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Challenger Plateau orange roughy fishery

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CHALLENGER PLATEAU ORANGE ROUGHY FISHERY

INTRODUCTION

The orange roughy fishery on the Challenger Plateau is the second largest in New Zealand waters. The fishery occurs in Quota Management Area 7A, which is part of the former Deepwater Fisheries Management Area H. Orange roughy are caught throughout the year, but most activity centres on a relatively small area (around 40 S, 168 E) in winter and spring.

Catches have been regulated by a TAC of 5000-6000 t during 1983/84 - 1985/86 fishing years. It was recommended at the 1986 assessment meeting that this be increased to 12000 t annually over a four year period to assess the effects of heavier fishing on the population, based on a deterministic fisheries model incorporating the assumption that M = 0.2. The TAC was subsequently increased to 10000 t.

Permanent quota, totalling 5626 t, is currently owned by 14 companies. For the 1986/87 fishing year, a further 3780 t of annual quota was allocated.

REVIEW OF THE FISHERY

The fishery for orange roughy developed from late 1981 (Table 1). Initially, foreign chartered vessels dominated the fishery, but these have been progressively replaced by domestic boats (which accounted for 94% of the 1985/86 catch).

There have been changes in seasonal distribution of catches since 1982. July and October/November were then the months of greatest catches, but in 1986 most fish were caught in June/July and September.

In recent years, vessels have occasionally fished outside the 200 mile EEZ for orange roughy. Up until 1987, catch rates were low, but from July to September 1987, eight vessels fished outside with frequent large catches.

RESEARCH

Research by FRC on orange roughy on the Challenger Plateau since 1981 has involved a number of cruises of GRV 'James Cook' and trawl surveys using 'Arrow' under charter-for-quota contracts (e.g. Tracey et al 1987). Estimates of fish abundance from trawl surveys have shown low precision. Typically there have been very high catch rates and few trawl stations in a small spawning area.

Research in 1987 involved three cruises of the 'James Cook', and a trawl survey using FV 'Amaltal Explorer' under charter-for-quota. 'James Cook' conducted extensive hydrographic sampling, as part of a programme to monitor environmental conditions and

current flow across the Plateau. Trawling and plankton work were also carried out.

1987 winter trawl survey

The 'Amaltal Explorer' survey took place three weeks earlier than previous surveys in an effort to sample fish prior to the formation of dense schools during spawning. However, schools were already present by mid-June. The survey firstly covered an area of 8153 sq. km, and then concentrated on a reduced area. Biomass indices are given in Table 2.

Biomass estimates from 1983-1986 are also presented in Table 2. The area covered by each survey since 1983 has differed, and there has also been variation in the timing of surveys, which means the estimates are not directly comparable. No account has been taken of vertical distribution of orange roughy, which is likely to be an important factor as the fish form very tight schools when spawning.

Fish distribution in 1987 appeared to be similar to previous years, with two main schools of spawning fish on the flat. Their position and size (16 sq. km) was similar to 1986. Spawning concentrations of orange roughy occurred also in two other areas: the 'Pinnacles', and 'Westpac Bank', the latter being outside the EEZ.

Results of this survey are detailed in Clark and Tracey (1988). However, biomass estimates have been revised since this report.

Biological analyses

Preliminary comparisons have been made of biological parameters of size-at-maturity, age structure, size structure, and timing of spawning measured during two or more surveys from 1984 to 1987.

a) Size-at-maturity in 1987 is less than that in 1984 (Table 3).

b) Age structure: Age determination continues to be a major problem for orange roughy management, as no technique has been validated (Robertson et al, 1988). Nevertheless, otoliths from 1984 and 1987 have been read using the principal axis length (PAL) technique (Gauldie,unpubl). Catch curves based on these preliminary samples are shown in Figure 1. The differences between these curves are unexpected, and difficult to interpret pending examination of further samples, and from intervening years.

c) Size structure: Length frequency distributions are similar for all winter surveys, showing a unimodal distribution with a peak at 32-33 cm. Proportions of fish by length class from the central spawning area 1984-87 showed no trend (Table 4). Samples taken from a school of fish which has been present at the same location in 1984, 1985, and 1987 were examined in more detail. Mean

lengths of all fish 25 cm and longer are shown in Table 5. There are no consistent differences.

d) Reproductive aspects of fecundity and timing of spawning are being investigated. For the latter, a level of 20% of fish spent has been used by Pankhurst (1988) to define a reference point for 1984-86 data. This information, together with 1987 figures are given in Table 6. Timing is consistent with previous years.

Commercial data analysis

CPUE for orange roughy is difficult to derive from commercial data. Fish can be highly aggregated, saturation fishing occurs, the catch can be made in a very short time, or in a small proportion of the total time a trawl is on the bottom, gear damage with loss of catch can frequently occur, vessels have different gear and fishing power, and fishing logbooks do not have accurate information on length of tow.

However, it is probably reasonable to assume that some of these problems even out if the number of trawls is reasonably large. In Table 7 is given mean catch per trawl and number of trawls for all domestic vessels by month from 1983 to 1986. Data have not been separated here by vessel power, tonnage class, or gear size, as each month tends to have similar vessels fishing (e.g large factory trawlers predominate during September-December, with smaller vessels at other times).

Catch rates are consistently high during the June-August spawning period. Outside these months, however, CPUE shows a general decline between years. This is further seen in data solely from NZ factory trawlers (Table 8) where percentage of missed shots has progressively risen. Catch/trawl has increased in 1985/86 over 1984/85, but is less than in earlier years.

There are several possible explanations for these changes, including:
-fish abundance is declining, so that although catches are high when schooled for spawning, when they disperse catch rates are lower.
-distributional changes; perhaps fish are more dispersed out of the spawning season, or are in smaller concentrations that are harder to locate.
-behavioural changes; whereby fish are less accessible to trawl gear.

Analysis of yield

Results of the 1987 trawl survey have been used in computer model simulations to estimate virgin biomass, and predict future biomass levels.

The simulation model used here is described in Robertson et al (1988). It has been applied to Chatham Rise, Challenger, Kaikoura, and Wairarapa fisheries in the past. Parameter values and catch histories used in the simulations are given below:

Bo	=	virgin biomass	= 142000 t
M	=	natural mortality	= 0.1
Ar	=	age at recruitment	= 5
Am	=	age at maturity	= 5
a	=	length-weight parameter	= 0.0963
b	=	length-weight parameter	= 2.68
L_∞	=	growth parameter	= 39.18
k	=	growth parameter	= 0.215
to	=	growth parameter	= 2.17

Catch (t)	
1981/82	4072
1982/83	11947
1983/84	9475
1984/85	5117
1985/86	7753
1986/87	10000

Recruitment was assumed to follow a Beverton-Holt function, with steepness of 0.95.
In calculation of Bo, a level of 30% overrun of reported catches has been used.

Yield estimates:
1) Maximum Constant Yield (MCY)

This is derived from the formula
MCY = 0.25 x M x Bo
= 0.25 x 0.1 x 142000

MCY = 3550 t

2) Current Annual Yield (CAY)

This is based on the formula
CAY = F0.1 x Bcurrent

A value of F0.1 = 0.15 has been assumed. This is lower than in other orange roughy fisheries, where a value of 0.18 has been used. Growth is thought to be slower on the Challenger Plateau. Computer model simulations have been run to determine expected biomass in 1988/89 (= Bcurrent). These are based on results of the trawl survey in 1987. It is assumed there is no fishing outside the EEZ on the Plateau, the level of reported catch

overrun in the past and in 1987/88 is 30%, and the catch in 1987/88 is equal to the TAC of 12000 t.

Bo = 142000 t
B(1986/87) = 89930 t
B(1987/88) = 77660 t
B(1988/89) = 67600 t

From the model, the CAY for 1988/89 = 10170 t.

Long-term equilibrium under a constant fishing mortality strategy of F0.1 = 0.15 with the above assumptions is approximately 5250 t. Consequently, there will need to be a progressive reduction in yield (and TAC) in future years.
Simulating one year ahead:
B(1989/90) = 61030 t
CAY = 9180 t

This assessment applies to a recommendation of yield in 1988/89. However, a TAC for 1988/89 of 9300 t can be anticipated, under a proposed orange roughy quota trade between Chatham Rise and Challenger Plateau fisheries. This will reduce the expected yield in 1989/90 to 8900 t. (Table 9).

MANAGEMENT IMPLICATIONS

We do not have a good time series of data on orange roughy abundance on the Challenger Plateau. Most biomass estimates have a high variance, and their comparability is limited. Results from the 1987 trawl survey have a lower variance, and this general survey design is to be used in the future as a basis for monitoring changes in abundance. Acoustic estimation is also planned.

The apparent decline in commercial CPUE figures suggest changes in abundance or distribution are occurring.

The stock collapse analysis presented in 1987 (Robertson et al 1988) showed the current management strategy based on M = 0.2 had a reasonable probability of causing stock collapse below 0.2Bo within 20 years. In view also of increasing evidence that the Chatham Rise fishery is being over-exploited, and the possibility of successive years of poor recruitment, the value of M has been revised to 0.1 (based on otolith age data) for current analyses.

An additional complication on the Challenger Plateau is a developing fishery for orange roughy in western regions of the Plateau outside the EEZ. There were isolated catches in 1985 and 1986 (see Table 1), but activity increased markedly in 1987. The 'Amaltal Explorer' experienced high catch rates on the 'Westpac Bank' during the winter survey, and subsequently other vessels recorded large catches outside the EEZ to the north-west of the spawning area and on the 'Westpac Bank'. From July to September

1987, approximately 800 t of orange roughy was caught by commercial vessels outside the EEZ (Scientific Observer Programme records). Analysis of distribution of commercial activity and catches last year suggests there is some dispersal of fish from the spawning area in August and September to the west, and north-west, outside the EEZ. If this fishery developed further, it could make control of fishing pressure on the winter spawning population inside the EEZ very difficult.

References

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Table 1: Reported catches (t) of orange roughy from the Challenger Plateau (Area H). (1981/82-1985/86 data from FSU, 1986/87 from QMG)

Fishing year (Oct-Sep)	Area H	Catches reported outside EEZ
1981/82	3695	377
1982/83	4535	7412*
1983/84	6332	3143*
1984/85	5043	74
1985/86	7711	42
1986/87	8008	937

* probable catch in Area H, reported outside EEZ.

Table 2: Biomass indices of orange roughy from the Challenger Plateau, winter surveys 1983-87. (cv = coefficient of variation: wingtip distance = 22.8m for 1987, 19.5m for 1983-86: doorspread distance = 81.0m for 1987, 87.4m for 1983-86).

Year	Area(sq.km)	Nstns	Biomass index wingtip	Biomass index doorspread	cv
1983	101000	180	103657	23127	38
1984	11956	118	185366	41357	60
1985	209	16	103903	23182	85
1986	94	10	184893	41252	83
1987	8153	129	89769	25225	27

Table 3: Mean length-at-maturity of orange roughy from the Challenger Plateau, 1984 and 1987.

		N	Std length (cm)	95% conf. int
Male	1984	622	27.1	26.5 - 27.6
	1987	2247	24.4	23.5 - 25.1
Female	1984	886	25.7	25.0 - 26.3
	1987	2033	24.3	23.1 - 25.2

Table 4: Percentage composition of orange roughy by length class from the central area, Challenger Plateau, 1984-87 (total, scaled LF, sexes combined, figures rounded off).

Length (cm SL)	1984	1985	1986	1987
16-20	0.01	0	0	0
21-25	1.0	0.7	1.6	0.9
26-27	2.9	3.0	3.4	3.0
28-29	7.2	9.0	12.0	9.2
30-31	20.2	18.3	22.3	22.5
32-33	29.3	25.7	26.5	29.7
34-35	24.9	24.9	16.5	22.1
36-37	11.2	13.4	12.9	10.2
38-39	2.5	3.9	4.2	2.3
40-41	0.6	1.1	0.5	0.2
42-43	0	0.1	0	0.1

Table 5: Mean length of orange roughy (cm) sampled from the central flat area in 1984, 1985, and 1987. (fish > 25 cm SL, sample sizes in brackets)

	1984	1985	1987
Total	32.7 (60)	33.6 (60)	32.6 (96)
Male	32.1 (27)	33.0 (27)	32.2 (68)
Female	33.2 (33)	34.1 (33)	33.5 (28)

Table 6: Date on which 20% of fish sampled were spent (1984-86 data from Pankhurst (1988); E = earlier than, L = later than) (Table from Clark & Tracey (1988)).

	1984	1985	1986	1987 Area A	1987 Pinnacles
Female	12 Jul	9 Jul	10 Jul	12 Jul	10 Jul
Male	13 Jul	8 Jul	L. 16 Jul	E. 12 Jul	E. 10 Jul

Table 7: Comparison of monthly catch rate/trawl (CR, tonnes per trawl) in Area H by all domestic vessels, 1983-86. (Nt = number of trawls; D = downward trend, S = similar levels).

	1983		1984		1985		1986		
Month	CR	Nt	CR	Nt	CR	Nt	CR	Nt	
Jan			8.9	41	5.7	135	5.9	92	D
Feb			9.0	65	5.6	55	3.1	15	D
Mar	0.3	2	10.3	28					
Apr					2.3	18	9.3	6	
May			<0.1	11	8.0	21	1.2	15	
Jun					18.7	7	13.4	110	
Jul	18.1	67	13.5	21	18.4	26	12.9	100	S
Aug	13.4	107	17.8	9	16.2	13	15.7	48	S
Sep	19.9	48	15.9	24	8.2	41	7.3	254	D
Oct	11.7	90	4.7	164	4.8	189	3.8	118	D
Nov	9.2	160	3.4	123	2.7	68	2.3	196	D
Dec	5.6	55	3.0	83	1.7	44	1.5	44	D

Table 8: Catch effort data from NZ factory trawlers on the Challenger Plateau, 1982/83-1985/86

	82/83	83/84	84/85	85/86
% nil tows	4.0	7.6	17.6	23.2
Catch (t)/hr, ALL trawls included	10.4	5.4	1.3	3.0
Catch(t)/successful trawl	17.3	13.6	4.6	6.0
Catch(t)/ trawl, ALL trawls included	16.6	12.5	3.8	4.6

Table 9: Comparison of biomass levels and yield from computer model simulations of the Challenger Plateau orange roughy population under two management strategies: a) TAC based on F0.1 yield for 1988/89; b) set TAC of 9300 t in 1988/89. (figures in tonnes).

Fishing year	TAC	Biomass	CAY
a)			
1987/88	12000	77660	
1988/89	F0.1	67600	10170
1989/90	F0.1	61030	9180
b)			
1987/88	12000	77660	
1988/89	9300	66550	
1989/90	F0.1	59235	8900

Figure 1: Plot of catch curves (age v. lnN in sample) from July 1984 and July 1987.