Assessing the orange roughy south of *Johnies*

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Abstract

The biomass of orange roughy for the region south of *Johnies* is estimated coarsely by treating the product of standardised CPUE and area as an index of abundance, and then calibrating against population model based estimates of abundance from the recognised aggregations. For the intermittent aggregation model estimates of abundance, this suggests a biomass in this *South* region in the 20 000–70 000 ton range, with a corresponding annual sustainable yield in the 500–1 500 ton range.

Introduction

Over the past few years an increasing quantity of orange roughy has been taken from outside the existing quota management areas that correspond to the four recognised aggregations (*Hotspot*, *Rix*, *Frankies* and *Johnies*). Recently most of this additional catch has come from the area south of *Johnies* (see Table 1).

It is important therefore to attempt to relate the size of this catch to the likely biomass of orange roughy in this region and the likely sustainable yield therefrom. This paper attempts some coarse computations by using the product of standardised CPUE and sub-aggregation area as an index of abundance.

Comparative Abundance Indices

Fig. 1 shows the tows made south of *Johnies*. A polygon was drawn around the central core of this distribution (see Figure), and used to compute ocean areas for sub-

aggregations which are taken to be defined by lines of latitude. The results are reported in Table 2.

A GLM-standardisation of the CPUE data from these *South* sub-aggregations was then conducted as in Brandão and Butterworth (2004a). The results of this exercise (for the four recognised aggregations as well as for *South*) are given in Table 3, where the CPUE predicted for a chosen vessel and month has been multiplied by sub-aggregation area and added over the constituent sub-aggregations of each aggregation to provide an index of abundance (of the form density×area).

A concern for this analysis is the possibility of "double counting": are the orange roughy south of *Johnies* merely the fish that normally aggregate during the July – August spawning period at *Johnies*, which then arguably disperse to the south in other months. Fig. 2 compares the month factor estimated in the GLM analyses for the recognised and for the *South* aggregations. Both plots show very similar trends, suggesting therefore that these *South* roughy are not the same fish as aggregate at *Johnies*. (Furthermore, the fish from *South* tend to be smaller, R. Morrison, pers. commn.)

Note also that the abundance index time series for *South* in Table 3 shows a marked peak over 2001–2002. This effectively precludes use of this series to fit a population model to obtain abundance estimates, as this trend is contrary to the decline to be expected in terms of the effect of catches as predicted by conventional models.

Calibrating the CPUE-based indices

Table 4 lists population model-based estimates of abundance for the various recognised aggregations from Brandão and Butterworth (2004b). The averages over time for each aggregation can then be used to calibrate the averaged abundance indices in Table 3 to provide estimates of biomass in *South*:

$$\text{Biomass } \textit{South} = \text{Average Biomass for recognised aggregn} \times \frac{\text{Average CPUE} \times \text{Area for } \textit{South}}{\text{Average CPUE} \times \text{Area for recognised aggregn}}$$

The results are shown in Table 5 (from which *Hotspot* was excluded as it is dissimilar to the other larger aggregations), and range from some 6 000 to 70 000 tons.

What level of *South* catch might be sustainable?

The total catch from the *South* region to date is only 1 492 tons. Compared even to the lowest of the estimates in Table 5, this is relatively small, suggesting that the catch has not depleted abundance in this region substantially, so that estimates in Table 5 would correspond closely to the pristine population abundance (*K*).

MSY estimates in Brandão and Butterworth (2004b) suggest that the ratio of MSY/*K* is some 2.2% for an *M* of about 0.05 yr^{-1}. This in turn suggests annual sustainable yields for the *South* region of some 130–350 tons based upon Reference Case biomass estimates, or some 500–1 500 for those derived from the intermittent aggregation models.

Further work should examine the length structure of orange roughy from *South* more closely. The sustainable yield estimates for *Johnies* assume that juvenile orange roughy from that population are not present on the aggregation, and are not subject to harvest. One needs to verify that the *South* fish are not sufficiently small in size to possibly constitute the juvenile component of the population associated with *Johnies*.

Acknowledgements

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References

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Brandão, A. and Butterworth, D.S. 2004b. Updated stock assessment of Namibian orange roughy populations under the assumption of intermittent. Namibian Ministry of Fisheries and Marine Resources document: DWFWG/WkShop/Mar04/doc2.

Table 1. Yearly (fishing year) catches of orange roughy (in tons) taken from the aggregations considered in this paper. The notation of, for example, "1996" for year refers to the period July 1996 to June 1997. The year 2003 is incomplete as data were available only until September.

Year	Johnies	Frankies	Rix	Hotspot	South
1994	1 145	—	—	2 169	77
1995	3 773	2 291	323	897	82
1996	2 062	8 736	1 861	477	18
1997	7 539	4 817	3 836	482	6
1998	1 917	650	3 921	358	72
1999	1 367	40†	444	226	37
2000	667	11†	307	224	4
2001	452	214†	183	106	134
2002	376	155††	350	336	590
2003*	299	125††	96	59	472
Total	19 597	16 494	11 321	5 334	1 492

* Incomplete

† Closed to normal commercial fishing

†† Fishery partially reopened since September 2002

Table 2. Geographical area for each sub-aggregation of orange roughy off Namibia including sub-aggregations south of *Johnies*.

Aggregation	Sub-aggregation	Area (km^2)
Johnies	***Johnies1***	82.8
	Johnies2	457.2
	Johnies3	198.2
	Johnies4	587.1
Frankies	***21 Jump Street***	39.2
	Frankies Flats	17.8
	Frankies Outer	1 255.0
	Three Sisters	39.6
	Smifton	15.8
Rix	***Rix Inner***	99.4
	Rix Outer	685.6
Hotspot	***Hotspot Inner***	97.3
	Hotspot Outer*	89.0
South	***South 26***	164.5
	South 27	1 789
	South 28	1 295
	South 29	989.6

Table 3. Abundance indices for orange roughy aggregations obtained by standardising the CPUE using the delta-lognormal model assuming binomial errors for the proportion positive to the observed CPUE data for Namibian orange roughy and then multiplying this index of density by the area of the sub-aggregation in question. The "zero" method is applied for years in which there is no data for sub-aggregations.

Year	Aggregation				
	Johnies	**Frankies**	**Rix**	**Hotspot**	**South**
1997	207.407	131.231	378.253	12.522	54.608
1998	74.588	61.583	161.464	19.936	68.811
1999	33.671	29.242	32.061	10.402	81.201
2000	28.446		32.243	4.025	59.410
2001	16.230	41.644	23.607	6.736	208.433
2002	20.488	14.333	25.517	14.171	254.554
2003	14.338	2.687	16.757	1.918	98.316
Average	56.453	46.787	95.700	9.959	117.905

Table 4. Biomass estimates (in tons) obtained by Brandão and Butterworth (2004) for orange roughy aggregations for the reference case and the intermittent aggregation models.

Year	Aggregation					
	Johnies		Frankies		Rix	
	Reference case	Intermittent aggregation	Reference case	Intermittent aggregation	Reference case	Intermittent aggregation
1997	11 233	36 446	8 354	26 770	13 386	23 196
1998	3 925	29 390	4 114	22 502	9 735	19 566
1999	2 269	28 014	4 054	22 416	6 116	15 982
2000	1 181	27 225	4 594	22 933	5 986	15 886
2001	800	27 148	5 152	23 468	5 997	15 932
2002	637	27 290	5 500	23 796	6 134	16 102
2003	551	27 509	5 898	24 176	6 109	16 109
Average	2 942	29 003	5 381	23 723	7 637	17 539

Table 5. Estimates of biomass in the *South* aggregation obtained by calibrating against a CPUE×Area index of abundance for other aggregations, and the model estimates of average biomass in Table 4.

Calibrated against	**Average biomass in *South* aggregation**	
	Reference case	**Intermittent aggregation**
Johnies	6 145	60 575
Frankies	15 820	69 747
Rix	9 410	21 609

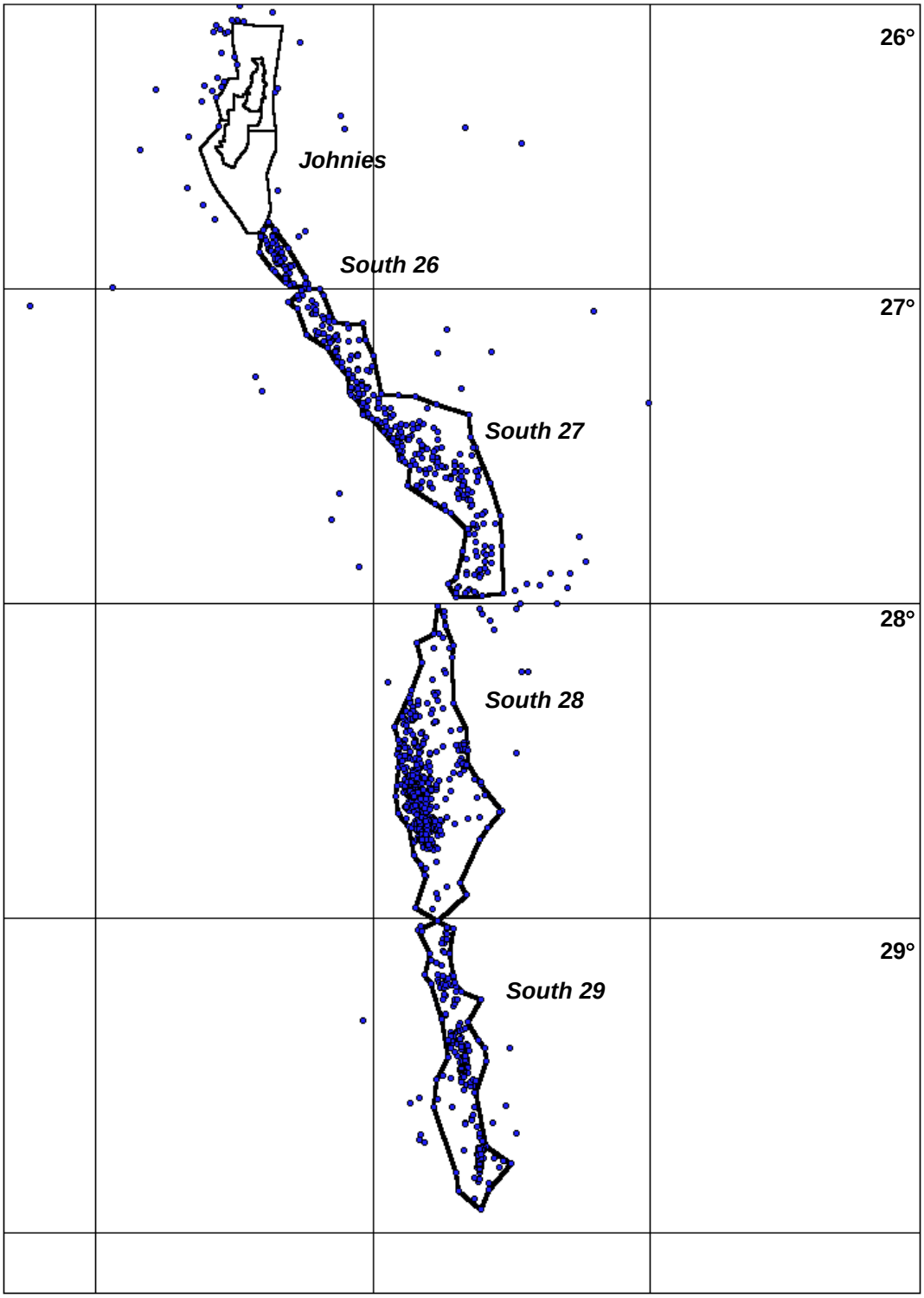

Figure 1. Commercial tows of orange roughy south of *Johnies*.

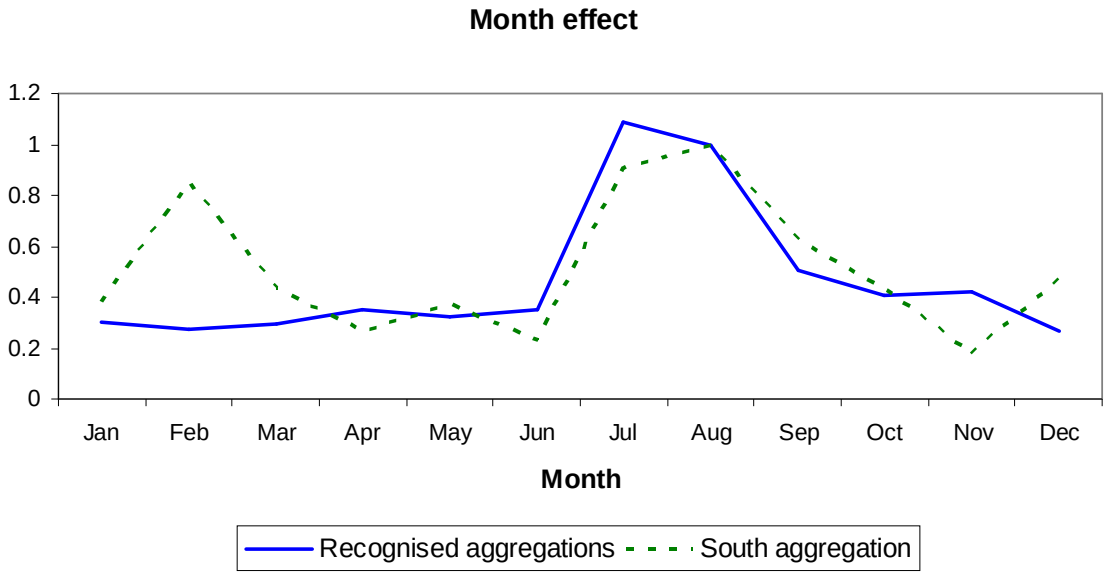

Figure 2. Comparison of the month factor estimated in the GLM analyses for the recognised and for the *South* aggregations.