.358	46.957	128.0	3375
Puysegur	963	70	30-Jan-97	165.352	46.957	151.0	4077
Puysegur	963	81	01-Feb-97	165.443	47.042	152.0	10503
Puysegur	983	139	16-Apr-97	165.445	47.095	139.3	2892
Puysegur	1012	139	04-Jul-97	165.552	47.010	119.0	5764
Puysegur	1012	143	04-Jul-97	165.417	46.937	111.0	6100
Puysegur	1012	153	05-Jul-97	165.438	46.967	111.0	4688
Ritchie	986	28	06-Apr-97	178.215	39.995	143.6	600
Ritchie	1009	10	05-Jun-97	178.452	39.370	133.5	1778
Ritchie	1009	11	05-Jun-97	178.228	40.023	130.6	14615
Ritchie	1009	12	05-Jun-97	178.238	40.022	134.5	18565
Snares	963	46	24-Jan-97	166.125	48.040	222.0	7182
Snares	963	51	26-Jan-97	166.127	48.040	218.0	2889
Snares	963	54	27-Jan-97	166.123	48.038	210.0	1728
Snares	963	56	27-Jan-97	166.122	48.038	233.0	2327
Snares	963	59	28-Jan-97	166.123	48.037	223.0	5513
Snares	963	129	10-Feb-97	166.122	48.033	169.0	1674
Snares	963	130	10-Feb-97	166.125	48.033	192.0	6939
Snares	963	131	11-Feb-97	166.087	48.020	191.0	2133
Snares	963	135	12-Feb-97	166.088	48.022	189.0	1269
Snares	963	136	13-Feb-97	166.088	48.020	178.0	2322
Snares	963	138	13-Feb-97	166.088	48.022	185.0	6831
Snares	963	147	16-Feb-97	166.118	48.038	163.0	1836
Snares	1012	127	02-Jul-97	165.027	47.972	70.0	336
South Rise	956	78	01-Dec-96	184.550	44.683	130.0	6696
South Rise	956	79	01-Dec-96	184.683	44.717	128.0	15206

Area	Trip number	Tow number	Date	Longitude (0°-360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
South Rise	956	107	06-Dec-96	184.792	44.642	116.0	8031
South Rise	956	120	07-Dec-96	184.790	44.642	117.5	2436
South Rise	967	4	26-Jan-97	184.800	44.673	122.0	2800
South Rise	967	6	27-Jan-97	184.813	44.658	127.6	4800
South Rise	967	18	29-Jan-97	184.800	44.673	117.7	1280
South Rise	967	20	29-Jan-97	184.775	44.655	116.8	1640
South Rise	967	21	29-Jan-97	184.675	44.682	111.7	960
South Rise	967	52	10-Feb-97	183.233	44.728	101.1	28804
South Rise	967	85	28-Feb-97	181.270	44.433	110.1	1824
South Rise	967	88	01-Mar-97	184.800	44.673	146.0	21099
South Rise	983	13	24-Mar-97	182.637	44.658	130.6	1632
South Rise	983	78	04-Apr-97	184.808	44.668	137.5	7589
South Rise	983	80	05-Apr-97	184.673	44.717	144.8	4732
South Rise	983	85	05-Apr-97	184.662	44.703	157.1	4852
South Rise	983	90	06-Apr-97	183.972	44.662	117.5	2743
South Rise	983	92	06-Apr-97	183.398	44.747	120.2	5640
Spawning box	983	55	01-Apr-97	183.098	42.830	143.2	12882
Spawning box	1012	2	02-Jun-97	182.800	42.770	108.9	8046
Spawning box	1012	12	04-Jun-97	182.587	42.772	101.0	5535
Spawning box	1012	16	05-Jun-97	182.697	42.737	111.0	10179
Spawning box	1012	22	06-Jun-97	183.117	42.847	113.0	5532
Spawning box	1012	27	07-Jun-97	183.082	42.837	140.0	9307
Spawning box	1012	31	08-Jun-97	182.780	42.760	110.0	2741
Spawning box	1012	32	08-Jun-97	182.683	42.733	111.0	18018
Spawning box	1012	36	09-Jun-97	182.570	42.752	114.0	1737
Spawning box	1012	85	16-Jun-97	182.668	42.763	226.0	16079
Spawning box	1012	88	18-Jun-97	182.655	42.773	114.0	6095
Spawning box	1012	91	18-Jun-97	183.085	42.838	111.0	11288
Spawning box	1012	95	19-Jun-97	183.285	42.797	121.0	12529
Spawning box	1012	96	19-Jun-97	183.462	42.815	111.0	18907
Spawning box	1012	97	19-Jun-97	183.628	42.822	119.0	19979
Subantarctic	963	43	23-Jan-97	168.123	48.037	210.0	5859
Tolaga	986	9	01-Apr-97	178.723	38.968	165.0	4803
Tolaga	1009	9	04-Jun-97	178.722	38.968	108.8	2173
Wairarapa	986	30	07-Apr-97	176.717	41.222	131.0	2800
Westpac	1014	25	08-Jun-97	167.250	39.800	130.5	7730
Westpac	1014	45	12-Jun-97	167.230	39.798	119.5	1283
Westpac	1014	141	28-Jun-97	167.233	39.800	133.0	6655
Westpac	1014	146	29-Jun-97	167.217	39.800	130.0	5462
Westpac	1014	152	30-Jun-97	167.233	39.733	142.5	10000

Area	Trip number	Tow number	Date	Longitude (0°–360°)	Latitude (S)	Sample weight (kg)	ORH weight (kg)
Westpac	1014	170	02-Jul-97	167.150	39.800	118.5	684
Westpac	1014	174	03-Jul-97	167.250	39.783	119.5	21000
Westpac	1014	175	03-Jul-97	167.233	39.800	122.0	23000
Westpac	1014	184	05-Jul-97	167.250	39.783	133.5	2284
Westpac	1014	189	05-Jul-97	167.250	39.783	119.0	11970
Westpac	1014	210	08-Jul-97	167.217	39.800	124.0	15000
Westpac	1014	216	09-Jul-97	167.233	39.783	120.0	2690
Westpac	1014	253	14-Jul-97	167.233	39.800	125.5	1200