

Information used to support orange roughy stock structure assumptions

Introduction

Innovative Solutions Ltd (ISL) was contracted by SIOFA to provide a stock assessment for orange roughy in the Walter's Shoal region (WSR) and to apply the New Zealand Harvest Control Rule (HCR) to other orange roughy stocks in the SIOFA area. The region WSR was established on the basis of a review of spawning stocks in the SIOFA region initially provided to the SC in SC-01-INFO-16.

There are two major fishing areas for orange roughy in the Southwest Indian Ocean, the Walter's Shoal region to the west, and 300 nautical miles to the southeast, the Southwest Indian Ridge. This ridge extends for over 840 nautical miles.

The four SIOFA Statistical Regions that cover these fishing areas (SIOFA1, SIOFA2, SIOFA3a, SIOFA3b) were not established on the basis of scientific data. Using such regions was considered inappropriate for the stock assessments being undertaken.

To facilitate the contracted stock assessments outside of the South Walter's region, updated biological data were used to produce more realistic spatial areas that could be considered as interim management areas. This review took into account spawning stock data including timing of peak spawning, size composition, habitat type and spatial separation from other spawning aggregations.

This current report provides summary biological data from orange roughy to assist with stock assessments using acoustic data collected by the vessel *Will Watch* from 2004 to 2017 under the flag of the Cook Islands.

Materials and Methods

The full data collection protocols for vessels operating in the Indian Ocean were described in Shotton (2007). This protocol was updated in 2012, and forms part of the vessel permit requirements for vessels registered under the Cook Islands flag.

The biological sampling is as follows:

3. SAMPLING PROCEDURES

3.1 Selection of a Trawl for Sampling

Biological samples are to be collected from the catch taken from at least *one* trawl for each day of fishing. One of two options should be used:

- i. randomly selecting a trawl for each day or
- ii. sampling every trawl with a catch greater than 5000 kg.

The trawl catch to be sampled should be selected at random from the fishing undertaken on a given day. Selection is to be determined based on a random time of the day for the time the trawl is on deck (i.e. when it is completed). The first trawl retrieved after the random time for that day is to be chosen for biological sampling. However, if the catch from this trawl is too small for a good sample, i.e. the total catch of either species is less than 500 kg then the catch from the next trawl with a total catch larger than 500 kg should be sampled.

3.2 Calculation of Random Time for Trawls

Lists of random times for each day of fishing are provided in **Attachment 1**. For example, for a random time of 04:33 sample the catch from the next trawl landed on deck which has a total catch greater than 500 kg is to be sampled. Remember not to sample the catch from trawls with a catch of less than 500 kg.

For random times later than 2000, it is possible that the next trawl will not be landed on deck until after midnight. However, the next trawl should still be sampled and considered as the sample from the previous day. In such cases where the random time for the next day is early and overlaps with the previous night's sample, select the next random time on the list for the sample from the following day.

3.3 Selection of a Sample from the Catch

A sample of 100 fish is to be measured for each species from the catch. The number of fish comprising the sample does not change in relation to the size of the catch.

The sample of fish to be measured must be selected at random from the entire catch. All samples are to be selected from an appropriate sample point on board the vessel. The sample point should be established at a location that enables all fish in the catch to have an equal chance of being selected in the sample. *The sample point should not change from day to day, but remain fixed for the whole trip. It is important that the sampling point chosen allows sampling before any fish are sorted.*

The position of the sample point will vary depending on the size of the vessel and layout of the processing area and/or fish hold. On larger vessels, an appropriate sampling point would be located at the conveyor in front of the fish ponds, while on small vessels it may be necessary to collect a sample directly from the codend of the trawl.

The sub-sample of 100 fish is to be selected from the catch at one time. Individual fish will be drawn from the sampling point by successively selecting the fish with the eyeball nearest the sampling point. In the Indian Ocean the volume of 100 orange roughy will require about 10-12 35-40 kg fish bins.

ACOUSTIC SURVEY BIOLOGICAL DATA

Acoustic surveys with calibrated Simrad ES60/70 echosounders were carried out from 2004 to 2016, following the protocols described in Shotton (2007), and in Niklitschek and Patchell (2016). In 2017 the protocols were modified following the ABNJ Acoustic Review for SIOFA, to increase the pulse length during surveys.

Overall across the regions there is a complex species mix, which varies considerably between depth, bathymetric feature and area. As well as aggregations of orange roughy and alfonso, there are significant aggregations of black and spiky oreo dories, smooth oreo dory, cardinal fish (*Epigonus spp.*). The difference in species composition between areas is important for acoustic biomass estimation. In the analysis below, there is a species composition in the area at the time of the survey, in the region where the Echoview 'Schools' analysis is undertaken. Where mixed species occur in the water column, they were separately detected in the analysis. In addition, three dimensional plots of schools, were overlaid on 3D bathymetry. This enabled the observation of aggregation integrity, to ensure confidence that the schools which were taken into the acoustic assessment were distinct single species aggregations. This provided an auditing process on the mark

identifications in the regions where more than one species existed, or on steep seamounts and ridges where the fish were known to move around from one side to the other. From the Echoview Scene, further analysis allowed the removal of schools which were not considered part of the aggregation.

In 2014, several multi-frequency tow body acoustic surveys were carried out using the CSIRO developed Acoustic Optical System (Sealord AOS Mk II). This allows verification of the species composition in mixed species aggregations (Ryan et al 2015).

Only where there was uncertainty about the ability to separate out marks, was a species mix applied.

RESULTS

In total, 66,408 orange roughy were sampled for length, weight, sex and maturation, from 522 target trawls shots between 2004 and 2017. In total, there were 52 known separate spawning aggregations of orange roughy identified in the region, and 123 features that contain orange roughy. Some of these aggregations are separated by only 10 miles, but they remain distinctively separated during the spawning season, as has been established by acoustic surveys, and multiple vessels fishing them at the same time. In many cases, the stocks are separated by waters 2000-5000 metres deep, and there is a difference in the timing of spawning by stocks. Spawning occurs across the region from June to October.

Some biological data are held for at least 54 stocks, including size and weight distribution, maturation and spawning data, and otoliths (Table 1).

Historical information is also available for a number of other stocks, for which we have no biological and catch information available at present for this analysis. In the SIOFA region, there were 123 features where at least 10 kg of Orange Roughy were caught.

The data used included catch data from 12,702 bottom trawl shots over the region and a total greenweight catch of 28,295 tonnes of orange roughy over 18 years, and a large number of acoustic surveys on individual stocks.

The updated biological data were used to produce more realistic spatial areas that could be considered as interim management areas (Figure 1). This review took into account spawning stock data including timing of peak spawning, size composition, habitat type and spatial separation from other spawning aggregations

Table 1 Summary Data for Southwest Indian Ocean

Orange Roughy Spawning Aggregations	52
Features with Catch data (>100 kg)	123
Number of stocks heavily fished	20
Stocks with Acoustic survey biomass estimates available	24
Biological data available	54
Features with Estimated catch available	70