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**Orange roughy fisheries in southern areas of New Zealand: a summary of commercial catch and effort information from 1991–92 to 1996–97 fishing years**

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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 the 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.**

# **Orange roughy fisheries in southern areas of New Zealand: a summary of commercial catch and effort information from 1991–92 to 1996–97 fishing years**

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**N.Z. Fisheries Assessment Research Document 98/14. 16 p.**

## **1. EXECUTIVE SUMMARY**

1. The Quota Management Area ORH 3B extends from the Chatham Rise off the east coast of the South Island, southwards to the limits of the New Zealand EEZ, around to the west coast of Fiordland. Within this large area, several orange roughy fisheries have developed in the 1990s.
2. Catch summaries for these fisheries have been compiled with catch and effort data from the Quota Management System (QMS). The principal data source has been Trawl-Catch-Effort-Processing>Returns, which have detailed information on the position and catch of individual trawls. The period covered is from the 1991–92 to the 1996–97 fishing years.
3. A fishery developed off the Puysegur Bank in 1991. Reported catches increased rapidly to almost 7000 t in 1991–92, before progressively declining with quota reductions to less than 500 t in 1996–97. General analyses of catch per unit effort (CPUE) show a decrease in catch rates over time.
4. Hills off the Auckland Islands have been fished since 1992–93. Catches rose to 1200 t in 1994–95, but have declined to 90 t in 1996–97. Catch and effort data have been difficult to interpret with variation in vessel numbers between years.
5. A new fishing ground on the eastern margin of the Pukaki Rise (west of the Antipodes Islands) was discovered in 1995–96, with reported catch about 3000 t. In 1996–97 total catch decreased to under 800 t, despite increased levels of effort.
6. Orange roughy are also taken in areas around the Bounty Islands, Snares Islands, and the Macquarie Ridge. Catches are generally small, and usually a bycatch of oreo fishing.
7. Increased exploratory fishing in southern waters during the 1990s has resulted in new fishing grounds being developed. However, few have sustained large catches for more than a year or two.

## 2. INTRODUCTION

### 2.1 Overview

Fisheries for orange roughy (*Hoplostethus atlanticus*) in New Zealand waters developed in the late 1970s to early 1980s in central regions of the EEZ. Fishing grounds on the Chatham Rise, Challenger Plateau, Wairarapa and Kaikoura coasts, Ritchie Banks, and Cook Canyon occur between latitudes 38° S and 46° S (Figure 1), and until the early 1990s there was little interest or success in locating orange roughy outside this central band.

However, with some of the major fisheries becoming overexploited towards the end of the 1980s, there was increased interest in deepwater fisheries potential in southern regions of the New Zealand EEZ. There was sporadic exploratory fishing activity by individual companies, and in 1991 a consortium of companies (The Exploratory Fishing Company (ORH 3B) Ltd) organised an exploratory survey of the Macquarie Ridge-western Campbell Plateau region (Clement 1991, Clark & Tracey 1992). This discovered spawning grounds of orange roughy on Puysegur Bank, and positive signs off the Snares. It was followed in 1992 by another survey of the southeastern South Island coast, the northern Pukaki Rise, and Bounty Platform (Clark & Tracey 1993). This confirmed orange roughy concentrations off the Waitaki Canyon, but found little else. In 1993 there was a third survey, concentrating on southern parts of the Macquarie Ridge in the New Zealand EEZ, and hills off the Auckland Islands were found to host orange roughy (Clark & Thomas 1994).

Since then, emphasis on exploratory work has shifted to use of swath-mapping techniques for identifying seamount-features and other areas of likely orange roughy habitat (Anon. 1994). Such bathymetric work has covered large strips of the margins of the Campbell Plateau, Auckland Islands Shelf, Pukaki Rise, and Bounty Platform in southern regions of New Zealand. These surveys have then been followed up by commercial fishing vessels targeting regions of potential habitat. This has seen areas of the Bounty Platform and eastern Pukaki Rise yield catches of orange roughy in recent years.

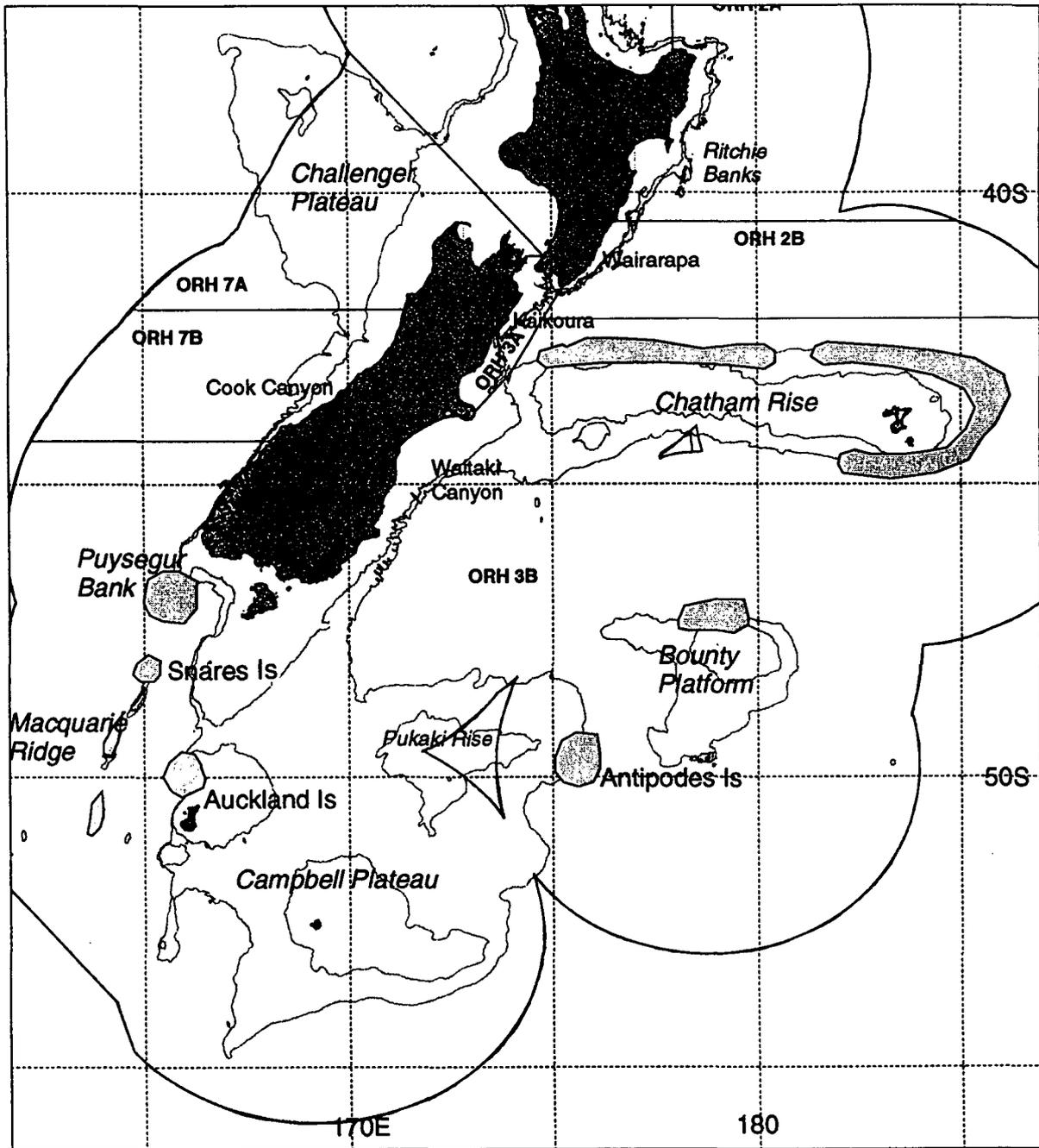
In this report, commercial catch and effort information is summarised for a number of southern fisheries (*see* Figure 1):

- Puysegur Bank
- Snares
- Auckland Islands
- Macquarie Ridge
- Bounty Platform
- Antipodes

A general account is given of the distribution and catch levels in these fisheries over time, with data from commercial fishing returns for the last two fishing years, 1995–96 and 1996–97, being examined in more detail. This work was carried out by NIWA as part of the Ministry of Fisheries project ORH9702 (Orange roughy stock assessment) for the 1997–98 year.

### 2.2 Literature review

General accounts of some of the initial exploratory fishing in southern areas were given by Clement (1991) and Clark (1993). Specific research trawl surveys of orange roughy and oreos



**Figure 1: The New Zealand region, showing orange roughy Quota Management Areas, the distribution of fisheries in ORH 3B, and the main bathymetric features and fishery names referred to in the text.**

on Puysegur Bank have been carried out in 1991 (Clark & Tracey 1992), 1992 (Anon. 1992, Clark & Tracey 1993, 1994), and 1994 (Clark *et al.* 1996). Exploratory work off the southeast coast of the South Island, Pukaki Rise, and Bounty Platform in 1992 was summarised by Clark & Tracey (1993), and that off the Auckland Islands-Macquarie Ridge in 1993 by Clark & Thomas (1994).

Summaries of commercial catch and effort data, as well as results of the Puysegur Bank research surveys, have regularly been included in stock assessment papers of the ORH 3B fishery (e.g., Francis *et al.* 1993, 1995). Catch totals have also been given in Plenary Reports (e.g., Annala & Sullivan 1997). A stock assessment of the fishery was carried out in 1996 (Annala & Sullivan 1996) using a combination of trawl survey and commercial catch per unit effort indices to estimate biomass and yields.

### **3. REVIEW OF THE FISHERIES**

#### **3.1 Data sources**

Data on catch and effort are recorded by all New Zealand registered deepwater fishing vessels, including charter vessels, on Trawl-Catch-Effort-Processing>Returns (TCEPR). These give tow by tow information, with specific location and estimated catch for each trawl. These data for a number of orange roughy and oreo fisheries have been regularly extracted from the Ministry of Fisheries catch-effort database. They have been loaded into a relational database at NIWA. This database was the source of all catch and effort information presented here. Other fishing return types (e.g., Catch-Effort-Landing>Returns) are not used to any extent in these offshore deepwater fisheries, so were not examined. Data were extracted from the NIWA database into an Excel spreadsheet for analysis.

Data have been error-checked in some detail. 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. These mistakes were corrected before analysis. Some errors could remain (i.e., discrepancies that only become evident with detailed scrutiny and a lot of time to evaluate them) but I am confident the bulk of the data are as good as possible.

The data provided to NIWA for the 1996–97 fishing year contained a major error. For all records in January 1997, the orange roughy catch was entered as the sum of orange roughy and smooth oreo catch. This meant the total orange roughy catch recorded on the database was 1900 t greater than the true catch on the TCEPR forms. This mistake has been corrected for analyses in this report. However, it means that catch figures for some areas differ from those reported to the Deepwater Working Group in February 1998. The difference between TCEPR and QMR data for ORH 3B has not been determined accurately for the 1996–97 data, and therefore catches reported here are not scaled to the QMR catch. It is thought that about 90% of the QMR has been captured by the TCEPR estimates.

Data for the 1996–97 fishing year are likely to be incomplete. TCEPR records were obtained from the Ministry of Fisheries in November for the previous fishing year (i.e., October 1996 to September 1997). Data that have not yet been supplied by fishing vessels, those records not punched into the Ministry system, or forms sent back to quotaholders for correction, mean

that information for the last few months of the year will not be complete. Previous experience suggests data are good to the end of July, but potentially patchy after that.

Data have been analysed separately where appropriate by fishing year from 1991–92 through to 1996–97. The basis for catch analyses is the estimated catch by species on the individual TCEPR forms. This enables tow by tow analysis of catch and effort, and also the location of each catch to be assigned to the appropriate fishing ground. Totals from TCEPR records are generally less than the reported catch from the QMS. Therefore, although estimated catch is used to apportion catch between fishing grounds, the totals are then adjusted to the reported QMS total.

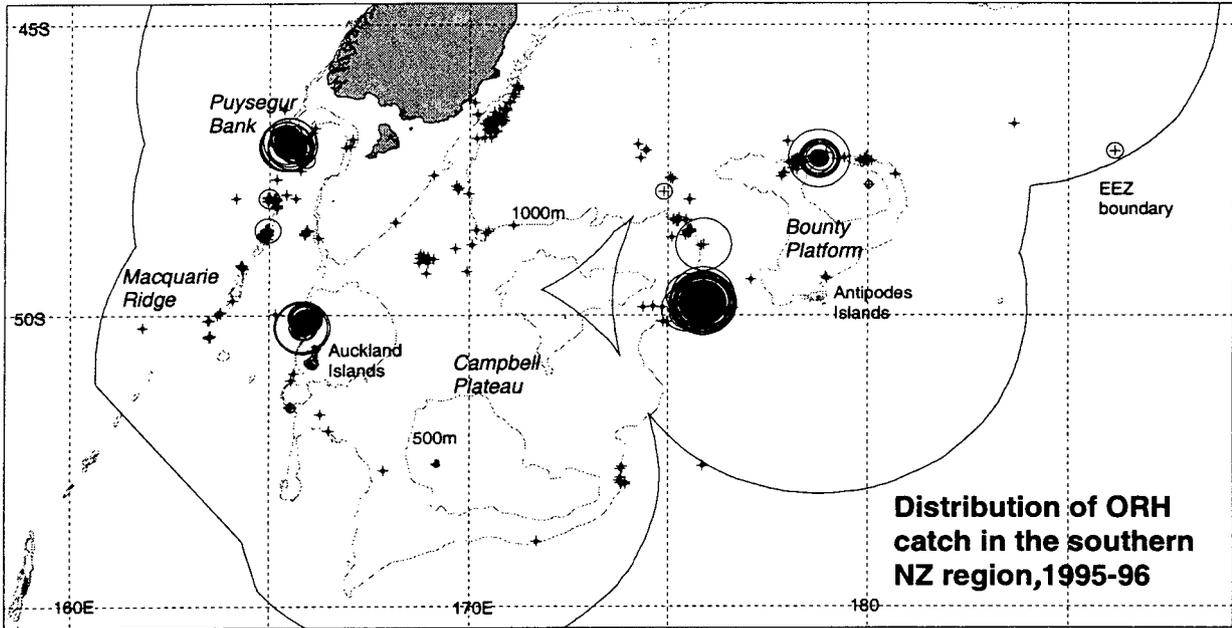
### 3.2 Distribution of the fisheries

The distribution of deepwater trawl shots (target/catch of orange roughy or oreos), as well as the catch of orange roughy (catch per tow) for the 1995–96 and 1996–97 fishing years is shown in Figures 2 and 3 respectively. In both years there is a similar pattern of catch distribution. Four main fishing areas are identifiable, with other grounds giving good catches at times. The main fisheries are as follows:

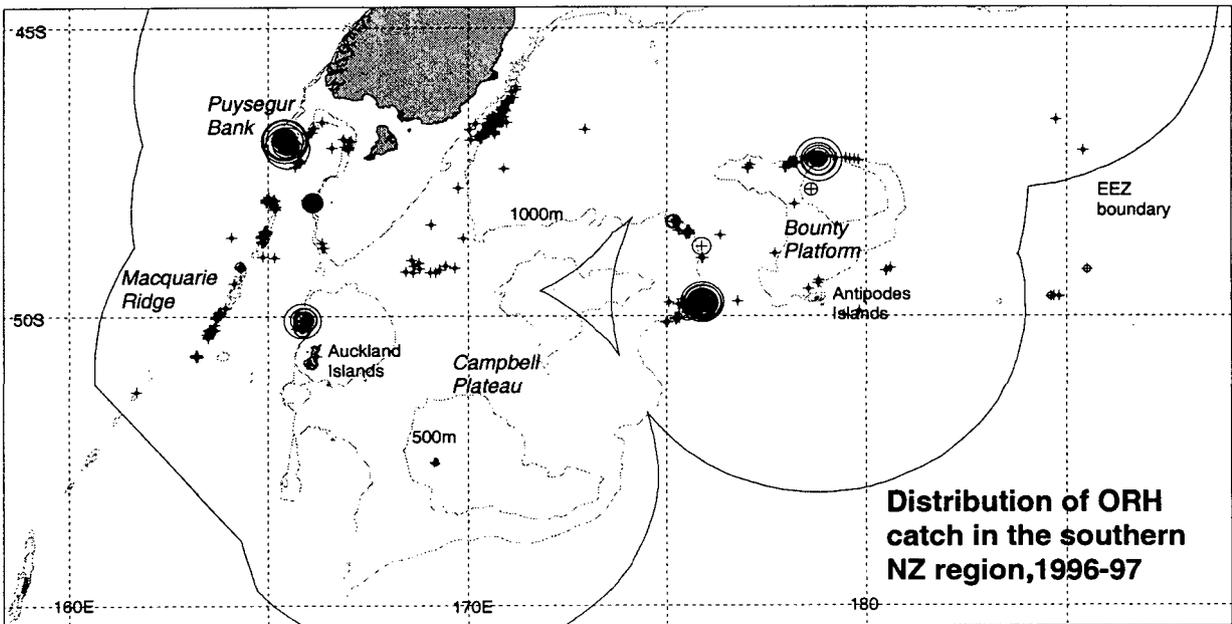
- 1) Puysegur Bank: off the southwestern corner of the South Island. This is an area of small hills (e.g., Goomzy, Godiva, Malcolm's Monument, Acne) and drop-off features (e.g., Alistairs).  
The 'Puysegur Box' boundaries are: 46°00'–47°30' S, 165°00'–166°30' E
- 2) Auckland Islands: northwest of the Auckland Islands. A complex of small hill features (e.g., Barbara Thomas, DSW, Jenny Shipley).  
Area applied here: 49°50'–50°20' S, 165°40'–166°10' E
- 3) Bounty Platform: on the northern slopes north of the Bounty Islands. This is an area of undulating bottom, with numerous peaks and drop-offs. It is more a target oreo fishery, with the occasional large catch of orange roughy.  
Area applied here: 46°30'–48°00' S, 177°30'–180°00'
- 4) Antipodes: although referred to within industry as the 'Antipodes' region, this fishery occurs on the eastern margin of the Pukaki Rise. It is an area of small hill features (e.g., Barbaras, Bob's knob).  
Area applied here: 49°00'–50°30' S, 174°00'–177°00' E
- 5) Snares: Off the Snares Islands is a large ridge-shaped hill (Bob's Gun), with two smaller hills off to the west (Fifino, Pipino). More an oreo feature.  
Area applied here: 47°45'–48°15' S, 164°50'–166°20' E
- 6) Macquarie Ridge: a long ridge with hill features trending southwest of Puysegur Bank.  
Area applied here: South of 48°30' S, west of 165°00' E.

### 3.3 Puysegur Bank

The Puysegur fishery developed in 1991 with about 800 t taken (Table 1), most during the first exploratory research/fishing survey. The fishery increased rapidly with a catch allowance of 5000 t transferred from the Chatham Rise in 1991–92. From 1993–94, however, catches started to decline, and the catch limit has been correspondingly reduced on several occasions. For the last 4 fishing years, the catch limit has not been caught. Although orange roughy had



**Figure 2: Distribution of trawls and catch of orange roughy in the southern NZ region during the 1995-96 fishing year (TCEPR data, catch per tow, max. circle size = 55t)**



**Figure 3: Distribution of trawls and catch of orange roughy in the southern NZ region during 1996-97 (TCEPR data, catch per tow scale as above).**

historically been the prime target species, the catch of oreos is now at similar (and low) levels to that of orange roughy. Although orange roughy spawn at Puysegur, the fishery has generally been a non-spawning one. The seasonal distribution of catch is summarised in Table 2, which gives the proportion of reported catch from June to August, the main spawning period of orange roughy. Note that for catch-effort analyses for Puysegur, an area smaller than the defined 'Puysegur Box' is used, as two hills in this Box are oreo features (Duncan/Porirua), and are not representative of the orange roughy fishery. I have applied a latitude cut-off of 47°10' S, so data south of this are excluded.

**Table 1: Catch of orange roughy (ORH) and oreos (BOE+SSO+OEO) by area and year for the southern New Zealand region. (catch in t; ORHsc, TCEPR catch scaled to QMS total; Norh, number of tows declared as targeting ORH)**

Area/year	ORH	ORHsc	OEO	Ntows	Norh	Catch limit
<b>PUYSEGUR</b>						
1990-91	790	850	2 104	288	127	na
1991-92	6 592	6 900	2 432	645	589	>5 000
1992-93	4 720	5 250	1 901	778	634	5 000
1993-94	2 381	2 600	1 927	1 283	1 259	5 000
1994-95	1 449	1 550	527	205	157	2 000
1995-96	754	800	610	354	301	1 000
1996-97	321		348	219	176	500
<b>SNARES</b>						
1990-91	28	30	226	23	13	
1991-92	9	9	372	22	13	
1992-93	490	525	3 004	395	149	
1993-94	37	40	2 345	401	333	
1994-95	29	30	300	63	26	
1995-96	8	9	801	142	77	
1996-97	55		1 208	161	80	
<b>AUCKLAND</b>						
1992-93	211	235	307	72	20	
1993-94	190	210	300	163	154	
1994-95	1 180	1 260	557	341	178	
1995-96	377	430	499	270	238	
1996-97	87		167	83	61	
<b>BOUNTY</b>						
1993-94	3	3	434	23	0	
1994-95	50	55	1 282	158	5	
1995-96	210	240	733	162	34	
1996-97	120		83	131	13	
<b>ANTIPODES</b>						
1995-96	2 686	3 077	1 375	265	241	
1996-97	790		2 041	446	434	
<b>MACQUARIE</b>						
1995-96	11	13	1 108	195	65	
1996-97	18		1 163	272	62	

**Table 2: Percentage of reported orange roughy catch from the Puysegur Box reported in winter months (June, July and August)**

Year	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
%catch	7.7	3.5	42.6	7.5	9.3	27.8

The fishery is centred on the southwestern protrusion of Puysegur Bank. This Bank has a number of small hill features, as well as areas of undulating slope and drop-offs. The distribution of the fishery on these features has differed between years (Figure 4). In the early years of fishing, both effort and catch was focused on the western part of the Bank, on hills of ‘Godiva’ and ‘Goomzy’, and slope to the west of them (‘Alistairs’). From 1993–94 less catch came from these areas as more effort was directed to the slope southeast of the hills, and the southern hill feature (‘Malcolm’s Monument’).

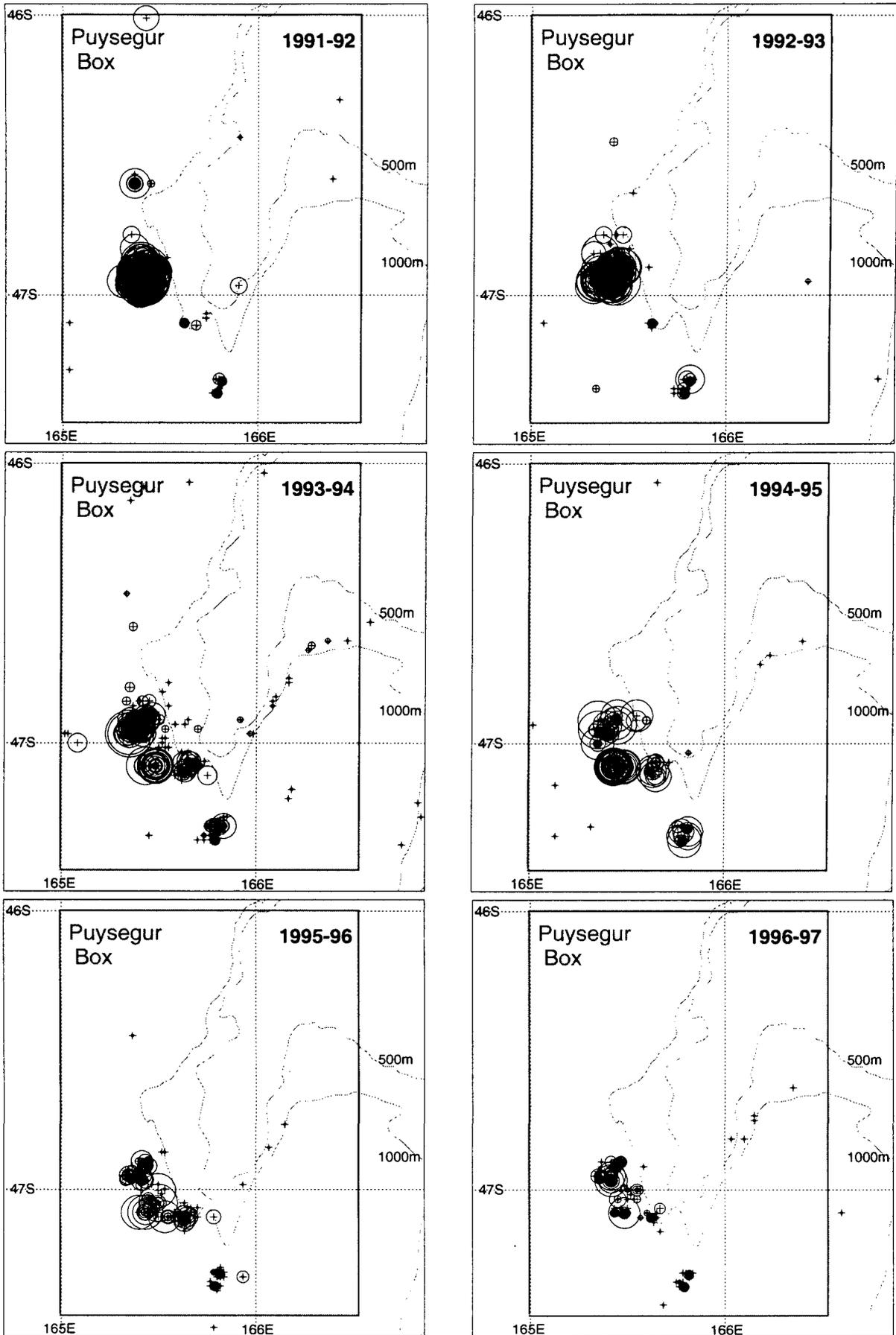
Monthly catch and effort have been examined for each year (Figure 5). Both have varied considerably between years. Initially, catch levels were high in the period October–March, but from 1993–94 catch dropped in most months throughout the fishing year. Effort (the number of trawls carried out) was high for extended periods in the first three years, but from 1994–95 dropped considerably, and has generally remained at low levels. The scale is the same for all panels in this figure, so it also shows changes in fishing success. In the early years the catch bars were higher than or near the effort line, but over time the catch bars have dropped well below the corresponding effort line.

These changes in catch and effort are likely to be a combination of changes in quota levels, fishing schedules, and abundance of the fish. There is no period of the year when effort has been sufficiently high to provide a reliable measure of catch per unit effort (CPUE). In an earlier stock assessment (Francis *et al.* 1995), average catch per tow for vessels over 50 m in length between November and February was used as a relative measure of CPUE for the years 1991–92 to 1993–94. This series was discontinued because the number of vessels decreased (Table 3).

**Table 3: Number of vessels involved in the Puysegur fishery (>5 tows per year)**

Year	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
Total number	18	14	13	4	5	4
Number >50 m	5	5	6	1	1	1

The composition of the fleet changed dramatically between 1993–94 and 1995–96. Generally the same vessels have been involved in recent years, and so CPUE may be more comparable. However, the catch and effort is now at such low levels that it is not practical to consider detailed temporal divisions. This also limits the use of standardised techniques. Unstandardised CPUE has been examined by combining all vessels, and all months, in order to monitor the relative state of the fishery (Table 4). CPUE is simply the total catch divided by the number of trawls, to give an average catch per trawl. The ‘oreo area’ of the Puysegur Box is excluded. Although not all tows are classified as targeting orange roughy, exclusion of



**Figure 4: Distribution of trawls and orange roughy catch (catch per tow) on Puysegur Bank from 1991-92 to 1996-97 (TCEPR data, maximum circle size 50 t, filled dots are the main hill features in the area).**

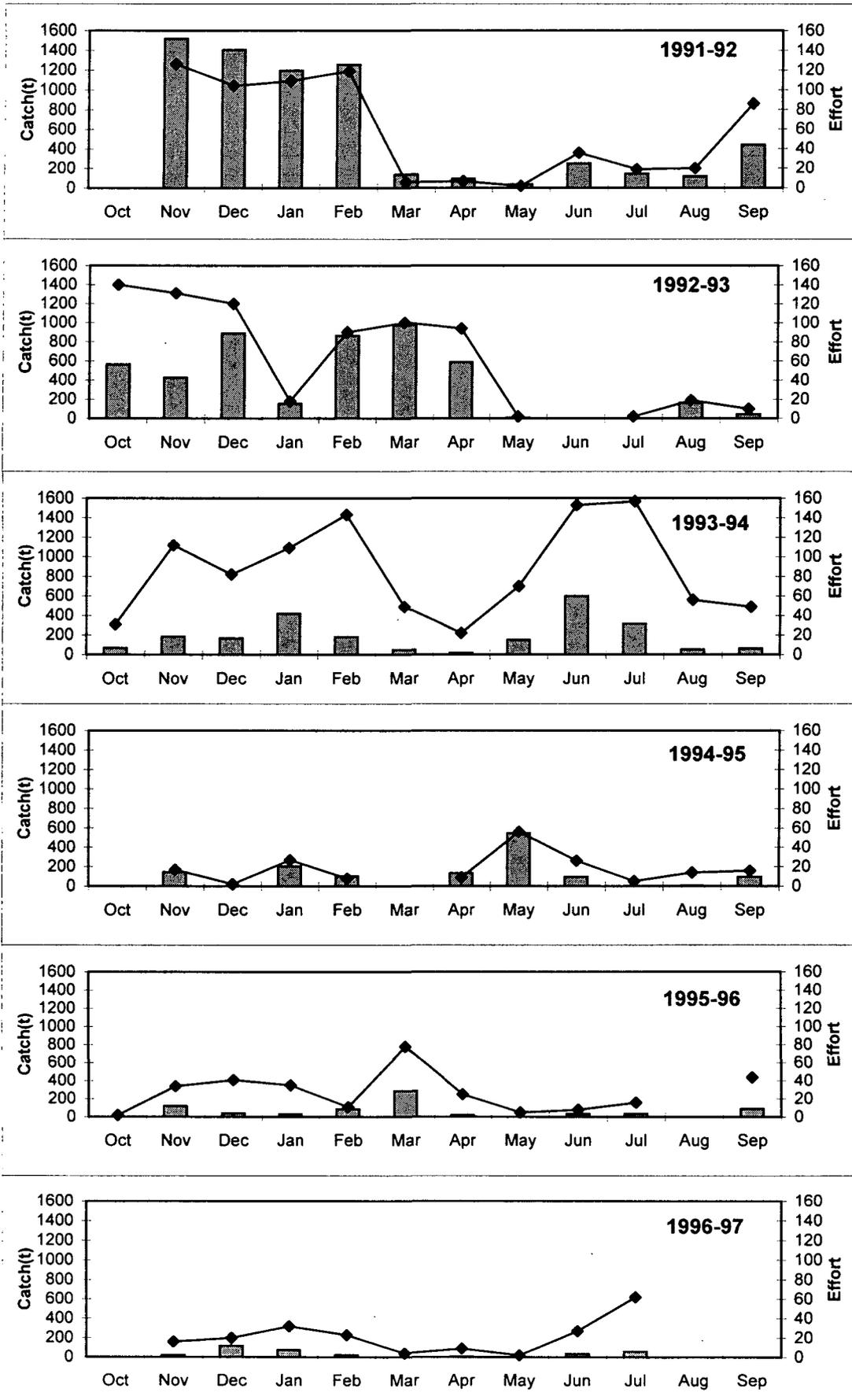


Figure 5: Monthly catch (t, bars) and effort (number of trawls, lines) for orange roughy on the Puysegur Bank, 1991-92 to 1996-97.

non-target trawls makes negligible difference to the result, so the complete data set is retained.

**Table 4: Unstandardised CPUE (t per trawl) of orange roughy in the Puysegur fishery**

Year	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
CPUE	10.4	6.4	2.2	7.3	2.5	1.7

Comparability of the results over the full time period is limited by the change in vessel composition, but the strong declines between most years indicate a marked decline in abundance.

### 3.4 Snares

Orange roughy catches have generally been small in this fishery (*see* Table 1). In 1992–93 over 500 t were taken, but this has been the only year when more than just a few tens of tonnes catch was reported. Nevertheless orange roughy is regularly recorded as the target species.

Oreo (both black and smooth) have been the main species taken off this feature, with 2000–3000 t in 1992–93 and 1993–94 fishing years. However catches have since decreased, partly because of lower levels of effort in this fishery (*see* Table 1).

On account of the small size of this fishery, and amount of data available, more detailed analyses have not been carried out.

### 3.5 Auckland Islands

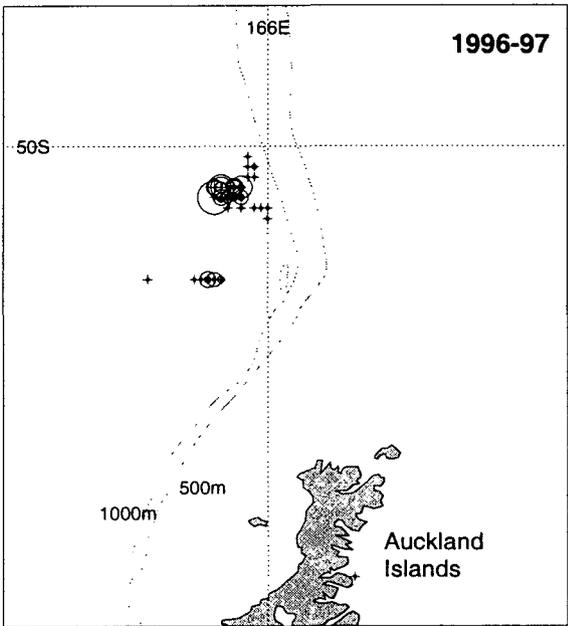
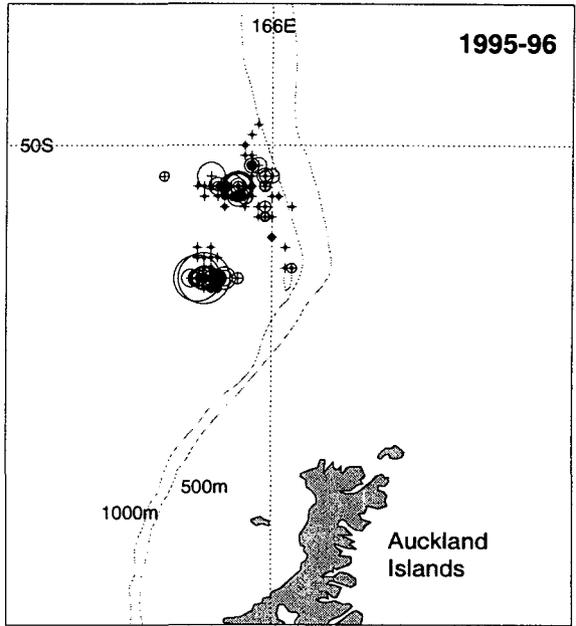
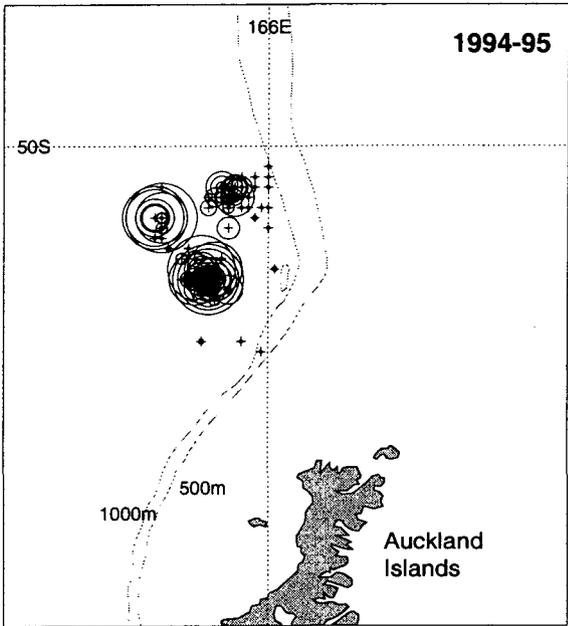
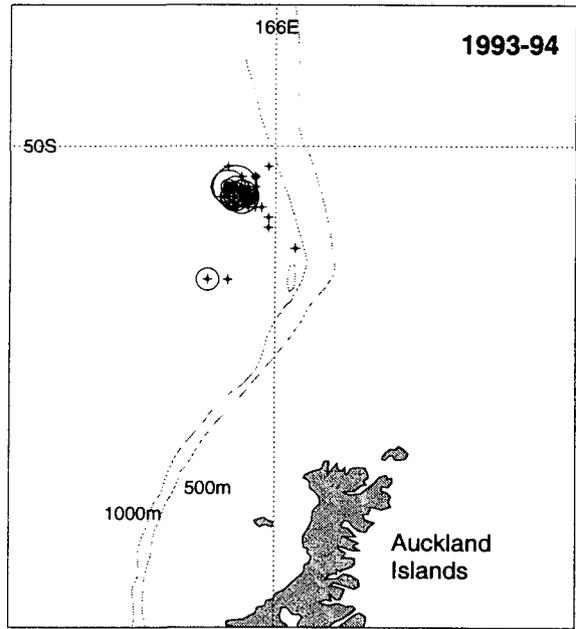
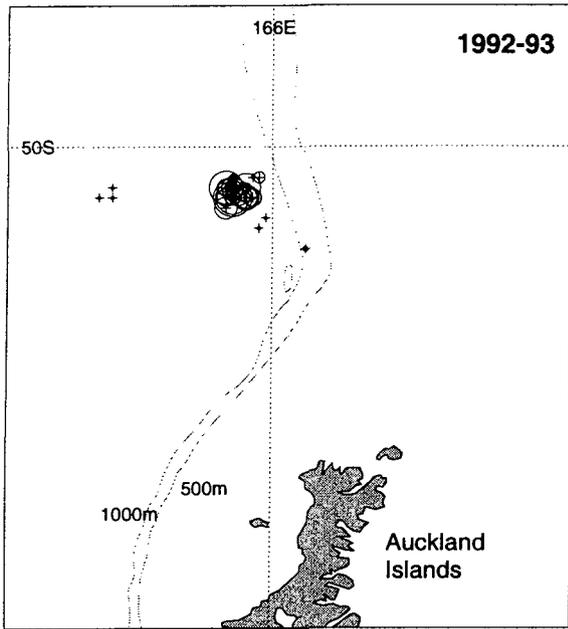
The orange roughy fishery off the Auckland Islands developed in 1992–93 (*see* Table 1). The first two years had catches of about 200 t, but in 1994–95 over 1200 t was caught. Since then, catch levels have dropped back, and in 1996–97 only 90 t was taken.

The fishery is almost entirely non-winter (non-spawning), although indications from research surveys are that orange roughy spawn in the region. The proportion of catch in the winter (spawning) months is summarised in Table 5.

**Table 5: Percentage of reported orange roughy catch from the Auckland Island hills in winter (June–August)**

Year	1992–93	1993–94	1994–95	1995–96	1996–97
%catch	5.2	0	5.6	0	1.0

The distribution of catch between hills of the ‘DSW complex’ has varied between years (Figure 6). The fishery initially focused on a group of hills close together to the north. In 1994–95 a new hill was located to the south, and this gave several large catches. In 1996–97 most catch was taken again from the northern hills.



**Figure 6: Distribution of trawls and catch of orange roughy from the Auckland Is, 1992-93 to 1996-97 (TCEPR data, max. circle size = 50 t).**

The fishery has varied between years in the number and size of vessels, number of tows, and level of catch. This limits the use of detailed analysis of commercial catch and effort data to monitor the state of the fishery. Information on vessel size and number of tows is summarised in Table 6.

**Table 6: Number of vessels ( $\geq 5$  tows) and tows in the Auckland Islands orange roughy fishery**

Year	1992–93	1993–94	1994–95	1995–96	1996–97
Total vessel number	3	2	4	5	4
Vessels > 50 m					
No. of vessels	2	1	1	0	0
No. of trawls	57	155	74	0	0
Vessels < 50 m					
No. of vessels	1	1	3	5	4
No. of trawls	15	5	265	270	83

The composition of the smaller size-class of vessel has been relatively consistent since 1994–95, hence the most comparable CPUE data over time are from this group. Values of CPUE (average catch divided by number of tows) for this group during non-winter months (i.e., excluding June to August) are summarised in Table 7. Unstandardised non-winter CPUE for the entire fishery (all vessels) has been summarised previously (Annala & Sullivan 1997), and this series is updated also in Table 7.

**Table 7: Unstandardised CPUE (t per trawl) of orange roughy for the Auckland Islands fishery**

Year	1992–93	1993–94	1994–95	1995–96	1996–97
CPUE (< 50 m)	na	na	2.2	1.4	1.1
CPUE (all vessels)	2.9	1.2	3.5	1.4	1.1

### 3.7 Bounty Islands

Small catches of orange roughy were reported from the Bounty Platform in 1993–94 as a minor bycatch in the developing oreo fishery (*see* Table 1). There was a fourfold increase in the orange roughy catch in 1995–96, and an increase also in the proportion of orange roughy to oreo catch from 4 to 30%. The number of tows where orange roughy was the stated target has remained small, and although the catch has decreased from 200 t to 100 t in 1996–97, it now exceeds the level of oreo catch.

### 3.8 Antipodes Islands

An exploratory fishing trip located orange roughy concentrations in an area on the eastern margin of the Pukaki Rise in April 1996, with a catch of about 200 t. This was quickly followed by full commercial fishing, and over 3000 t of orange roughy was taken in the 1995–96 fishing year (*see* Table 1). This was much greater than the oreo catch, even though most trawls were targeting oreo. Although effort almost doubled in 1996–97, the total catch was more than halved, to 800 t.

### 3.9 Macquarie Ridge

In 1995–96 there was scattered exploratory fishing around the margins of the Campbell Plateau, and on parts of the Macquarie Ridge. However, no substantial catches of orange roughy were reported outside the established fishing grounds in the area (Puysegur Bank and the Auckland Islands).

There was more extensive fishing on the Macquarie Ridge in 1996–97, but catches of orange roughy were small

## 4. DISCUSSION

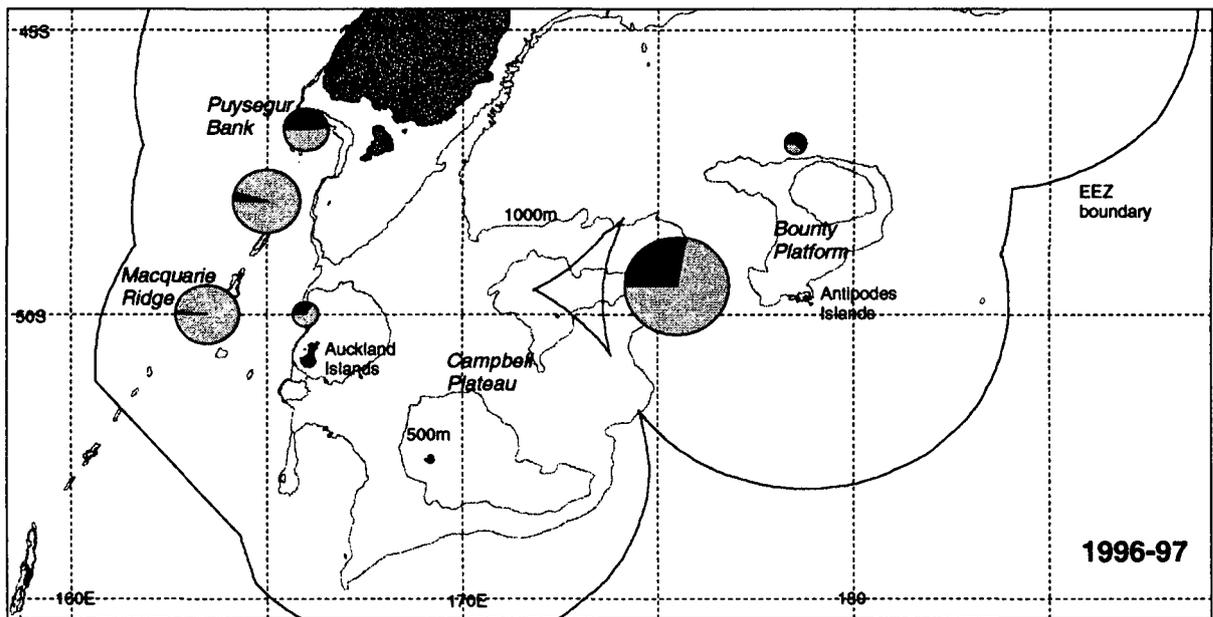
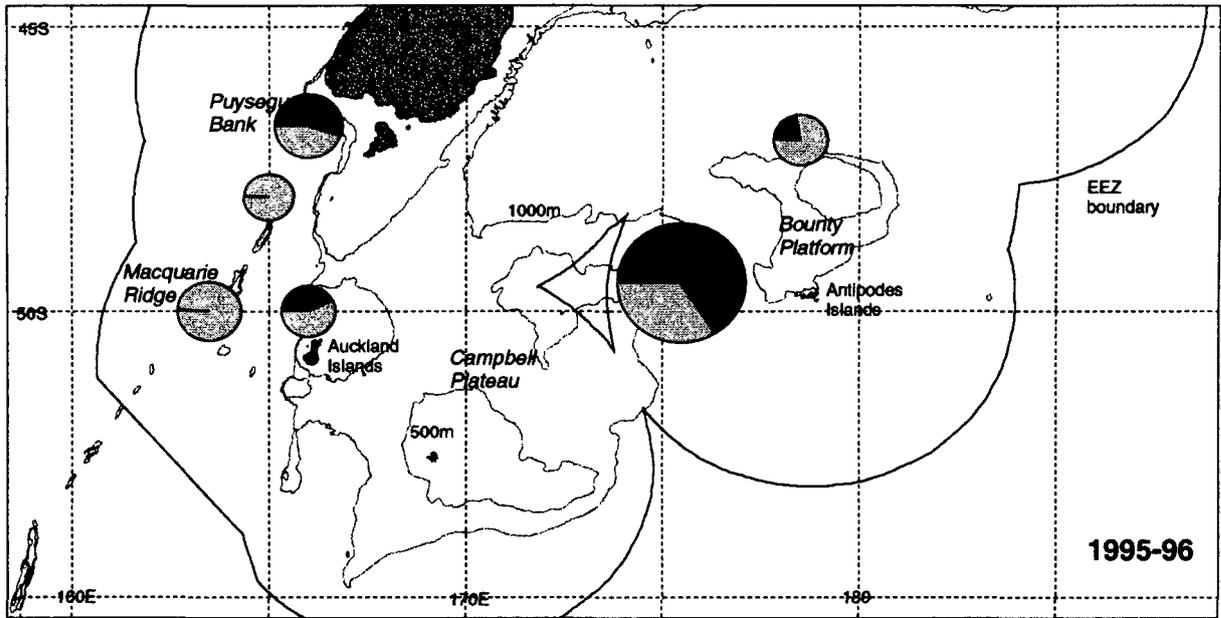
Orange roughy fisheries in southern regions of ORH 3B are generally not managed separately. The Puysegur Bank fishery is an exception, with catch limits applied to a defined Box since 1992–93. The rest of the area is managed as one, with an 'exploratory' quota in 1996–97 of 5000 t.

The Puysegur fishery has been overexploited. The allowable catch has not been taken since 1992–93, and has generally been substantially undercaught (Annala & Sullivan 1997). Variation between years in the level of commercial catch and effort makes such data hard to compare, but unstandardised CPUE reported here shows a general decline. Biomass indices from research trawl surveys have also shown marked decreases in abundance of both orange roughy and oreo species (Clark & Tracey 1993, Clark *et al.* 1996). The Puysegur Box has been voluntarily closed by the Orange Roughy Management Company to fishing for orange roughy during 1997–98.

The exploratory quota limits for the area south of 46° S have generally not been caught. Typically, orange roughy fisheries in southern New Zealand waters tend to be variable between years. Individual fishing grounds have yielded good catches for a short time, such as the Auckland Islands in 1994–95 (1200 t), and the Antipodes in 1995–96 (3000 t). However, catches have not been sustained. The fishery patterns suggest small and localised populations of fish. Catch rates can still at times be high because of the strong aggregation behaviour of orange roughy, but catch levels in the longer term are likely to be low.

Southern areas of the EEZ are still being explored. Swath bathymetry surveys were carried out over large areas of the Campbell Plateau in 1995, and the development of new grounds off the Antipodes Islands gave renewed impetus to exploration in the area. Further new fishing grounds may be developed, but, like the others currently being worked in the subantarctic, are likely to be small. Fishing patterns may also affect the level of effort and catches, depending on the distribution of fishing fleets between the more established deepwater fisheries and the southern fisheries.

A feature of the southern deepwater fisheries is the mixed species nature of the area. Oreos are fished as well as orange roughy, and appear the more dominant species (especially smooth oreo) as latitudes increase. This is clearly seen in Figure 7, which summarises changes in catch size and composition between 1995–96 and 1996–97. Orange roughy dominated catches in 1995–96 off the Antipodes Islands, and to a lesser extent Puysegur Bank, but



**Figure 7: Pie-charts of the relative size and composition of deepwater trawl fisheries in southern areas of New Zealand in 1995-96 (top) and 1996-97 (bottom) (black,ORH; grey,BOE&SSO; circle size proportional to maximum at 4100 t).**

oreos formed most of the catch in other areas. In the following year overall catches had decreased in most areas, and oreos formed the bulk of the catch even when orange roughy was the target species.

## ACKNOWLEDGMENTS

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