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Descriptive analysis of orange roughy fisheries in the
New Zealand region outside the EEZ:
Lord Howe Rise, Northwest Challenger Plateau,
West Norfolk Ridge, and Louisville Ridge
to the end of the 2006–07 fishing year

M. R. Clark

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M. R. Clark

NIWA
Private Bag 14901
Wellington 6241

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EXECUTIVE SUMMARY

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Commercial catch and effort data for New Zealand vessels were obtained from the Ministry of Fisheries for the fishing years 2005–06 and 2006–07, and data from Australian vessels fishing the five areas were provided by the Bureau of Resource Sciences in Canberra to the end of the 2006 calendar year. The distribution of trawls confirmed the Lord Howe Rise, Northwest Challenger Plateau, and West Norfolk Ridge were the main areas of orange roughy catch in the Tasman Sea outside the New Zealand EEZ. The Louisville Ridge fishery continued to the east of New Zealand. The South Tasman Rise has not been fished by New Zealand in the last three years, and there was no other recorded fishing activity beyond the New Zealand region.

Descriptive analyses of these fisheries were carried out for the period 2004–05 to 2006–07. Total catch and levels of effort were summarised by month and by subarea.

Most fisheries outside the New Zealand EEZ have had variable levels of catch and effort between years. Catches have decreased for all fisheries since they began, but in the early 2000s until about 2004–05 the total catch by New Zealand vessels had been consistent at 2000–3000 t. There was a substantial decrease in total catch from about 2500 t to 1700 t between 2004–05 and 2005–06, but a greater one again in 2006–07, when for the first time the combined catch of orange roughy from outside the EEZ was less than 1000 t. This was partly driven by decreases in effort, from 2200 tows in 2004–05 to 600 in 2006–07. Over the last three years the fisheries on Northwest Challenger and Louisville have shown marked changes, reducing from 18% and 61% respectively of the total orange roughy catch in 2004–05, to 4% and 35% respectively in 2006–07. The only fishery to increase has been West Norfolk, which increased from 270 t in 2004–05 to over 700 t in 2005–06, before dropping to 540 t in 2006–07. The catch in 2006–07 amounted to 58% of the total catch by New Zealand vessels outside the EEZ. Trends in catch and effort have been difficult to interpret, given changes in the vessel composition over time and the areas fished between years.

1. INTRODUCTION

1.1 Overview

This report summarises commercial catch and effort information from New Zealand vessels for orange roughy fisheries outside the New Zealand EEZ. These areas include the Lord Howe Rise, Northwest Challenger Plateau, South Tasman Rise, Louisville Ridge, and West Norfolk Ridge. Overall results are given for all years of the fisheries, but the three most recent fishing years to 2006–07 are covered in more detail (excluding the South Tasman Rise which is now closed).

The work was carried out by NIWA in collaboration with the Bureau of Rural Sciences (BRS) as part of the MFish research project ORH2007/03 (“Orange roughy fisheries outside the EEZ”). The specific objective (#1) was “To update descriptive analyses of commercial catch and effort data from orange roughy fisheries in the mid Tasman Sea (Lord Howe Rise and Northwest Challenger), Louisville Ridge, and South Tasman Rise with the inclusion of data up to the end of the 2006/07 fishing year”. Note that the scope of work requested by MFish this year was restricted to general summaries, without the more detailed analyses of catch and effort covered by recent reports.

1.2 Description of the fishing grounds

The main fishing grounds in the New Zealand region outside the EEZ are shown in Figure 1.

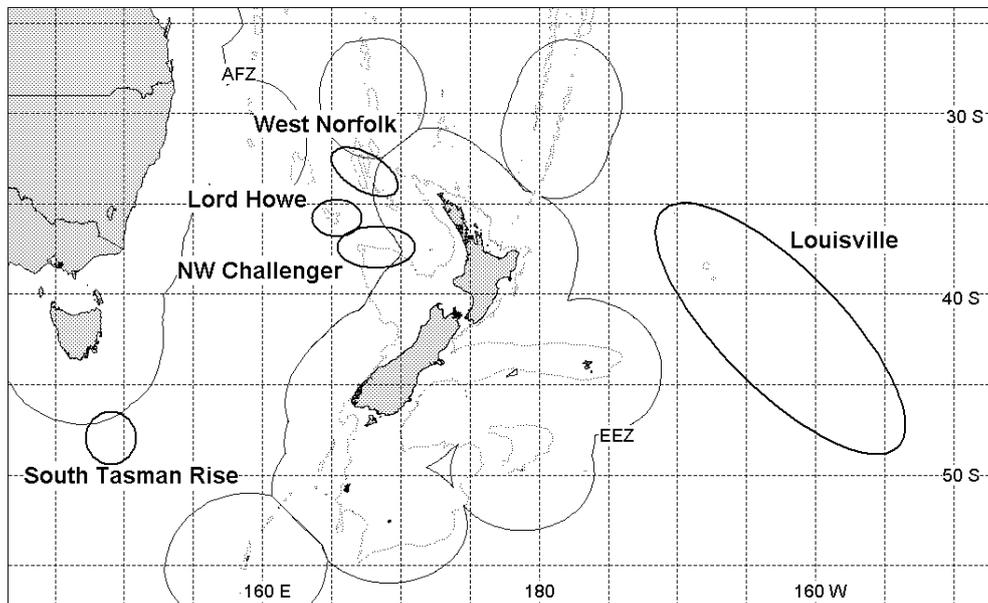


Figure 1: The New Zealand region, showing location of major fisheries for orange roughy outside New Zealand and Australian EEZs (1000 m depth contour shown around New Zealand).

1.3 Literature review

The Lord Howe Rise/Northwest Challenger fishery has been described in various assessment documents by Clark (1990, 1993, 1998a, 1998b), Clark & Tilzey (1996), Field (2000), O’Driscoll (2001, 2003), and Clark & O’Driscoll (2002). These reports include summaries of commercial catch and effort data from New Zealand vessels, together with biological data on

size structure and reproduction. A stock reduction analysis using CPUE indices to estimate biomass and indicate yields was carried out by Clark & Tilzey (1996). Field (2000) and O'Driscoll (2001, 2003) attempted similar stock reduction modelling including more recent data, but did not update estimates of virgin biomass. CPUE indices were not thought to be an appropriate estimate of abundance for Lord Howe, and CPUE indices from the Northwest Challenger showed no decreasing trend over time.

The Louisville Ridge fishery has been described by Clark (1998c, 1998d, 1999, 2000, 2003a) and Clark & Anderson (2001, 2003). Standardised analyses of CPUE were carried out, but even when considered on an individual seamount basis, were not felt to be successful in tracking abundance of orange roughy. A "seamounts meta-analysis" by Clark (2003b) included estimates of virgin biomass based on the physical features of the fishing grounds.

Descriptive analyses of catch and effort data for the South Tasman Rise fishery were given by Tilzey (2000), Clark & Tilzey (2001), and Clark & O'Driscoll (2002). A standardised analysis by Wayte et al. (2001, 2003) showed a decline in catch rate over time. Echo-sounder surveys and biological sampling of the spawning grounds were carried out in 2000 and 2001 (Prince & Diver 2001a, 2001b).

Clark (2003c, 2004, 2006a, 2006b, 2008) updated and summarised catch and effort data for all these fisheries to the end of the 2001–02, 2002–03, 2003–04, 2004–05, and 2005–06 fishing years respectively. These data were included in summary reports of catch and effort in the proposed South Pacific Regional Fisheries Management Organisation area (Penney et al. 2007, 2008).

2. METHODS

2.1 Data sources

Data on catch and effort are recorded by all New Zealand registered deepwater fishing vessels (and charter vessels) on Trawl-Catch-Effort-Processing>Returns (TCEPR) and High-Seas Trawl-Catch-Effort>Returns (HS-CER). Australian vessels involved in the South East Fishery (SEF) reported their catches in SEF logbooks or other Daily Fishery logbooks. These returns give tow-by-tow information, with specific location, duration, and estimated catch for each trawl. New Zealand data were obtained from the Ministry of Fisheries. Australian data were provided by the Australian Fisheries Management Authority (AFMA) to the Bureau of Rural Sciences (BRS) in Canberra, who in turn provided selected information for NIWA to combine with the New Zealand data. Available data where orange roughy or oreos were either caught or targeted were extracted from the Ministry of Fisheries catch-effort database and loaded into a relational (Empress) database at NIWA in December 2008.

Data were error-checked. Obvious mistakes in position (e.g., large differences in start and finish coordinates) were corrected, as were positions well outside any other fished area where typing or recording mistakes could be resolved by examining that vessel's tows in sequence. Data for the 2006–07 fishing year may be incomplete due to forms not yet supplied by fishing vessels and records not yet entered into the Ministry database (although this is likely to be minor). Records containing errors that couldn't be resolved or corrected were excluded from further analyses. Catch data from research survey work by FV *Thomas Harrison* outside the EEZ on the Westpac Bank in 2005 and 2006 were excluded.

2.2 Fishing area boundaries

The following coordinates were used to define fishing areas (after Clark 2004, 2006a, 2006b).

a) Lord Howe Rise

The main region of the fishery is 35°00' S – 36°45' S and 164°00' E – 167°00' E

In recent years there has been activity to the north of this, and so data were also extracted for a northern area, 32°30' S – 35°00' S, 162°00' E – 166°00' E.

b) Northwest Challenger Plateau

The total area is between 36°50' S – 39°30' S (north of the Westpac Bank area) and 166°00' E – 170°00' E, but excluding tows that fell within the New Zealand EEZ. Note that in previous reports analyses have also been conducted for a smaller “core area” (which has not been done this year).

c) West Norfolk Ridge

32°30' S – 34°30' S, 166°30' E – 168°10' E, excluding tows within the New Zealand EEZ.

d) South Tasman Rise

The area covered by this analysis is bordered by 46°00' S and 50°00' S and 145°00' E to 150°00' E.

e) Louisville Ridge

Trawls on the Louisville Ridge have been clustered in three general areas for a number of analyses in this report:

- North: 35° S to 39.9° S, 165° W to 172° W.
- Central: 40° S to 44.9° S, 157° W to 167° W.
- South: 45° S to 50° S, 148° W to 159° W.

3. RESULTS

3.1 Location of the fisheries

In the New Zealand region, there are clearly defined fishing grounds on the Lord Howe Rise, Northwest Challenger Plateau, West Norfolk Ridge, Louisville Ridge and, up until 2000–01, on the South Tasman Rise. Over the last three years there have been only minor changes in the distribution of fishing (Figure 2).

3.2 Overall catch and effort in the fisheries

The total reported New Zealand orange roughly catch outside the EEZ in 2006–07 was about 940 t. This was almost 800 t less than in 2005–06, and 1500 t less than in 2004–05. The quantity of catch reported in the QMS is similar to that from the tow by tow records. It was low for 2004–05, for reasons which are unknown, although there is a discrepancy in the oreo figures the other way (Table 1). The catch (and effort) in all the fisheries has decreased substantially in 2006–07 relative to 2005–06.

Table 1: Reported catch (t) of orange roughly (ORH) and oreos (OEO) and level of effort (Ntows, number of vessels in parentheses) by fishing area for fishing years 2004–05, 2005–06, and 2006–07 for New Zealand vessels (totals include CELR data).

Area	2004–05			2005–06			2006–07		
	Ntows	Catch (t)		Ntows	Catch (t)		Ntows	Catch (t)	
		ORH	OEO		ORH	OEO		ORH	OEO
Lord Howe Rise	218	255	2	71	123	0	40	34	0
Northwest Challenger	1 007	445	2	399	200	1	77	36	0
West Norfolk	248	274	0	337	727	1	215	543	0
Louisville	745	1 510	324	581	669	67	283	323	131
South Tasman Rise	0			0			0	0	0
Reported total	2 218	2 484	328	1 388	1 719	69	615	936	131
QMS		1 696	747		1 613	49		935	213

Australian vessels are the only other nationality known to regularly fish these grounds (Table 2).

Table 2: Reported catch (t) of orange roughly and level of effort (Ntows) by fishing area for fishing years 2004–05, 2005–06, and 2006–07 for Australian vessels (note South Tasman Rise catch is for a 1 March to 28 February fishing year).

Area	2004–05			2005–06			2006–07		
	Ntows	Catch (t)		Ntows	Catch (t)		Ntows	Catch (t)	
		ORH	OEO		ORH	OEO		ORH	OEO
Lord Howe Rise	21	175	0	21	117	0	13*	6	1
Northwest Challenger	4	19	0	1	1		52	60	0
West Norfolk	2	3		0			22	9	0
Louisville	0			22	6	0	0		
South Tasman Rise	34	55	42	18	12	158	0		
Reported total	61	252	42	62	136	158	87	75	1

*This excludes about 200 tows in the northern Lord Howe region which targeted primarily alfonso and caught 2 t of ORH.

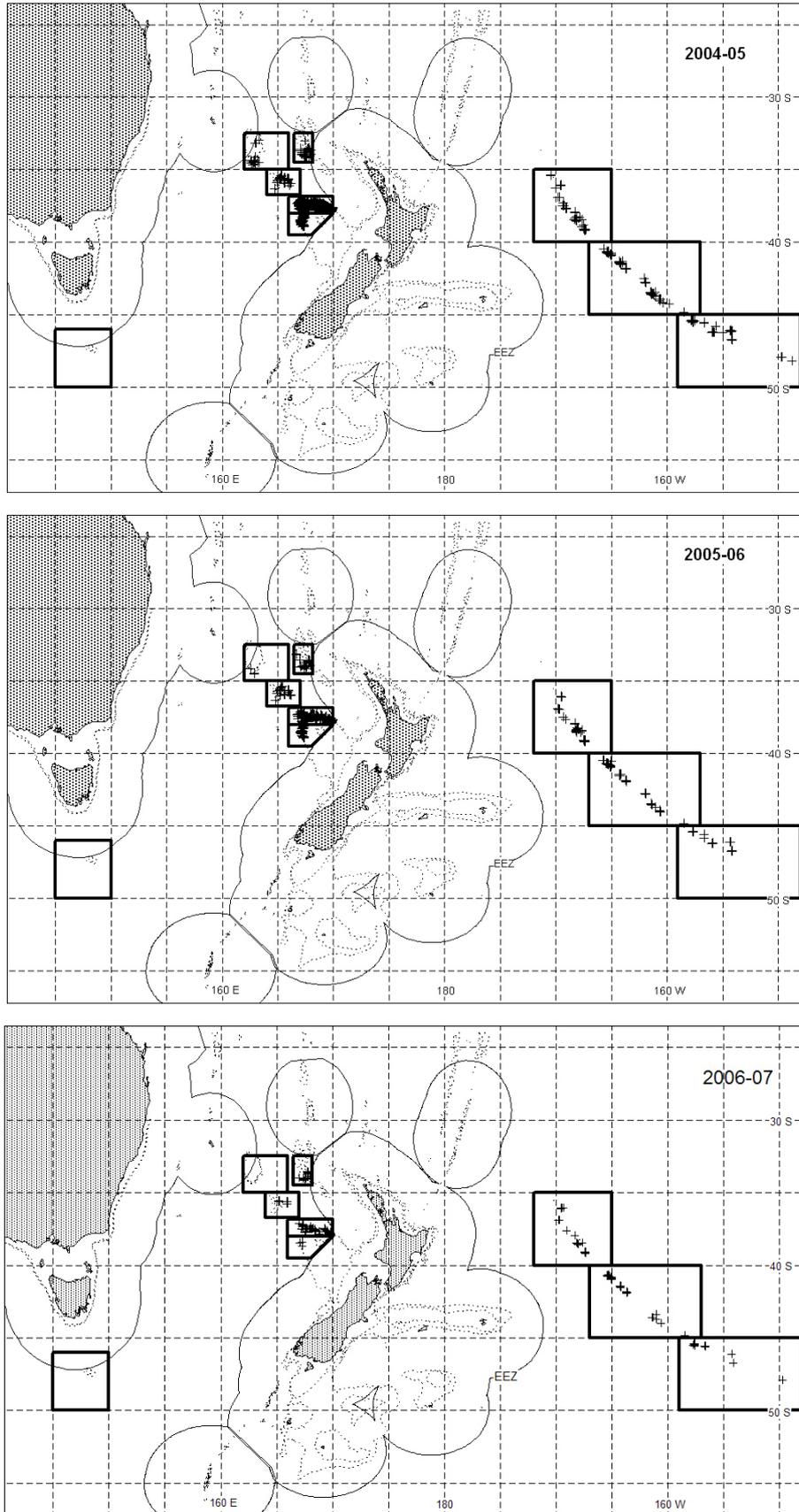


Figure 2: Distribution of New Zealand fishing for orange roughy in the New Zealand region during 2004–05 (upper panel) to 2006–07 (lower panel).

Total catches from the fisheries outside the EEZ in the New Zealand region have varied over time, and between fishing areas. Table 3 includes estimates of historical catch from other nationalities (including Japan, USSR up to 2000, Korea, Norway, South Africa, and China). Catch statistics are likely to be incomplete.

Table 3: Estimated catches (t) of orange roughy for ORH ET fisheries from 1987–88 to 2006–07 (Data from New Zealand (FSU, QMS), Australia (AFMA), and various sources for other countries. Note the fishing year for South Tasman Rise is March to February, all others are October to September)

Fishing year	Lord Howe	NW Challenger	Louisville	West Norfolk	South Tasman	Total
1987–88	4000	5	0	0	0	4005
1988–89	2430	297	0	0	0	2727
1989–90	927	425	0	0	0	1352
1990–01	282	123	0	0	0	405
1991–02	859	620	0	0	0	1479
1992–03	2300	2463	0	0	0	4763
1993–04	840	1731	689	0	0	3260
1994–05	761	1138	13252	0	0	15151
1995–06	5	500	8816	0	0	9321
1996–07	139	332	3209	0	5	3685
1997–08	26	397	1404	0	3930	5757
1998–09	440	961	3164	0	705	5270
1999–00	52	473	1369	0	4110	6004
2000–01	428	1228	1598	10	830	4094
2001–02	120	2075	1004	649	170	4018
2002–03	272	1010	1296	94	110	2782
2003–04	324	654	1419	90	3	2490
2004–05	430	464	1510	277	55	2736
2005–06	240	201	675	727	12	1855
2006–07	40	96	323	552	0	1011

3.3 The Lord Howe Rise fishery

3.3.1 Catch effort data

The Lord Howe Rise fishery has historically included 54 vessels. In the last three years the number of vessels has dropped from 12 to 3. Almost all tows have targeted orange roughy, although in 2004–05 and 2005–06 small numbers targeted alfonsino or cardinalfish in the northern part of the Rise. Levels of catch and effort have decreased appreciably over the last three years, with only 40 tows, and 34 t catch, recorded in 2006–07.

Tows were relatively long (3 h) in the early years (1988–91) when most fishing effort was on the flat ground of the broad platforms (Table 4). There was then a trend towards shorter tows (less than 1 h) from 1991 to 1998 associated with a shift to fishing on rough ground in the area. Short tows still dominate with mean tow durations in the last three fishing years of 0.3–0.7 h. The mean depth of fishing has varied between 870 m and 910 m. Catch rates decreased from relatively high levels in the first four years of the fishery to low levels in the late 1990s (mean of 0.2–0.3 t/tow) but have been at higher levels since 2000–01. Catch rates have increased over the last few years, almost doubling in 2005–2006, but then decreased in 2006–07.

3.3.2 Seasonal and spatial distribution of catch and effort

Catch and effort have historically been concentrated during the winter spawning period (May–July), with scattered effort during the rest of the year. Since 2004–05 this has become further restricted to June and July (Figure 3). The distribution of catch rates in the southern region has been consistent in recent years (Figure 4). In the past there have been two regions of good catch rates, but in the last few years only the more northern area produced high catch rates, with a more scattered distribution of catches in areas to the east.

Table 4: Summary of groomed tow-by-tow data from TCEPR/HS-CER forms for the Lord Howe Rise.

Fishing year	Number of vessels	Number of tows	Total recorded catch (t)	Mean tow speed (kt)	Mean tow length (h)	Mean tow length (n.mile)	Mean catch rate (t/tow)	Mean catch rate (t/h)	Mean catch rate (t/n.mile)
1988–89	6	181	766	3.3	3.0	9.9	4.2	5.2	1.5
1989–90	4	63	127	2.9	2.9	8.6	2.0	1.0	0.3
1990–91	3	14	52	3.0	2.9	8.7	3.7	2.0	0.7
1991–92	4	70	479	3.2	1.7	5.2	6.8	7.6	2.5
1992–93	18	825	1 363	3.0	1.3	3.9	1.7	3.6	1.2
1993–94	19	1 263	777	2.8	0.9	2.5	0.6	1.9	0.8
1994–95	8	110	61	2.9	1.2	3.6	0.6	0.5	0.2
1995–96	3	26	5	2.9	0.7	1.9	0.2	0.5	0.2
1996–97	5	179	44	3.0	0.8	2.5	0.2	0.8	0.3
1997–98	4	57	15	3.2	0.3	1.1	0.3	1.8	0.5
1998–99	16	138	48	3.1	1.0	3.3	0.3	0.5	0.2
1999–2000	8	121	34	2.9	1.1	3.4	0.3	1.3	0.5
2000–01	6	136	145	3.0	0.7	1.9	1.1	2.9	1.0
2001–02	10	191	110	3.1	0.7	2.3	0.6	2.3	0.7
2002–03	10	280	208	3.4	0.5	1.6	0.7	4.2	1.4
2003–04	9	207	180	3.1	0.7	2.1	0.9	4.7	1.6
2004–05	12	218	255	3.1	0.6	1.9	1.2	6.4	2.0
2005–06	6	71	123	3.2	0.4	1.5	1.7	15.8	5.2
2006–07	3	40	34	2.9	0.5	1.6	0.8	3.4	1.1

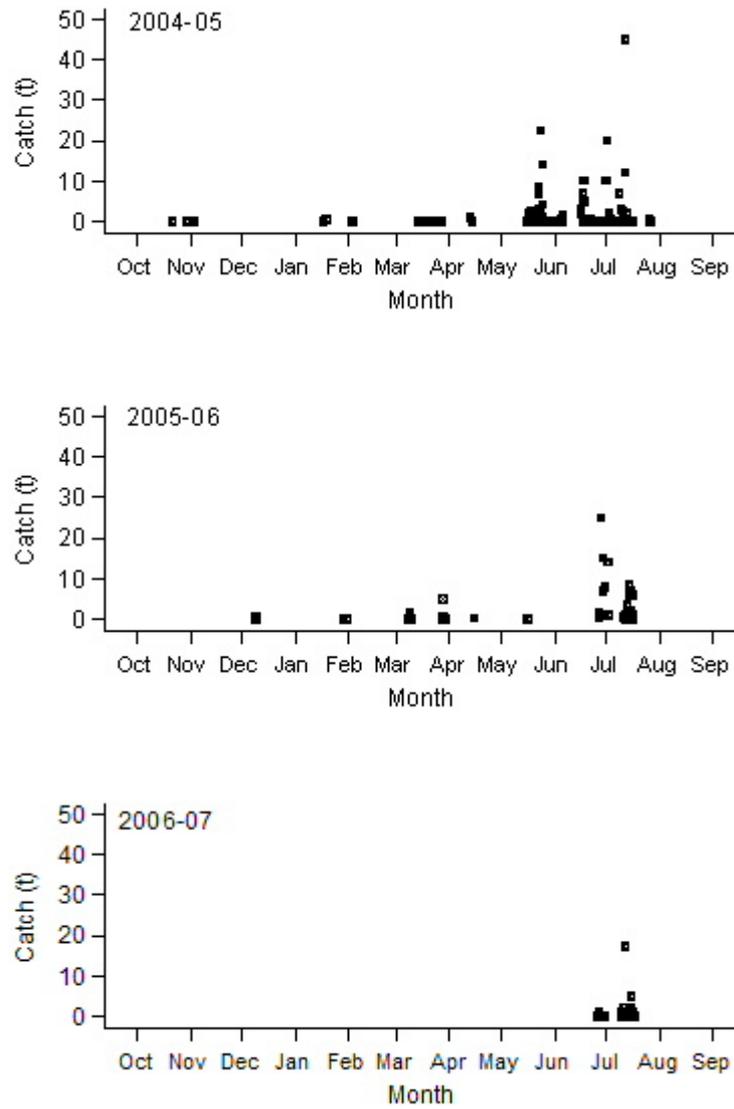


Figure 3: Seasonal distribution of catch rates (t/tow) in the Lord Howe region, 2004–05 to 2006–07.

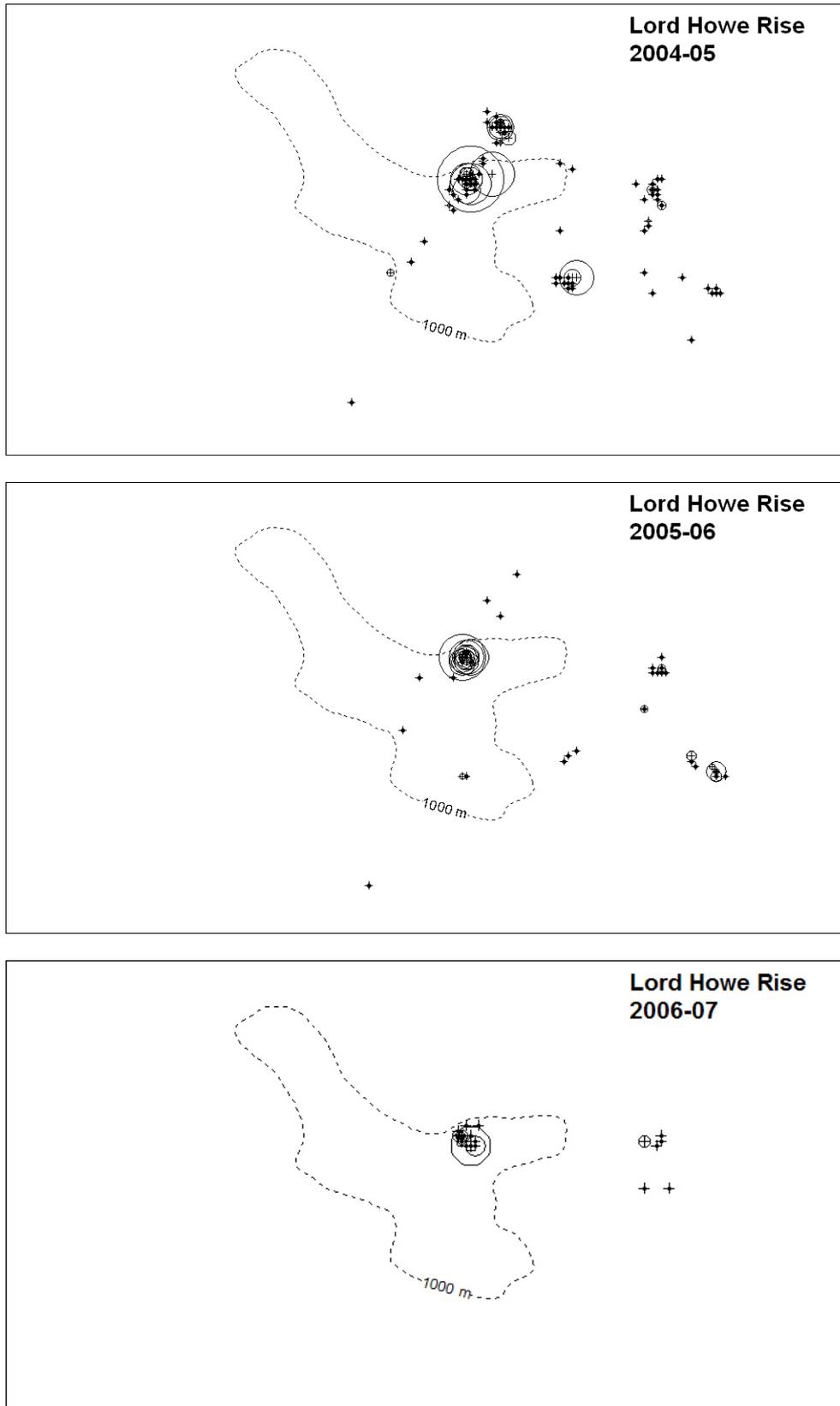


Figure 4: Distribution of catch rates of orange roughy (catch per trawl) on the Lord Howe Rise during the 2004–05 to 2006–07 fishing years (+, trawl position, circle area proportional to catch, max = 45 t).

3.4 Northwest Challenger Plateau fishery

3.4.1 Catch effort data

The fishery has experienced a marked decrease in levels of effort and catch in the last few years. The catch in 2006–07 of 36 t (Table 4) is the lowest since 1991–92. Tow duration and distance on Northwest Challenger were long in the first two years of the fishery, but decreased as fishing shifted to hill features (Table 4). From 1992–93 to 1999–2000 mean tow duration was relatively constant at between 0.7 and 1.1 h. There was a major increase in tow duration in 2000–01, and this has remained high. The increase in tow length was associated with changes in the spatial pattern of the fishery, with some effort moving away from the hills on to flat areas to the east. Average depth of fishing over the last three years has been consistent at about 930 m. The mean catch per tow overall has generally been highly variable, at between 1 and 2 t/tow, although it reached 4 t/tow in 1988–89. The catch rates in recent years are among the lowest for the entire time series. Catch rates have generally been higher than on the neighbouring Lord Howe Rise grounds, but in the last three years they have been lower, whether t/tow, t/h, or t/n.mile is considered.

3.4.2 Seasonal and spatial distribution of catch and effort

The relative distribution of catch rates by month has contracted in recent years (Figure 5). Fishing has become more restricted to June–July from 2004–05 when it was more widespread through the year. Catch rates have decreased, with no large catches at all in 2006–07.

The distribution of catch rates has been similar in recent years (Figure 6). Fishing occurs across the entire northern flank, although effort has become progressively less intensive. Highest catch rates are generally on the northwestern corner. Fishing continues to extend down the western margin of the Plateau, but catches are small.

Table 4: Summary of groomed tow-by-tow data from TCEPR/HS-CER forms for Northwest Challenger. Data from CELR forms in 2001–02 and 2002–03 are given below in parentheses.

Fishing year	Number of tows	Number of vessels	Total recorded catch (t)	Mean tow speed (kt)	Mean tow length (h)	Mean tow length (n.mile)	Mean catch rate (t/tow)	Mean catch rate (t/h)	Mean catch rate (t/n.mile)
1988–89	33	3	107	2.8	3.2	9.2	3.3	1.5	0.5
1989–90	40	4	25	2.8	2.4	6.8	0.6	0.6	0.2
1990–91	4	1	1	3.5	0.2	0.6	0.3	1.5	0.4
1991–92	56	2	230	3.5	0.5	1.8	4.1	12.8	3.7
1992–93	1 370	19	2 250	3.2	0.8	2.5	1.6	3.9	1.2
1993–94	1 499	19	1 394	2.8	1.1	3.2	0.9	1.4	0.5
1994–95	877	11	1 138	2.9	0.8	2.2	1.3	5.7	2.0
1995–96	270	7	500	2.9	1.0	3.1	1.9	10.0	3.4
1996–97	385	7	332	3.0	0.8	2.5	0.9	3.5	1.2
1997–98	215	8	228	3.1	0.7	2.2	1.1	6.0	2.0
1998–99	707	21	838	3.0	0.8	2.3	1.2	4.2	1.4
1999–2000	598	11	335	3.0	1.0	3.2	0.6	2.6	0.9
2000–01	1 002	13	944	3.0	2.6	7.5	0.9	1.5	0.5
2001–02	2 154 (277)	20 (2)	1 656 (207)	2.9	3.9	11.2	0.8	1.4	0.5
2002–03	1 939 (40)	22 (1)	938 (10)	2.9	3.8	10.8	0.5	0.9	0.3
2003–04	869	16	495	2.9	3.5	10.6	0.6	1.0	0.3
2004–05	1 007	17	442	2.8	4.7	13.0	0.4	0.7	0.2
2005–06	399	8	200	2.7	5.2	13.8	0.5	0.6	0.2
2006–07	77	4	36	2.8	4.6	12.4	0.5	0.4	0.1

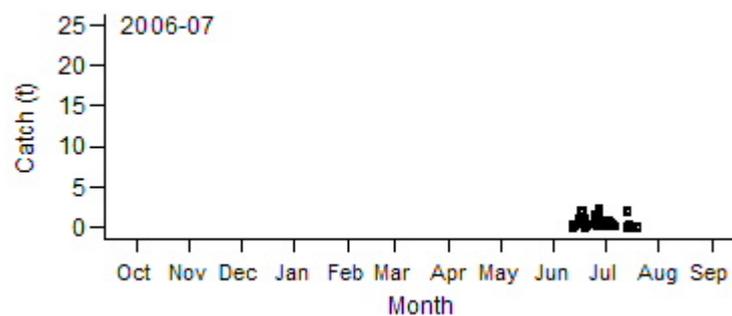
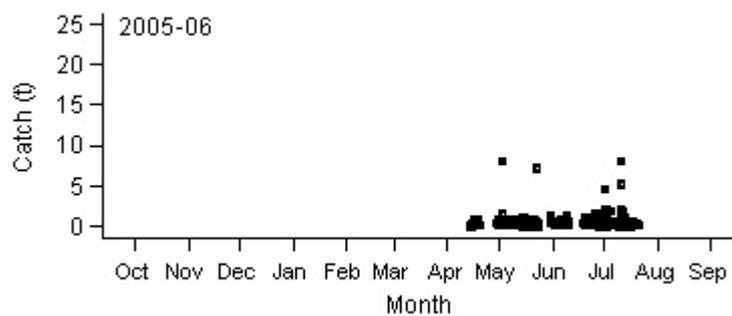
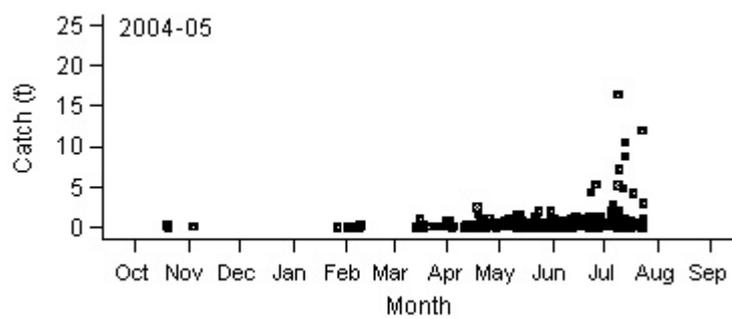


Figure 5: Seasonal distribution of catch rates (t/tow) in the Northwest Challenger region, 2004–05 to 2006–07.

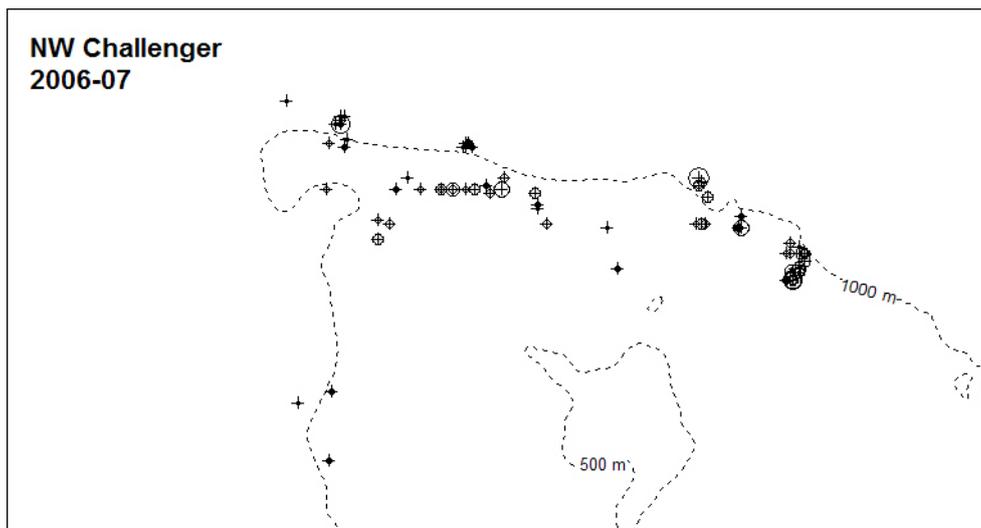
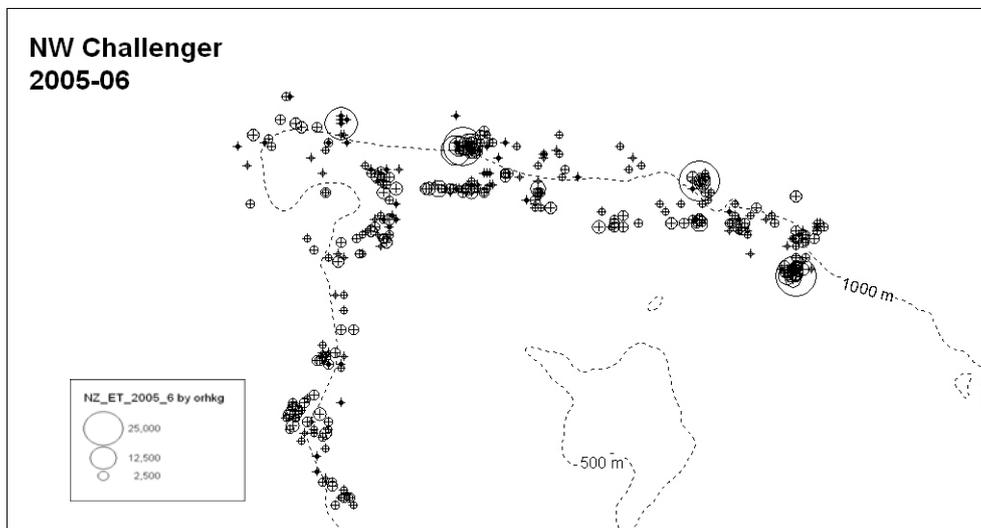
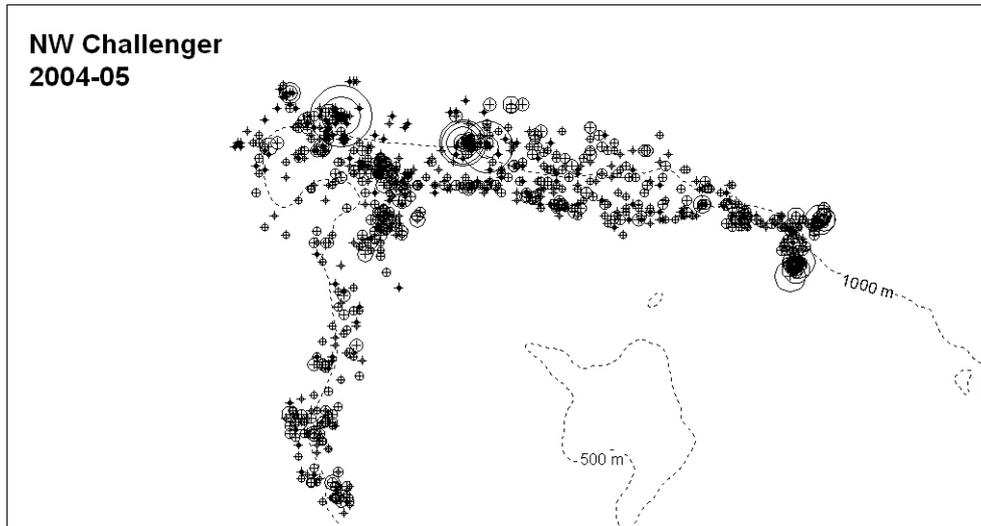


Figure 6: Distribution of catch rates of orange roughy (catch per trawl) on the Northwest Challenger Plateau (total area) during 2004–05 to 2006–07 fishing years (+, trawl position; circle area proportional to catch, max = 25 t).

3.5 West Norfolk Ridge fishery

3.5.1 Catch effort data

The fishery developed in 2000–01. Almost all trawls have been reported as targeting orange roughy (99%) with a few cardinalfish target tows in 2005–06. The fishery catch increased rapidly, then dropped, and has picked up again in the last three years (Table 5). The fishery has become the largest for New Zealand vessels working outside the EEZ, contributing 58% of the total catch in 2006–07.

Tows have been very similar in duration and distance over the period of the fishery, with a mean tow duration of 0.3–0.5 h, and a mean distance of 0.9–1.5 n.mile. The fishery takes place largely on small seamount-like features and peaks along the West Norfolk Ridge. There is limited ground for longer flat-bottom trawling, as it is deep between the ridge peaks. Unstandardised catch rates for all groomed data combined were expressed as tonnes per tow, tonnes per hour, and tonnes per nautical mile (Table 5). These three measures all decreased from 2001–02 to 2003–04, but then have increased each year from 2004–05.

3.5.2 Seasonal and spatial distribution of catch and effort

Effort in the fishery has been spread over much of the year. Fishing in June 2006 recorded average catch rates of 7 t/tow. The dramatic increase in fishing success in 2005–06 and 2006–07 is seen in Figure 7 where catches of 10 t to 35 t per tow were common.

The distribution of catch rates has changed between years, but not much over the last three (Figure 8). In 2003–04 highest catch rates were on the western ridge and extended northwest. Largest catches in 2004–05 were on the southern end of the northern ridge, with a spread of effort to the west. The southern end of the western ridge produced high catch rates in 2005–06 and 2006–07. This area was also fished in 2003–04, but with much less success.

Table 5: Summary of groomed tow-by-tow data from TCEPR/HS-CER forms for the West Norfolk Ridge orange roughy fishery.

Fishing year	Number of vessels	Number of tows	Total recorded catch (t)	Mean tow speed (kt)	Mean tow length (h)	Mean tow length (n.mile)	Mean catch rate (t/tow)	Mean catch rate (t/h)	Mean catch rate (t/n.mile)
2000–01	1	1	0.2						
2001–02	3	297	586	3.0	0.3	0.9	2.0	9.0	3.0
2002–03	5	91	35	3.0	0.3	0.9	0.4	2.4	0.8
2003–04	2	90	88	3.0	0.5	1.5	1.0	2.3	0.8
2004–05	6	248	274	3.0	0.4	1.3	1.1	4.5	1.5
2005–06	6	337	727	3.1	0.4	1.2	2.2	19.7	6.6
2006–07	4	215	543	3.0	0.3	1.0	2.5	12.7	4.0

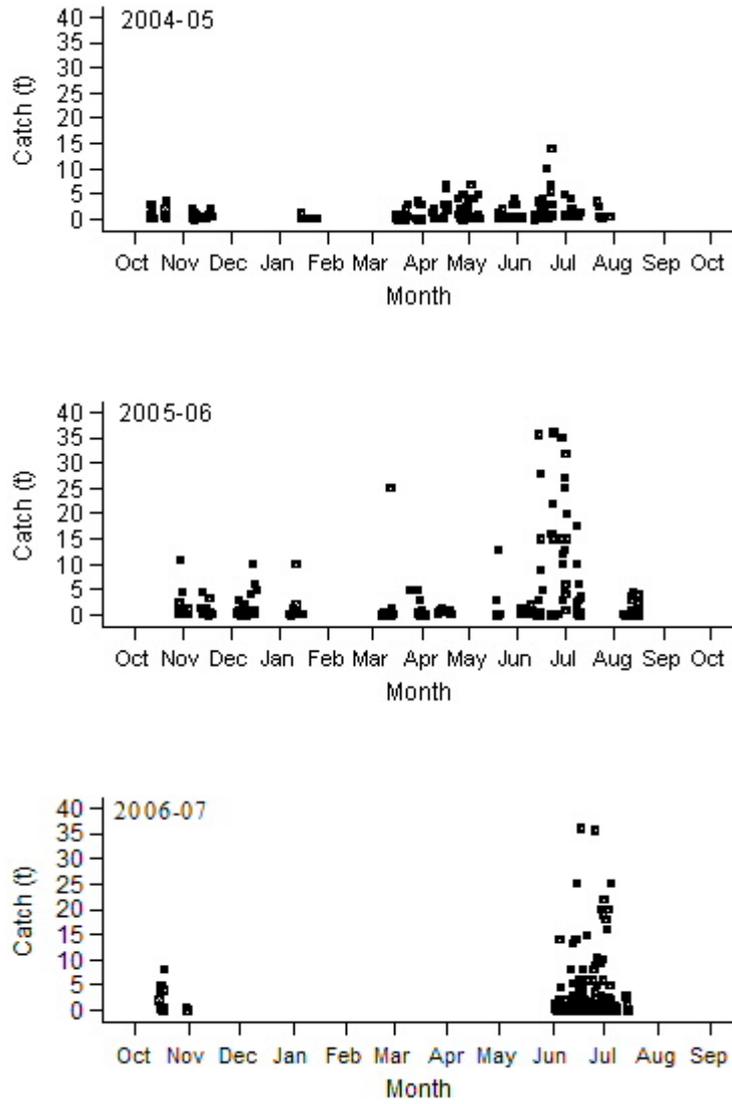


Figure 7: Seasonal distribution of catch rates (t/tow) in the West Norfolk region, 2004–05 to 2006–07.

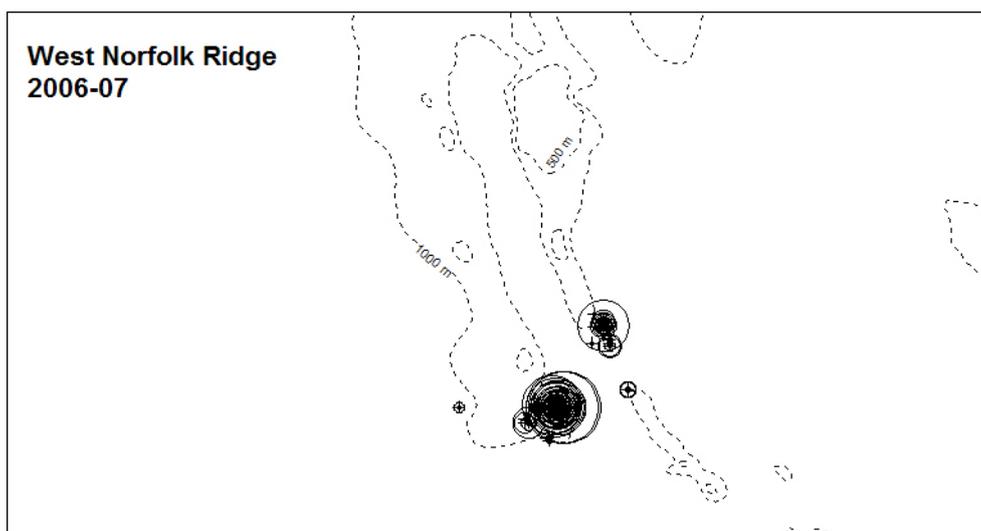
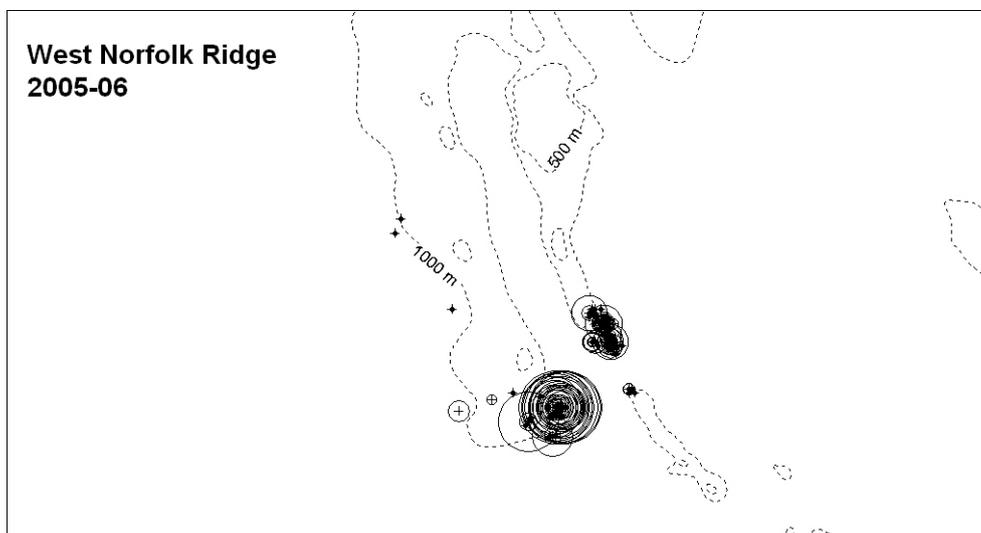
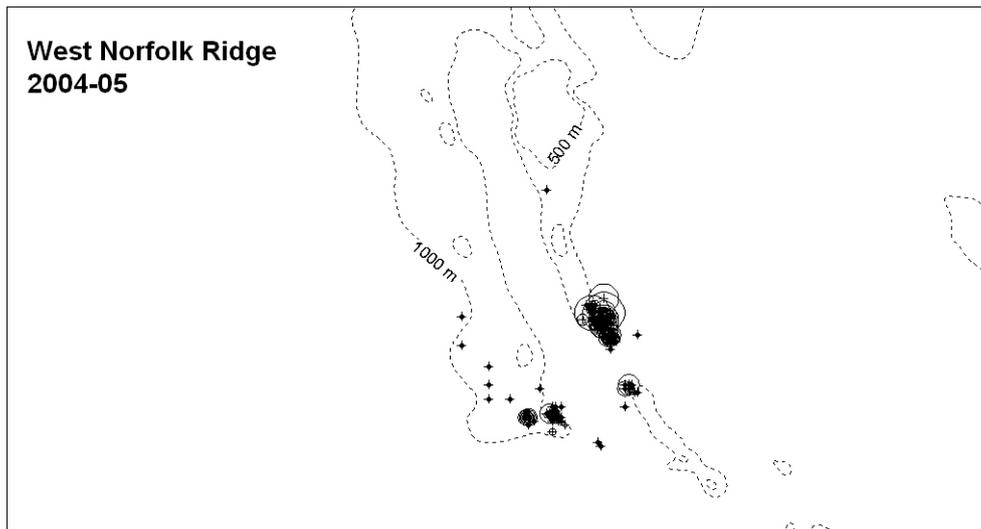


Figure 8: Distribution of catch rates of orange roughy (catch per trawl) on the West Norfolk Ridge during the 2004–05 to 2006–07 fishing years (+, trawl position; circle area proportional to catch, max = 40 t).

3.6 Louisville Ridge fishery

3.6.1 Catch effort data

The fishery is almost exclusively directed at orange roughy (99% during the last three years), with a very small number of tows targeting alfonso or oreos. The average depth of fishing is 850–900 m.

There has been a marked decrease in levels of both catch and effort in the last three years, with total annual catches decreasing from about 750 t in 2004–05 to less than 300 t in 2006–07 (Table 6). Tows have been similar in duration and distance in the last few years of the fishery, with a mean tow duration of 0.4–0.6 h, and a mean distance of 1–2 n.mile. These tows are relatively long for a fishery that takes place mainly on seamount features, but the Louisville seamounts are much larger than those in most New Zealand fishing grounds. Unstandardised catch rates have varied substantially in recent years, with relatively high levels in 2004–05, a substantial drop in 2005–06, but an increase in 2006–07 (Table 6).

3.6.2 Seasonal and spatial distribution of catch and effort

There have been strong seasonal trends between years in catch and effort. Initially effort in the fishery was spread over much of the year, but this began to contract in 1997–98, and from 1998–99 onwards, effort has been heavily concentrated in June, July, and August. This has continued to 2006–07 (Figure 9).

The distribution of New Zealand catches has varied between years. The fishery initially developed in the central region in 1994–95, with other grounds quickly developing in the northern region of the Ridge, and southern seamounts also yielding good catch rates from 1995–96. Over the last three years (Figure 10), effort has decreased in the central region, and good catch rates have occurred on fewer seamounts. In 2006–07 catch rates were lower in the northern area, with most success occurring on one seamount in the southern region.

Table 6: Summary of groomed tow-by-tow data from TCEPR/HS-CER forms for the Louisville Ridge.

Fishing year	Number of vessels	Number of tows	Total recorded catch (t)	Mean tow speed (kt)	Mean tow length (h)	Mean tow length (n.mile)	Mean catch rate (t/tow)	Mean catch rate (t/h)	Mean catch rate (t/n.mile)
1993–94	7	134	189	2.5	1.4	3.5	1.4	1.5	0.6
1994–95	31	4 294	11 340	2.5	0.7	1.7	2.6	10.6	4.2
1995–96	26	4 024	8 764	2.5	0.7	1.7	2.2	7.4	3.0
1996–97	16	1 849	3 209	2.5	0.8	1.9	1.7	5.3	2.1
1997–98	13	787	1 404	2.9	0.5	1.5	1.8	14.2	4.8
1998–99	17	1 093	3 025	2.9	0.5	1.5	2.7	14.2	5.2
1999–2000	12	918	1 369	3.0	0.5	1.5	1.5	11.4	3.8
2000–01	11	749	1 598	3.0	0.5	1.7	2.1	18.0	2.3
2001–02	15	889	1 004	3.1	0.6	2.0	1.1	7.4	2.4
2002–03	11	736	1 296	3.0	0.4	1.1	1.8	13.8	4.6
2003–04	12	1336	1419	3.1	0.4	1.1	1.1	8.7	2.9
2004–05	8	745	1 510	3.1	0.4	1.1	2.0	17.2	5.6
2005–06	5	581	669	3.0	0.6	1.6	1.2	6.2	2.0
2006–07	2	283	323	3.3	0.5	1.6	1.1	8.5	2.6

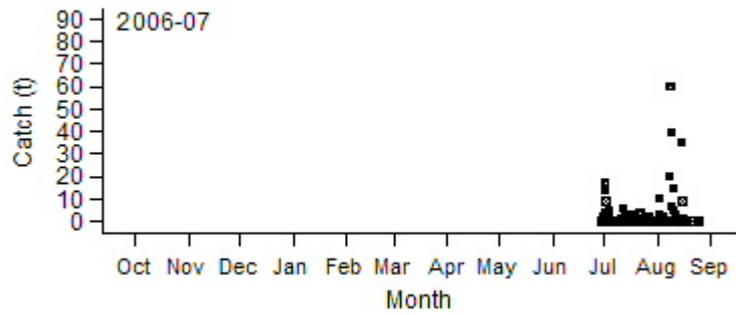
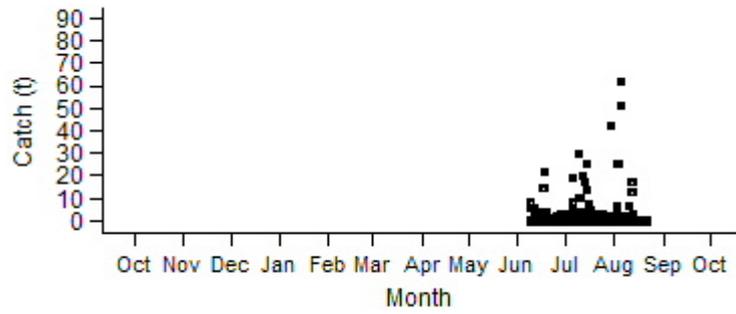
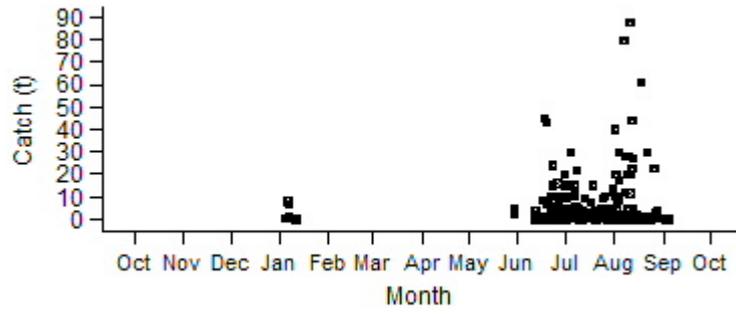


Figure 9: Seasonal distribution of catch rates (t/tow) in the Louisville Ridge region, 2004–05 to 2006–07.

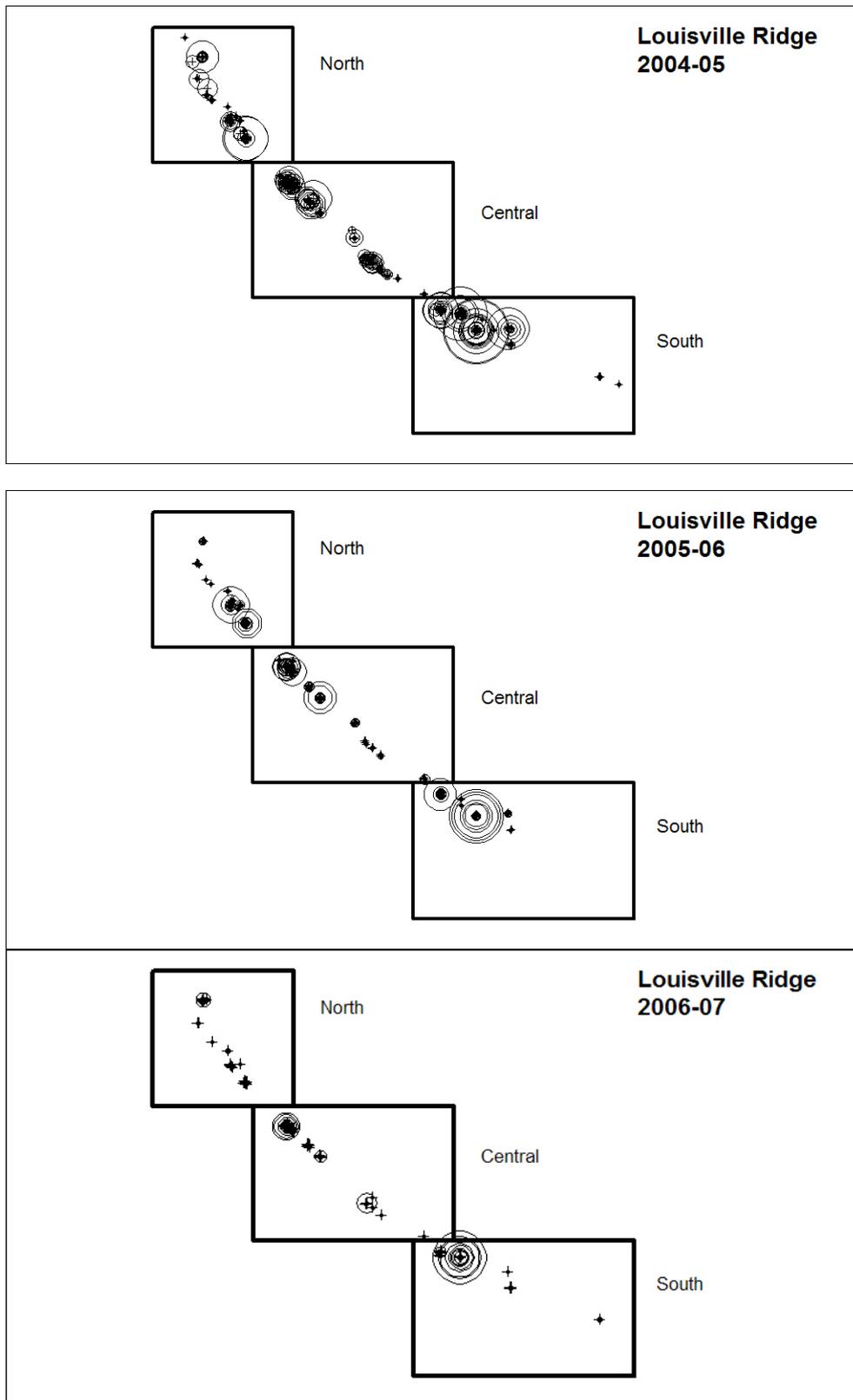


Figure 10: Distribution of catch rates of orange roughy (catch per trawl) on the Louisville Ridge during the 2003–04 to 2006–07 fishing years (+, trawl position; circle area proportional to catch, max = 90 t).

4. DISCUSSION

Most fisheries outside the New Zealand EEZ continue to have variable levels of catch and effort between years. Catch levels have decreased for all fisheries since they began, but in the early 2000s until about 2004–05 the total catch by New Zealand vessels had been consistent at 2000–3000 t. There was a substantial decrease in total catch between 2004–05 and 2005–06, but a greater one again in 2006–07, when for the first time the combined ET fisheries catch of orange roughy was less than 1000 t. Over the last three years the fisheries on Northwest Challenger and Louisville have shown marked changes, and the only fishery to increase has been West Norfolk. Trends in catch and effort have been difficult to interpret, given changes in the vessel composition over time and the areas fished between years.

None of these fisheries is formally managed, and levels of catch and effort are unpredictable between years. Typical catch rates are low, and none of the fisheries appear to represent substantial exploitable stocks. The decrease in overall catch is partly related to declines in effort (number of vessels and tows), but catch rates in the main fisheries of the Northwest Challenger and Louisville Ridge which were maintained during the late 1990s–early 2000s have also decreased. Marked declines seen in catch rates on some seamounts, especially on the Louisville Ridge, suggest that serial depletion can occur (Clark 2006b), and this is a difficult aspect to manage. Individual feature limits occur in some New Zealand orange roughy fisheries, and this will warrant consideration as the South Pacific RFMO develops (see Penney et al. 2008).

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