# Orange Roughy Research Plan for the Great Australian Bight Trawl Fishery

(Issued March 2025)

Great Australian Bight Fishing Industry Association Inc.
trading as GABIA - ABN 47 348 579 691

This page left blank intentionally

# Acknowledgements

This Research Plan has been assembled based on various documents used in the collection of data and assessment of Orange Roughy in Australia and New Zealand. The Great Australian Bight Industry Association (GABIA) would like to acknowledge the input from the Australian Fisheries Management Authority (AFMA), Ian Knuckey, Tim Ryan, Rudy Kloser, Fiona Ewing, Russell Hudson and Jeremy Hindell. Annual input/review by the Great Australian Bight Research Advisory Group (GABRAG) and the Great Australian Bight Management Advisory Committee (GABMAC) is also acknowledged.

# Introduction

Orange Roughy (*Hoplostethus atlanticus*) is a deepwater fish that is widely distributed in international waters, and Australian waters from Tasmania to southern Western Australia, with small catches reported from waters off New South Wales. The species forms dense aggregations at spawning times, usually associated with hills or seamounts. Relatively little is known about the environmental factors that drive these aggregations, such as water temperature, moon phase or why they are associated with bottom features. The species is long lived and slow to mature, making it particularly vulnerable to overfishing.

The Western Orange Roughy Zone within the Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) was the first region in Australia to be fished intensely for Orange Roughy. This occurred from the late 1980s through to the mid-1990s; with over 21,500 tonnes (t) removed from this zone between 1986 and 1996. The southern zones started to be exploited more seriously from 1989 onwards with 68,276 t removed between 1989 and 2006. Orange Roughy were targeted commercially in the Great Australian Bight Trawl (GABT) sector of the SESSF by demersal trawl in waters ranging 750 to 1,200 metres.

Since 1990, commercial catches of Orange Roughy in the western zone of the GABT have ranged from 200 to 1,400 t. Catches of Orange Roughy in the GABT have been sporadic andspatially scattered, making it difficult to conduct a quantitative assessment of the species (Tilzey and Wise 2005).

Orange Roughy was listed as Conservation Dependent under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in November 2006. The listing required additional measures to address specific objectives and requirements of the Orange Roughy Conservation Program 2006. The Conservation Program was reviewed by AFMA in 2014, and Orange Roughy is now managed under the Orange Roughy Stock Rebuilding Strategy 2022 (the Strategy)[1].

Management actions set out in the Strategy maintain low fishing mortality to support rebuilding, while continuing to monitor and assess the stocks. Within the GABTF this is done through:

- Deep-water closures within the GABTF to protect Orange Roughy and some other deep-water species, while providing access and flexibility to industry for species that are commercially sustainable
- restricting effort by limiting entry to existing fisheries (i.e., no new fishing concessions are created and, in order to fish in a fishery, an existing concession must be leased or purchased)
- research and monitoring to support stock assessments and to ensure the Strategy meets its objective: to return all Orange Roughy stocks to levels where they can be harvested in an ecologically sustainable manner, consistent with the Commonwealth Fisheries Harvest Strategy Policy (HSP) and ultimately maximise the economic returns to the Australian community.

Any assessment of GAB stocks is dependent on a time-series of catch and effort data as well as biological information on the size, age and sex structure of the population. The more robust assessments also rely heavily on some independent estimate of relative or absolute abundance obtained through acoustic surveys of the winter spawning aggregations using either a vessel-mounted or towed-body systems. Such surveys have been successfully conducted on stocks off Tasmania (Kloser et al. 1996).

[1] orange-roughy-rebuilding-strategy-2022.pdf (afma.gov.au)

In contrast to south-east Australia, historically few resources have been allocated to determine the status of Orange Roughy stocks in the Great Australian Bight (GAB). No independent surveys have been undertaken to gain independent estimates of abundance, largely because the irregular and inconsistent winter spawning aggregations of Orange Roughy that seem to occur in the GAB.

This Orange Roughy Research Plan for the GABTF (the Research Plan) was developed by the Great Australian Bight Industry Association (GABIA) to meet the requirements of the then Conservation Program and now Strategy; and was formulated in conjunction with AFMA, the Great Australian Bight Resource Assessment Group (GABRAG) and Great Australian Bight Management Advisory Committee (GABMAC). Commission endorsed revisions to the Research Plan in March 2020. In November 2024 GABRAG and GABMAC endorsed this Plan. This plan will remain in place until it is varied.

In March 2025, the AFMA Commission, on recommendation of GABRAG and GABMAC determined a Research Catch Allowance (RCA) of 200t for GAB Orange Roughy during the 2024–25 SESSF season. An additional 200t RCA (applying to unfished or lightly fished zones) may also be granted if at least 150t of the "base" RCA is caught this season.

# Objectives

The aim of the Research Plan is to assess the status of the GAB Orange Roughy stock and determine sustainable harvest levels for commercial fishing under the SESSF Harvest Strategy. This will be achieved by collecting robust scientific information, including biological data.

Specifically, the objectives are to:

1. collect appropriate data to enable future stock assessments to be completed, including:
    a. biologicals from each of the research zones fished under scientific permit
        i. length measurements from a minimum of 1,000 individuals
        ii. otoliths from a minimum of 500 individuals

        For the same 500 individuals from which otoliths were extracted, the following should be collected:

        iii. sex and gonad stage
        iv. fin clips (for stock discrimination)

    b. opportunistic acoustic surveys, to be conducted where the vessels' acoustic system has the capacity to record this information

    c. accurate catch and effort information.

    d. assist development of a robust set of indicators and reference points for GAB Orange Roughy in the future. These, integrated with the HSP, will determine when commercial fishing for Orange Roughy can resume and at what sustainable level

# Methods

## Scientific permit application process

Access to the GAB Orange Roughy Research Zones can be permitted under scientific permits granted by AFMA under s33(1) of the *Fisheries Management Act 1991 (FMA).*

To fish for Orange Roughy under the Research Plan, a GABTF SFR holder must submit a scientific permit application to AFMA. If approved, the permit will allow operators to enter the GAB Orange Roughy Research Zones and target Orange Roughy, provided they meet the data collection requirements described under Objectives 1 which will be stipulated in the conditions of their scientific permit.

Scientific permits are valid for six months. GABTF SFR holders can apply for a scientific permit at any time and prior to their existing permit expiring; which, if approved, will come into effect once the existing permit has expired allowing Orange Roughy research fishing to be undertaken year-round. The Scientific Permit will be at no cost to the applicant.

## Research Catch Allowance

An RCA is allocated each year and is subject to annual review by GABRAG and GABMAC; for final consideration by the AFMA Commission.

The RCA will be distributed as an Olympic allowance amongst SFR holders allocated a scientific permit; and can be utilised across the entire GAB fishery (not just within Research Zones).

# Commercial Quota

A 50 t bycatch TAC applies for Orange Roughy caught in the Albany and Esperance quota zones, as defined in the *Southern and Eastern Scalefish and Shark Fishery Management Plan 2003* (the Management Plan).

In addition to the bycatch TAC, an incidental bycatch trigger limit of 10t also exists in the following Orange Roughy Management Zones (Figure 1):

- Far West
- West
- Central West
- Central East
- East

Neither the bycatch TAC in the Albany & Esperance quota zones, nor the 10t triggers, can be accessed while a vessel is fishing under a scientific permit. That quota is intended as an incidental bycatch quota only and is not for targeted fishing.

## Orange Roughy Research Zones

AFMA implemented the GABTF Orange Roughy Research Zones in 2007 (Map at Figure 1 & Coordinates at Appendix 1). These Zones are positioned over commercial Orange Roughy fishing grounds that yielded more than 96% of all Orange Roughy taken in the history of the GABTF (and greater than 99% of Orange Roughy taken by the GABTF between 2001 and 2005).

These Zones are only accessible by vessels with Scientific Permits fishing in accordance with the Research Plan. Vessels that are allocated a scientific permit are provided access to the Orange Roughy Research Zones, where they may fish in accordance with the Research Plan – refer map below and zone definitions in Appendix 1. Within the Kangaroo Hill and Racetrack Zones there is a deepwater closure, that prohibits Orange Roughy fishing except under the Scientific Permit. Within these Zones areas are accessible outside of 750 m depth and the co-ordinates for each of those areas are in Appendix 1.

## Observers

Opportunistic observer coverage is required to verify catch records and collect important biological data. To minimise cost to industry, coverage will be aligned to occur during years when trips under the Integrated Scientific Monitoring Program (ISMP) are planned. In the GABT, this is every second calendar year. Additionally, where possible, the observer trips will follow a previous trip where Orange Roughy have been caught to maximise the opportunity for collecting samples (i.e., avoid trips where Orange Roughy may not be caught).

# Collection of data

When catches of Orange Roughy are taken under a scientific permit, data (logbook catch and effort and biologicals) must be collected as outlined in the conditions of the scientific permit. It is expected that analyses of collected data will, in the future, provide an indication of the sustainable exploitation level of the stock.

Catch and effort information will consist of standard data collected in daily fishing logbooks.

## Biological data

Noting the unpredictable nature of Orange Roughy fishing, the Research Plan aims to collect length measurements from a minimum of 1,000 individuals (length frequencies), and biologicals (otolith/length/sex) from a minimum of 500 individuals from each research zone fished under scientific permit.

Information from other Orange Roughy fisheries indicates that individual shots may not be representative of the actual size/sex structure of the entire aggregation. For this reason, it is better to collect the biological data from numerous small (5-10 t) shots rather than one large (50 t) shot. Whilst fishing under a scientific permit, skippers should endeavour to collect data from multiple shots in each research zone.

## Length Frequency

A minimum of 1,000 length measurements should be recorded for each research zone. This will be achieved by crew recorded length frequency measurements from two (2) bins per shot (where possible). Standard Length (SL) is to be recorded for each fish measured (see Appendix 2).

## Biological Collection

Where the catch of Orange Roughy is 5 t or more, biological samples (otolith/length/sex) are to be collected. AFMA must be notified to enable the collection of biological samples in port. Biologicals should not be taken from the same fish sampled for length frequencies. Separate fish must be sampled for biologicals and length frequencies because length sampling should be proportionate to the catch (random); whereas biological collection should ensure a representative sample across the lengths to develop an age-at-length-key.

A minimum of 500 biological samples are to be collected from each research zone.

Once the 5 t trigger has been reached:

- otoliths are to be collected from a sample of 100 fish per shot. Sex and gonad stage of the fish are to be collected (same fish from which the otolithwas extracted)
- fin clips are to be collected for stock discrimination purposes (same fish from which the otolith was extracted)

## Gonad Staging

All Orange Roughy which have their otoliths removed must also be sexed and staged according to the National Institute of Water and Atmospheric Research (NIWA) staging criteria for male and female Orange Roughy (See Appendix 3a/b). For non-observed trips training should be provided before leaving port. GABIA provide sexing and gonad staging information for all crew prior to undertaking the first Orange Roughy research trip each year. Gonad stage is an important parameter in interpreting spawning aggregations, particularly when peak spawning may have occurred. Staging is subjective and so the staging criteria must be readily available and regularly checked to ensure consistency between vessels and observers.

## Shot Information

Information is to be collected from each shot conducted under scientific permit in a research zone, regardless of whether any Orange Roughy are caught. Details of each shot are to be recorded in the standard daily fishing logbook (e-logs).

## Stock discrimination

Throughout the history of the Orange Roughy fishery in the GABTF, fish have been caught from discrete and widely dispersed fishing grounds. In assessing the status of these stocks, all catches have been pooled on the assumption that they represent one stock. Presently, there has been limited work to determine if this is a valid assumption.

GABIA recognises the importance of stock discrimination to distinguish between stocks from different fishing grounds within the GABTF; and between the GABTF and the stock further east in the SESSF. Biological data collected from the different Research Zones will be used to aid in stock discrimination research in the GAB, which has been identified as a key research priority.

## Acoustic surveys

Vessels fishing with a scientific permit under this research plan should conduct opportunistic acoustic surveys if the vessels' acoustic system has the capacity to record this information. It is envisaged that these opportunistic surveys will form the basis of a time series of relative abundance indices that can input into stock assessments or indicate if there is a significant change in the biomass. For information on conducting acoustic surveys, see Appendix 4.

Opportunistic surveys should be conducted by vessels fishing with a scientific permit where the boat is fitted with an appropriate acoustic system which has the capacity to record this information

### Temperature logging

Vessels fishing with a scientific permit under this Research Plan should endeavour to record water temperature at fishing depth and/or fit temperature loggers to their trawl gear (e.g., headline of net, trawl doors etc.).

## Data handling and storage

GABIA and AFMA will ensure that all information collected under the Research Plan is approved by the AFMA Database Manager and made available in the AFMA database.

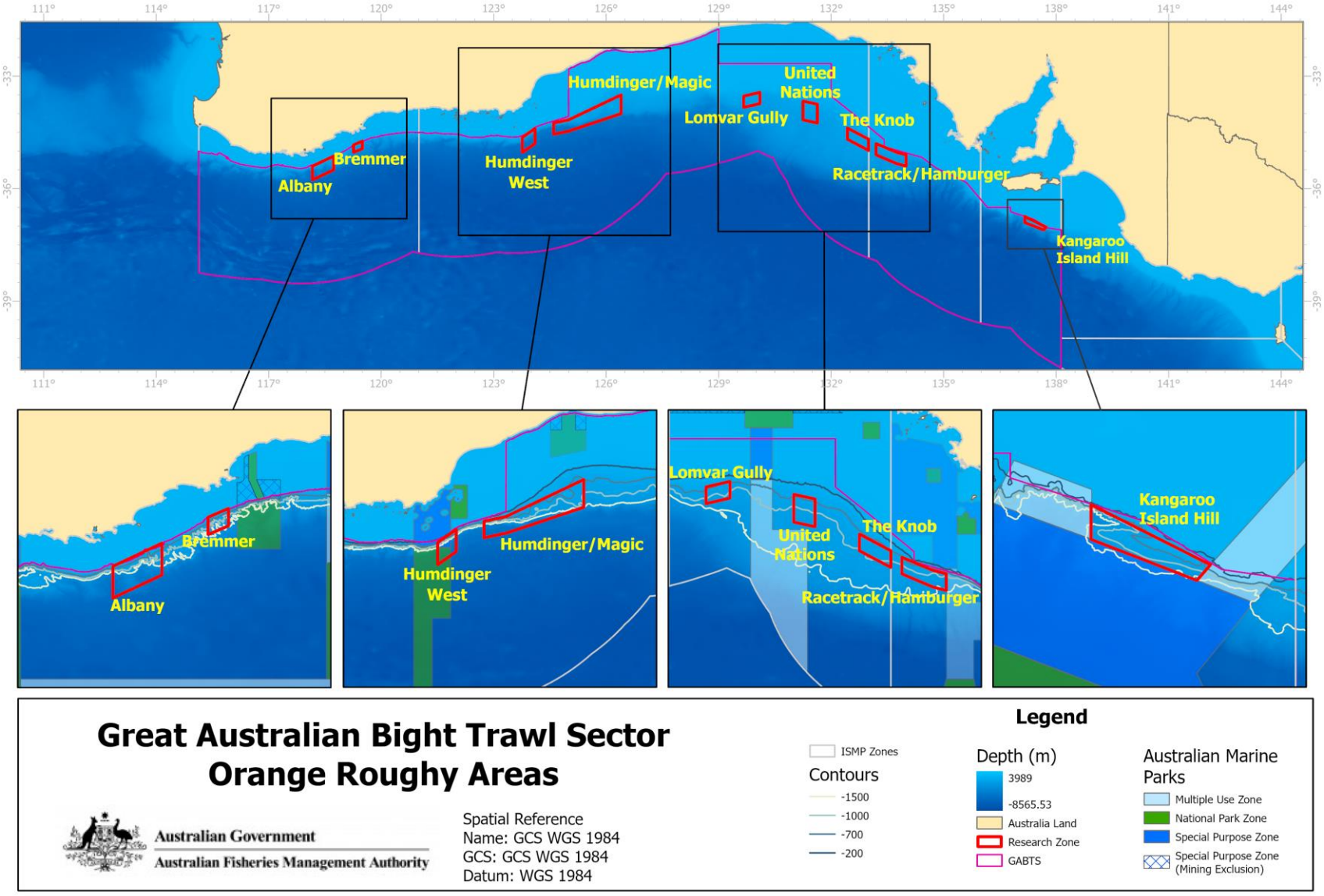



**Figure 1: Orange Roughy Research Zones**

# References

Orange Roughy Conservation Programme 2006. Australian Fisheries Management Authority. 14 pp.

Orange Roughy Stock Rebuilding Strategy 2022. Australian Fisheries Management Authority. 23 pp.

Kloser, R.J., Koslow, J.A. and Willams, A. 1996. Acoustic assessment of the biomass of a spawning aggregation of Orange Roughy (*Hoplostethus atlanticus*, Collett*)* off southeastern Australia 1990–93. Marine and Freshwater Research, **47**:1015–1024.

Tilzey, R., and Wise, B. 2005. Fishery Status Report 2004 Australian Government Department of Agriculture, Fisheries and Forestry, Bureau of Rural Sciences, 137–146.

# Appendix 1: GABTF Orange Roughy research zone boundaries

| | |
|---|---|
| **Albany**<br>118.167ºE 35.400ºS<br>118.733ºE 35.133ºS<br>118.733ºE 35.500ºS<br>118.167ºE 35.767ºS | **United Nations**<br>131.633ºE 33.750ºS<br>131.633ºE 34.250ºS<br>131.250ºE 34.167ºS<br>131.250ºE 33.667ºS |
| **Bremmer**<br>119.267ºE 34.833ºS<br>119.500ºE 34.733ºS<br>119.500ºE 34.933ºS<br>119.267ºE 35.033ºS | **The Knob**<br>132.433ºE 34.383ºS<br>133.000ºE 34.683ºS<br>133.000ºE 34.983ºS<br>132.433ºE 34.683ºS |
| **Humdinger West**<br>124.100ºE 34.400ºS<br>124.100ºE 34.800ºS<br>123.767ºE 35.033ºS<br>123.767ºE 34.633ºS | **Racetrack / Hamburger**<br>134.000ºE 35.100ºS<br>134.000ºE 35.400ºS<br>133.750ºE 35.333ºS<br>133.200ºE 35.100ºS<br>133.200ºE 34.800ºS<br>133.750ºE 35.033ºS |
| **Humdinger / Magic**<br>124.600ºE 34.550ºS<br>124.600ºE 34.250ºS<br>125.000ºE 34.167ºS<br>126.400ºE 33.500ºS<br>126.400ºE 34.000ºS<br>125.000ºE 34.467ºS | **Kangaroo Is Hill**<br>137.667ºE 37.100ºS<br>137.167ºE 36.906ºS<br>137.167ºE 36.742ºS<br>137.731ºE 37.026ºS |
| **Lomvar Gully**<br>129.667ºE 33.533ºS<br>130.100ºE 33.433ºS<br>130.100ºE 33.733ºS<br>129.667ºE 33.833ºS | |

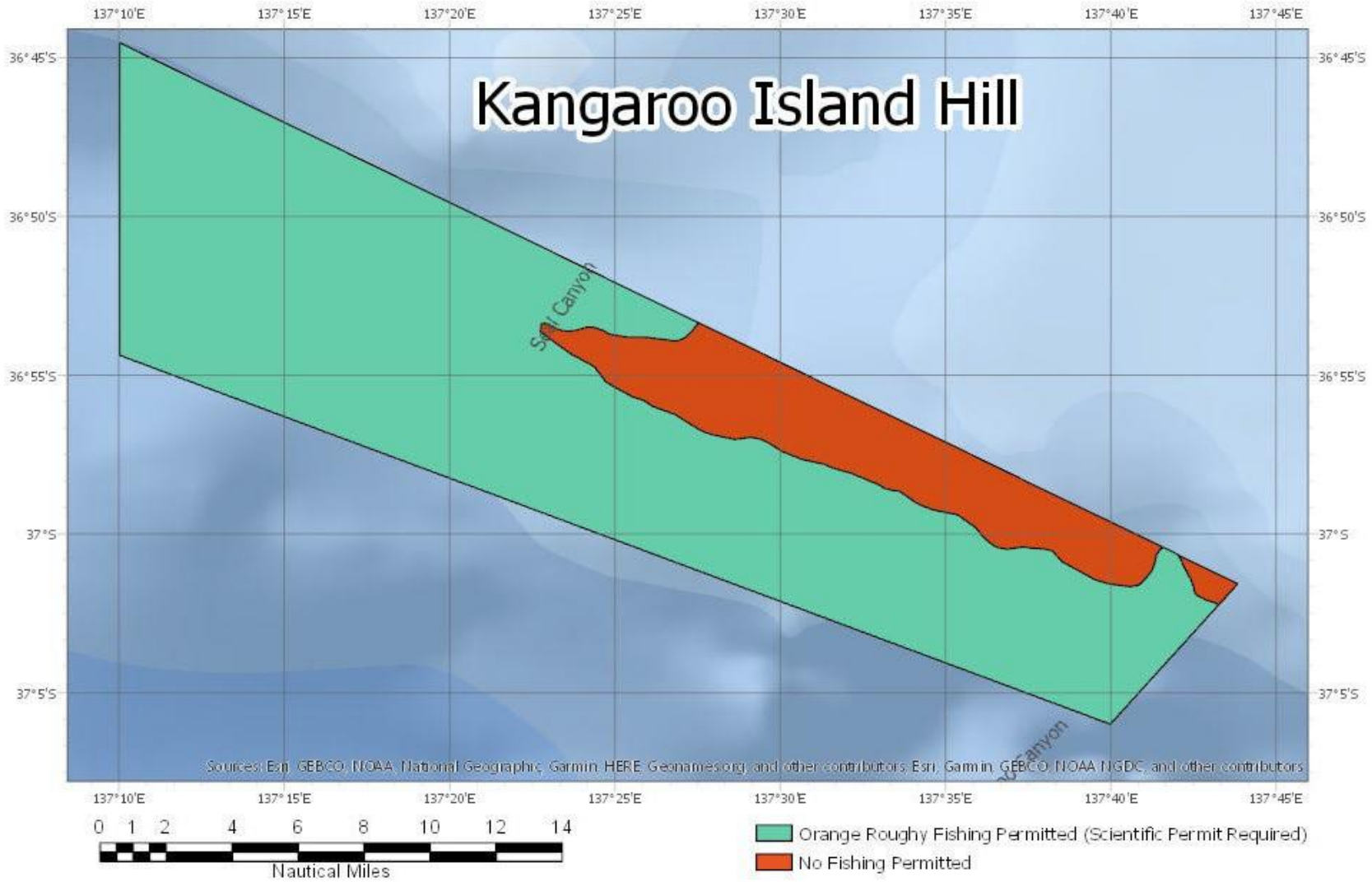

Kangaroo Island Hill
137°10'E
137°15'E
137°20'E
137°25'E
137°30'E
137°35'E
137°40'E
137°45'E
36°45'S
36°50'S
36°55'S
37°S
37°5'S
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors; Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
0 1 2 4 6 8 10 12 14
Nautical Miles
Orange Roughy Fishing Permitted (Scientific Permit Required)
No Fishing Permitted

*Table 1: Coordinates of area of Kangaroo Island Hill Closure where Orange Roughy fishing is permitted under scientific permit (green area shown in Figure 1).*

| Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 137.7214 | -37.0372 | **27** | 137.3795 | -36.8896 | **53** | 137.5603 | -36.9776 | **79** | 137.6647 | -37.0259 |
| **2** | 137.7214 | -37.0373 | **28** | 137.3791 | -36.8937 | **54** | 137.5625 | -36.9792 | **80** | 137.6688 | -37.0267 |
| **3** | 137.6667 | -37.1000 | **29** | 137.3812 | -36.8956 | **55** | 137.5680 | -36.9832 | **81** | 137.6730 | -37.0272 |
| **4** | 137.1667 | -36.9061 | **30** | 137.3941 | -36.9052 | **56** | 137.5727 | -36.9855 | **82** | 137.6771 | -37.0277 |
| **5** | 137.1667 | -36.7419 | **31** | 137.4063 | -36.9121 | **57** | 137.5757 | -36.9868 | **83** | 137.6814 | -37.0268 |
| **6** | 137.4587 | -36.8890 | **32** | 137.4122 | -36.9203 | **58** | 137.5771 | -36.9873 | **84** | 137.6845 | -37.0235 |
| **7** | 137.4586 | -36.8896 | **33** | 137.4177 | -36.9235 | **59** | 137.5810 | -36.9882 | **85** | 137.6879 | -37.0189 |
| **8** | 137.4559 | -36.8929 | **34** | 137.4258 | -36.9281 | **60** | 137.5812 | -36.9882 | **86** | 137.6893 | -37.0144 |
| **9** | 137.4520 | -36.8969 | **35** | 137.4313 | -36.9299 | **61** | 137.5895 | -36.9899 | **87** | 137.6900 | -37.0108 |
| **10** | 137.4478 | -36.8987 | **36** | 137.4355 | -36.9329 | **62** | 137.5990 | -36.9969 | **88** | 137.6918 | -37.0084 |
| **11** | 137.4324 | -36.8967 | **37** | 137.4472 | -36.9374 | **63** | 137.6020 | -37.0009 | **89** | 137.6934 | -37.0071 |
| **12** | 137.4228 | -36.8966 | **38** | 137.4589 | -36.9451 | **64** | 137.6026 | -37.0017 | **90** | 137.7007 | -37.0108 |
| **13** | 137.4134 | -36.8949 | **39** | 137.4646 | -36.9476 | **65** | 137.6031 | -37.0021 | **91** | 137.7020 | -37.0130 |
| **14** | 137.4117 | -36.8934 | **40** | 137.4772 | -36.9504 | **66** | 137.6062 | -37.0049 | **92** | 137.7060 | -37.0218 |
| **15** | 137.4062 | -36.8915 | **41** | 137.4854 | -36.9493 | **67** | 137.6080 | -37.0064 | **93** | 137.7071 | -37.0230 |
| **16** | 137.4021 | -36.8914 | **42** | 137.4905 | -36.9502 | **68** | 137.6104 | -37.0073 | **94** | 137.7078 | -37.0253 |
| **17** | 137.3979 | -36.8929 | **43** | 137.4944 | -36.9524 | **69** | 137.6146 | -37.0081 | **95** | 137.7085 | -37.0271 |
| **18** | 137.3938 | -36.8935 | **44** | 137.5011 | -36.9567 | **70** | 137.6230 | -37.0068 | **96** | 137.7088 | -37.0288 |
| **19** | 137.3934 | -36.8934 | **45** | 137.5110 | -36.9608 | **71** | 137.6266 | -37.0074 | **97** | 137.7094 | -37.0312 |
| **20** | 137.3902 | -36.8932 | **46** | 137.5221 | -36.9633 | **72** | 137.6332 | -37.0079 | **98** | 137.7105 | -37.0323 |
| **21** | 137.3883 | -36.8925 | **47** | 137.5270 | -36.9655 | **73** | 137.6371 | -37.0088 | **99** | 137.7146 | -37.0345 |
| **22** | 137.3869 | -36.8922 | **48** | 137.5360 | -36.9682 | **74** | 137.6427 | -37.0149 | **100** | 137.7152 | -37.0348 |
| **23** | 137.3854 | -36.8910 | **49** | 137.5505 | -36.9745 | **75** | 137.6498 | -37.0188 | **101** | 137.7173 | -37.0354 |
| **24** | 137.3841 | -36.8909 | **50** | 137.5519 | -36.9756 | **76** | 137.6538 | -37.0212 | **102** | 137.7187 | -37.0359 |
| **25** | 137.3822 | -36.8896 | **51** | 137.5528 | -36.9761 | **77** | 137.6582 | -37.0237 | **103** | 137.7197 | -37.0364 |
| **26** | 137.3812 | -36.8893 | **52** | 137.5563 | -36.9770 | **78** | 137.6604 | -37.0246 | **104** | 137.7210 | -37.0370 |

*Table 2: Coordinates of area of Kangaroo Island Hill Closure where no fishing is permitted (red area shown in Figure 1)*

| Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Section 1 | | | Section 2 | | | | | | | | |
| 1 | 137.7218 | -37.0368 | 1 | 137.4587 | -36.8890 | 30 | 137.5990 | -36.9969 | 59 | 137.4177 | -36.9235 |
| 2 | 137.7214 | -37.0373 | 2 | 137.6929 | -37.0069 | 31 | 137.5895 | -36.9899 | 60 | 137.4122 | -36.9203 |
| 3 | 137.7212 | -37.0371 | 3 | 137.6934 | -37.0071 | 32 | 137.5812 | -36.9882 | 61 | 137.4063 | -36.9121 |
| 4 | 137.7210 | -37.0370 | 4 | 137.6918 | -37.0084 | 33 | 137.5810 | -36.9882 | 62 | 137.3941 | -36.9052 |
| 5 | 137.7197 | -37.0364 | 5 | 137.6900 | -37.0108 | 34 | 137.5771 | -36.9873 | 63 | 137.3812 | -36.8956 |
| 6 | 137.7187 | -37.0359 | 6 | 137.6893 | -37.0144 | 35 | 137.5757 | -36.9868 | 64 | 137.3791 | -36.8937 |
| 7 | 137.7173 | -37.0354 | 7 | 137.6879 | -37.0189 | 36 | 137.5727 | -36.9855 | 65 | 137.3795 | -36.8896 |
| 8 | 137.7152 | -37.0348 | 8 | 137.6845 | -37.0235 | 37 | 137.5680 | -36.9832 | 66 | 137.3812 | -36.8893 |
| 9 | 137.7146 | -37.0345 | 9 | 137.6814 | -37.0268 | 38 | 137.5625 | -36.9792 | 67 | 137.3822 | -36.8896 |
| 10 | 137.7105 | -37.0323 | 10 | 137.6771 | -37.0277 | 39 | 137.5603 | -36.9776 | 68 | 137.3841 | -36.8909 |
| 11 | 137.7094 | -37.0312 | 11 | 137.6730 | -37.0272 | 40 | 137.5563 | -36.9770 | 69 | 137.3854 | -36.8910 |
| 12 | 137.7088 | -37.0288 | 12 | 137.6688 | -37.0267 | 41 | 137.5528 | -36.9761 | 70 | 137.3869 | -36.8922 |
| 13 | 137.7085 | -37.0271 | 13 | 137.6647 | -37.0259 | 42 | 137.5519 | -36.9756 | 71 | 137.3883 | -36.8925 |
| 14 | 137.7078 | -37.0253 | 14 | 137.6604 | -37.0246 | 43 | 137.5505 | -36.9745 | 72 | 137.3902 | -36.8932 |
| 15 | 137.7071 | -37.0230 | 15 | 137.6582 | -37.0237 | 44 | 137.5360 | -36.9682 | 73 | 137.3934 | -36.8934 |
| 16 | 137.7060 | -37.0218 | 16 | 137.6538 | -37.0212 | 45 | 137.5270 | -36.9655 | 74 | 137.3938 | -36.8935 |
| 17 | 137.7020 | -37.0130 | 17 | 137.6498 | -37.0188 | 46 | 137.5221 | -36.9633 | 75 | 137.3979 | -36.8929 |
| 18 | 137.7009 | -37.0111 | 18 | 137.6427 | -37.0149 | 47 | 137.5110 | -36.9608 | 76 | 137.4021 | -36.8914 |
| 19 | 137.7007 | -37.0108 | 19 | 137.6371 | -37.0088 | 48 | 137.5011 | -36.9567 | 77 | 137.4062 | -36.8915 |
| 20 | 137.7311 | -37.0261 | 20 | 137.6332 | -37.0079 | 49 | 137.4944 | -36.9524 | 78 | 137.4117 | -36.8934 |
| 21 | 137.7311 | -37.0261 | 21 | 137.6266 | -37.0074 | 50 | 137.4905 | -36.9502 | 79 | 137.4134 | -36.8949 |
| 22 | 137.7218 | -37.0368 | 22 | 137.6230 | -37.0068 | 51 | 137.4854 | -36.9493 | 80 | 137.4228 | -36.8966 |
| | | | 23 | 137.6146 | -37.0081 | 52 | 137.4772 | -36.9504 | 81 | 137.4324 | -36.8967 |
| | | | 24 | 137.6104 | -37.0073 | 53 | 137.4646 | -36.9476 | 82 | 137.4478 | -36.8987 |
| | | | 25 | 137.6080 | -37.0064 | 54 | 137.4589 | -36.9451 | 83 | 137.4520 | -36.8969 |
| | | | 26 | 137.6062 | -37.0049 | 55 | 137.4472 | -36.9374 | 84 | 137.4559 | -36.8929 |
| | | | 27 | 137.6031 | -37.0021 | 56 | 137.4355 | -36.9329 | 85 | 137.4586 | -36.8896 |
| | | | 28 | 137.6026 | -37.0017 | 57 | 137.4313 | -36.9299 | | | |
| | | | 29 | 137.6020 | -37.0009 | 58 | 137.4258 | -36.9281 | | | |

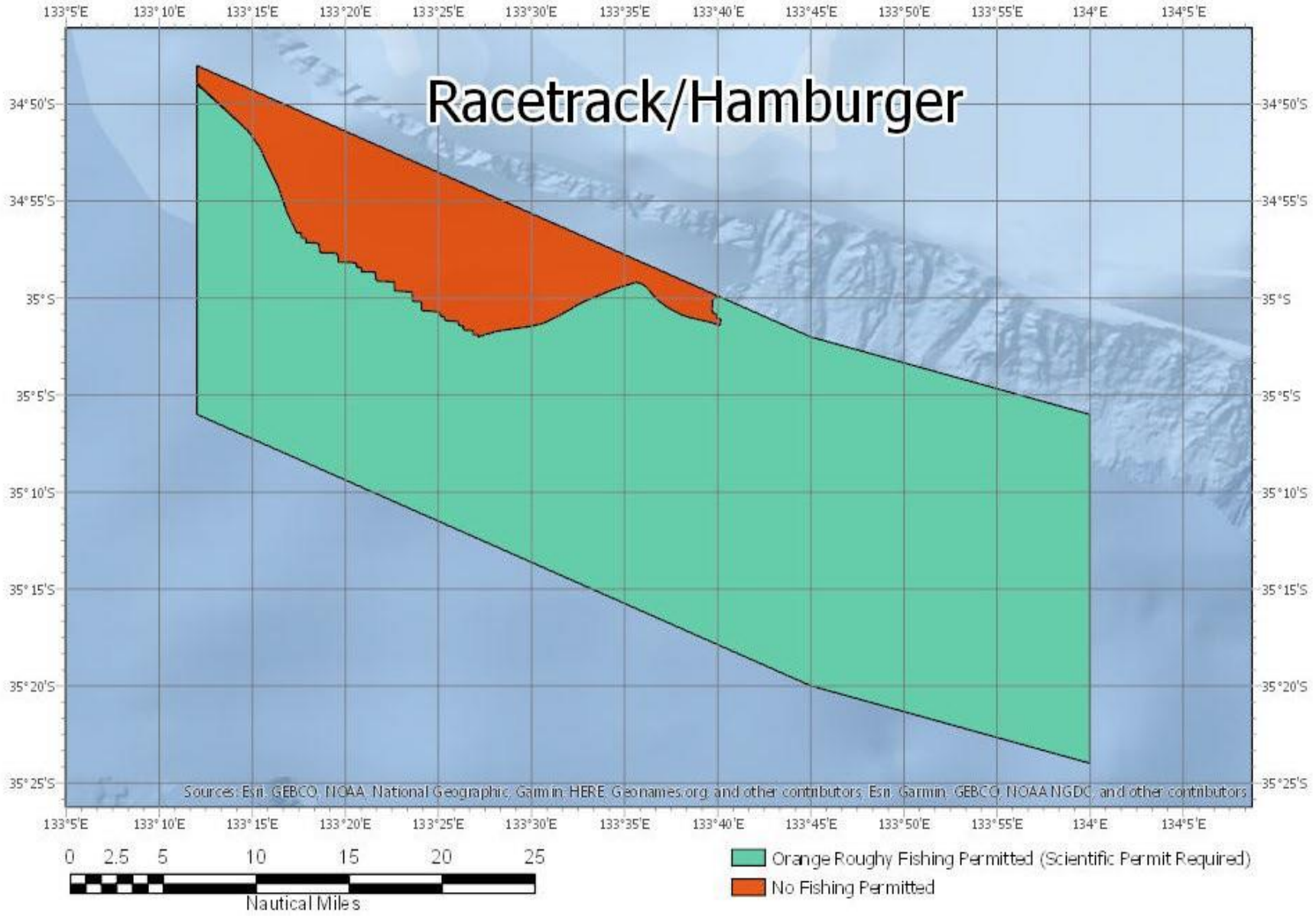

Racetrack/Hamburger
133°5'E
133°10'E
133°15'E
133°20'E
133°25'E
133°30'E
133°35'E
133°40'E
133°45'E
133°50'E
133°55'E
134°E
134°5'E
34°50'S
34°55'S
35°S
35°5'S
35°10'S
35°15'S
35°20'S
35°25'S
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
0 2.5 5 10 15 20 25
Nautical Miles
Orange Roughy Fishing Permitted (Scientific Permit Required)
No Fishing Permitted

*Table 3: Coordinates of area of Racetrack/Hamburger Closure where Orange Roughy fishing is permitted under scientific permit (green area shown in Figure 2)*

| Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 133.2000 | -34.8160 | 28 | 133.3396 | -34.9693 | 55 | 133.4364 | -35.0239 | 82 | 133.6273 | -35.0110 |
| 2 | 133.2000 | -34.8151 | 29 | 133.3406 | -34.9697 | 56 | 133.4386 | -35.0239 | 83 | 133.6352 | -35.0146 |
| 3 | 133.2453 | -34.8556 | 30 | 133.3427 | -34.9698 | 57 | 133.4387 | -35.0262 | 84 | 133.6371 | -35.0153 |
| 4 | 133.2561 | -34.8702 | 31 | 133.3430 | -34.9721 | 58 | 133.4394 | -35.0275 | 85 | 133.6437 | -35.0172 |
| 5 | 133.2726 | -34.9037 | 32 | 133.3435 | -34.9732 | 59 | 133.4437 | -35.0274 | 86 | 133.6590 | -35.0205 |
| 6 | 133.2726 | -34.9038 | 33 | 133.3444 | -34.9736 | 60 | 133.4444 | -35.0278 | 87 | 133.6688 | -35.0235 |
| 7 | 133.2727 | -34.9040 | 34 | 133.3472 | -34.9736 | 61 | 133.4473 | -35.0277 | 88 | 133.6694 | -35.0185 |
| 8 | 133.2727 | -34.9040 | 35 | 133.3475 | -34.9773 | 62 | 133.4476 | -35.0316 | 89 | 133.6676 | -35.0176 |
| 9 | 133.2765 | -34.9146 | 36 | 133.3598 | -34.9777 | 63 | 133.4519 | -35.0314 | 90 | 133.6656 | -35.0178 |
| 10 | 133.2807 | -34.9266 | 37 | 133.3604 | -34.9844 | 64 | 133.4521 | -35.0332 | 91 | 133.6659 | -35.0159 |
| 11 | 133.2851 | -34.9354 | 38 | 133.3632 | -34.9854 | 65 | 133.4683 | -35.0285 | 92 | 133.6652 | -35.0140 |
| 12 | 133.2895 | -34.9437 | 39 | 133.3766 | -34.9859 | 66 | 133.4813 | -35.0285 | 93 | 133.6630 | -35.0130 |
| 13 | 133.2934 | -34.9441 | 40 | 133.3771 | -34.9938 | 67 | 133.4959 | -35.0247 | 94 | 133.6620 | -35.0130 |
| 14 | 133.2935 | -34.9481 | 41 | 133.3928 | -34.9947 | 68 | 133.5058 | -35.0228 | 95 | 133.6622 | -35.0122 |
| 15 | 133.2974 | -34.9484 | 42 | 133.3932 | -35.0026 | 69 | 133.5123 | -35.0209 | 96 | 133.6616 | -35.0102 |
| 16 | 133.2977 | -34.9522 | 43 | 133.4010 | -35.0031 | 70 | 133.5272 | -35.0137 | 97 | 133.6621 | -35.0022 |
| 17 | 133.3063 | -34.9526 | 44 | 133.4015 | -35.0107 | 71 | 133.5450 | -35.0037 | 98 | 133.6629 | -35.0004 |
| 18 | 133.3072 | -34.9530 | 45 | 133.4174 | -35.0118 | 72 | 133.5734 | -34.9924 | 99 | 133.6646 | -34.9993 |
| 19 | 133.3093 | -34.9532 | 46 | 133.4175 | -35.0133 | 73 | 133.5938 | -34.9862 | 100 | 133.6656 | -34.9989 |
| 20 | 133.3095 | -34.9553 | 47 | 133.4183 | -35.0150 | 74 | 133.5978 | -34.9874 | 101 | 133.6663 | -34.9978 |
| 21 | 133.3102 | -34.9608 | 48 | 133.4200 | -35.0159 | 75 | 133.6017 | -34.9896 | 102 | 133.7500 | -35.0333 |
| 22 | 133.3229 | -34.9611 | 49 | 133.4216 | -35.0159 | 76 | 133.6059 | -34.9938 | 103 | 134.0000 | -35.1000 |
| 23 | 133.3242 | -34.9617 | 50 | 133.4217 | -35.0176 | 77 | 133.6080 | -34.9963 | 104 | 134.0000 | -35.4000 |
| 24 | 133.3258 | -34.9617 | 51 | 133.4227 | -35.0194 | 78 | 133.6120 | -35.0005 | 105 | 133.7500 | -35.3333 |
| 25 | 133.3259 | -34.9634 | 52 | 133.4341 | -35.0201 | 79 | 133.6153 | -35.0034 | 106 | 133.2000 | -35.1000 |
| 26 | 133.3265 | -34.9646 | 53 | 133.4343 | -35.0218 | 80 | 133.6193 | -35.0064 | | | |
| 27 | 133.3267 | -34.9691 | 54 | 133.4350 | -35.0233 | 81 | 133.6214 | -35.0077 | | | |

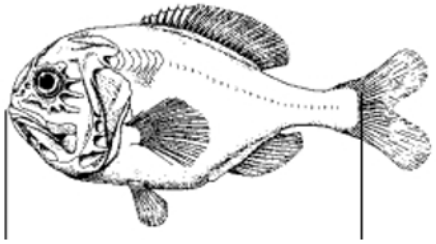
*Table 4: Coordinates of area of Racetrack/Hamburger Closure where no fishing is permitted (red area shown in Figure 2)*

| Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude | Point | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 133.2003 | -34.8001 | **27** | 133.6059 | -34.9938 | **53** | 133.4217 | -35.0176 | **79** | 133.3258 | -34.9617 |
| **2** | 133.6663 | -34.9978 | **28** | 133.6017 | -34.9896 | **54** | 133.4216 | -35.0159 | **80** | 133.3242 | -34.9617 |
| **3** | 133.6656 | -34.9989 | **29** | 133.5978 | -34.9874 | **55** | 133.4200 | -35.0159 | **81** | 133.3229 | -34.9611 |
| **4** | 133.6646 | -34.9993 | **30** | 133.5938 | -34.9862 | **56** | 133.4183 | -35.0150 | **82** | 133.3102 | -34.9608 |
| **5** | 133.6629 | -35.0004 | **31** | 133.5734 | -34.9924 | **57** | 133.4175 | -35.0133 | **83** | 133.3095 | -34.9553 |
| **6** | 133.6621 | -35.0022 | **32** | 133.5450 | -35.0037 | **58** | 133.4174 | -35.0118 | **84** | 133.3093 | -34.9532 |
| **7** | 133.6616 | -35.0102 | **33** | 133.5272 | -35.0137 | **59** | 133.4015 | -35.0107 | **85** | 133.3072 | -34.9530 |
| **8** | 133.6622 | -35.0122 | **34** | 133.5123 | -35.0209 | **60** | 133.4010 | -35.0031 | **86** | 133.3063 | -34.9526 |
| **9** | 133.6620 | -35.0130 | **35** | 133.5058 | -35.0228 | **61** | 133.3932 | -35.0026 | **87** | 133.2977 | -34.9522 |
| **10** | 133.6630 | -35.0130 | **36** | 133.4959 | -35.0247 | **62** | 133.3928 | -34.9947 | **88** | 133.2974 | -34.9484 |
| **11** | 133.6652 | -35.0140 | **37** | 133.4813 | -35.0262 | **63** | 133.3771 | -34.9938 | **89** | 133.2935 | -34.9481 |
| **12** | 133.6659 | -35.0159 | **38** | 133.4683 | -35.0285 | **64** | 133.3766 | -34.9859 | **90** | 133.2934 | -34.9441 |
| **13** | 133.6656 | -35.0178 | **39** | 133.4521 | -35.0332 | **65** | 133.3632 | -34.9854 | **91** | 133.2895 | -34.9437 |
| **14** | 133.6676 | -35.0176 | **40** | 133.4519 | -35.0314 | **66** | 133.3604 | -34.9844 | **92** | 133.2851 | -34.9354 |
| **15** | 133.6694 | -35.0185 | **41** | 133.4476 | -35.0316 | **67** | 133.3598 | -34.9777 | **93** | 133.2807 | -34.9266 |
| **16** | 133.6688 | -35.0235 | **42** | 133.4473 | -35.0277 | **68** | 133.3475 | -34.9773 | **94** | 133.2765 | -34.9146 |
| **17** | 133.6590 | -35.0205 | **43** | 133.4444 | -35.0278 | **69** | 133.3472 | -34.9736 | **95** | 133.2727 | -34.9040 |
| **18** | 133.6437 | -35.0172 | **44** | 133.4437 | -35.0274 | **70** | 133.3444 | -34.9736 | **96** | 133.2727 | -34.9040 |
| **19** | 133.6371 | -35.0153 | **45** | 133.4394 | -35.0275 | **71** | 133.3435 | -34.9732 | **97** | 133.2726 | -34.9038 |
| **20** | 133.6352 | -35.0146 | **46** | 133.4387 | -35.0262 | **72** | 133.3430 | -34.9721 | **98** | 133.2726 | -34.9037 |
| **21** | 133.6273 | -35.0110 | **47** | 133.4386 | -35.0239 | **73** | 133.3427 | -34.9698 | **99** | 133.2561 | -34.8702 |
| **22** | 133.6214 | -35.0077 | **48** | 133.4364 | -35.0239 | **74** | 133.3406 | -34.9697 | **100** | 133.2453 | -34.8556 |
| **23** | 133.6193 | -35.0064 | **49** | 133.4350 | -35.0233 | **75** | 133.3396 | -34.9693 | **101** | 133.2000 | -34.8151 |
| **24** | 133.6153 | -35.0034 | **50** | 133.4343 | -35.0218 | **76** | 133.3267 | -34.9691 | **102** | 133.2000 | -34.8000 |
| **25** | 133.6120 | -35.0005 | **51** | 133.4341 | -35.0201 | **77** | 133.3265 | -34.9646 | **103** | 133.3258 | -34.9617 |
| **26** | 133.6080 | -34.9963 | **52** | 133.4227 | -35.0194 | **78** | 133.3259 | -34.9634 | **104** | 133.3242 | -34.9617 |

# Appendix 2: Length measurements for Orange Roughy

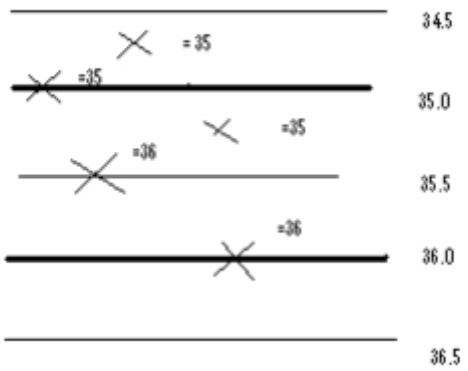
**MEASUREMENT**

Always use Standard Length (SL) as the measurement criteria for Orange Roughy.

| Species | Scientific name | CAAB |
|---|---|---|
| Orange roughy | *Hoplostethus atlanticus* | 255009 |
| |  SL | AFMA: ORO |

Measure each fish to the nearest “cm” mark on the measuring tape.

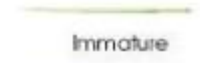
Rounding rule: 34.5 cm – 35.4 cm = 35 cm.



# Appendix 3a: Criteria for assessing sexual stages of OrangeRoughy males

**Males**

1 **Immature or resting**
Testes small and threadlike when immature.
Hard and brown with no milt when resting.



Immature

2 **Maturing**
Testes increased in size, but still small,
no milt expressable when cut.

Maturing

3 **Spermiated**
Viscous milt present when cut.
Testes can be relatively large.

Spermiated

4 **Spermiated, running**
Free-flowing milt. Testes shape and outline often not
sharp like (3) because of milt. Flows freely with light
pressure on the abdomen.

Running

5 **Spent**
Testes rather flaccid, and bloody.
Almost no milt is expressible.
Often has a 'glazed' brownish appearance.

Spent

8 **Partially spent**
Testes still quite large with some free flowing milt.
Brownish tinge, posterior end withered and bloody.

Partially spent

# Appendix 3b: Criteria for assessing sexual stages of OrangeRoughy females

**Gonad stages for orange roughy**

**Females**

1 **Immature or resting**
Ovary clear or pink, small. No eggs visible.



Immature

2 **Maturing**
Ovary pink, small eggs visible (as orange dots).
Ovary small.

Maturing

3 **Mature**
Orange, yolk filled eggs obvious (diameter 0.5-1.5 mm), filling the ovary.
Ovary quite large, bright orange.

Mature

4 **Ripe**
Ovary large. Clear eggs are present (more than just one or two).Ovary has mottled orange appearance, with mixed orange and clear eggs.

Ripe

5 **Running ripe**
Ovary large and thin walled, fragile.
Most eggs clear (hydrated).
Eggs flow freely when light pressure applied to the abdomen.

Running ripe

6 **Spent**
Ovary flaccid and bloody. Some residual eggs often present.

7 **Atretic**
Eggs yellow or blackish. Degenerating.

8 **Partially spent**
Ovary somewhat flaccid, slightly bloody.
Contains substantial numbers of clear freely flowing eggs, may have orange eggs also.
Some eggs lost.

Spent

9 **Immature showing atresia**

# Appendix 4: Guidelines for opportunistic acoustic surveys of Orange Roughy schools

**Version 1.10**

**Tim Ryan, 19 February 2007**

***Introduction***

Vessels that are fitted with Simrad ES60 or EK60 echosounders have the potential to greatly add to the stock assessment process by carrying out opportunistic acoustic grid surveys of schools that are observed during the normal course of fishing operations. The guidelines in this document describe how such surveys should be carried out to ensure that data is collected so that it is suitable for scientific analysis.

These guidelines assume that the sounder has been set up and is ready to log data. To log data the Simrad ES60 computer must be running software version 1.4.3.64 or higher. The very early Simrad ES60 computers are unlikely to have sufficient hard drive capacity to allow logging and will not allow data to be transferred to an external media. If this is the case the computer may need to be upgraded.

***Simrad echosounder settings***

Setup and operation of the Simrad echosounder for logging of scientific data is covered in Appendix A. Extra detail can also be found in the Simrad ES60 operator manual.

***Opportunistic grid survey***

If a substantial school mark is observed on the vessel's sounder a grid survey can be carried out as follows:

- Start the ES60 logging by clicking the L000X button at the bottom right hand side of the ES60 display. (Be sure power setting is 2000W, pulse length 2ms)
- Note the date/time
- Run a series of parallel transects perpendicular to the depth contours.
- Each transect line should continue until the school mark runs out. Vessel then turns and heads down to the start of the next transect line.
- Transects should be closely spaced with the aim of having 5-7 transects slicing through the main extent of the school (see Figure 1). Spacing of between 0.1 – 0.3 n.miles would be typical but skippers will have to make their bestjudgement at the time.
- The transects should continue until school mark are no longer observed. The completed survey should have encompassed the school in all directions
- If time permits, run a line back through the survey grid, targeting the main body of the school mark.

Figure 1. Example of an Orange Roughy mark on which a skipper may decide to undertake an acoustic survey

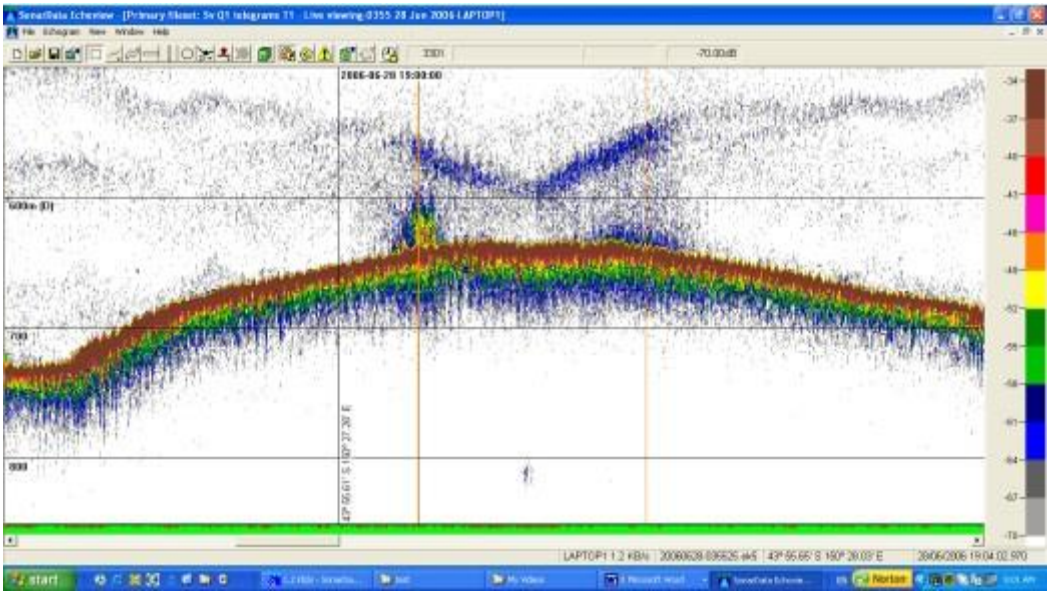
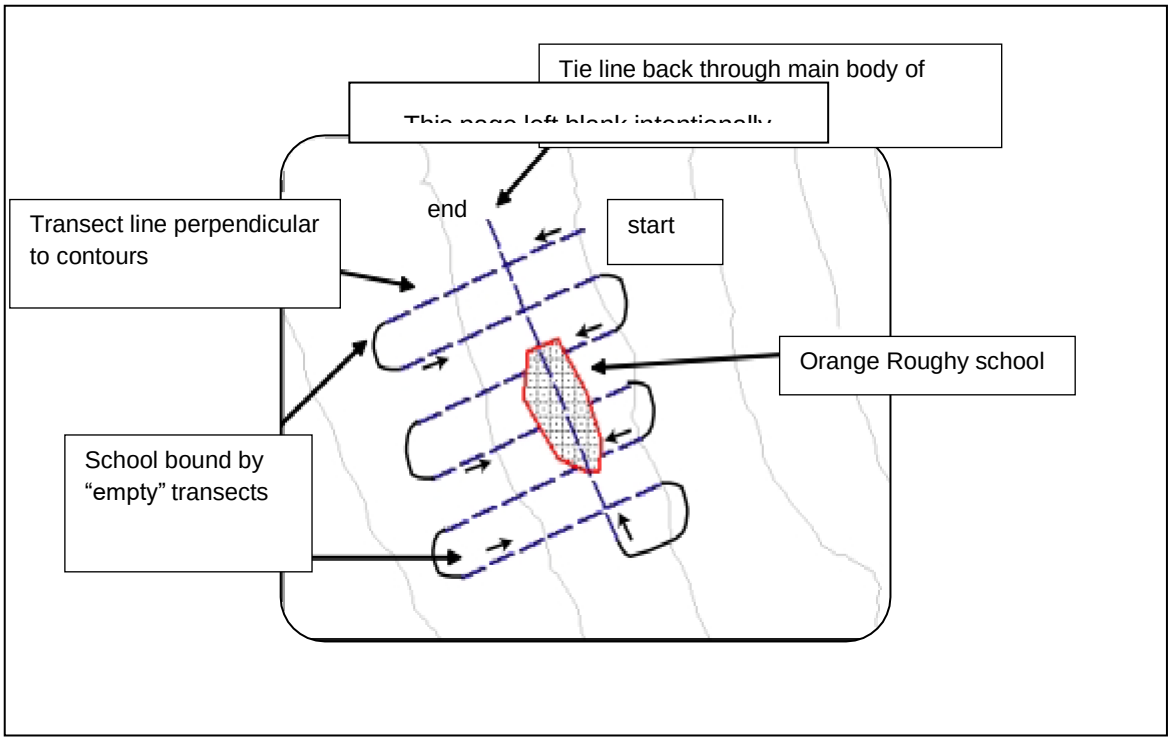


Figure 2. Example grid survey of school mark. Note transects are run so that school extent is encompassed in all directions




Once back onshore contact to arrange for the data to be transferred from the vessel's computer to asuitable external media (DVD, external hard drive).

**Contact**

Haris Kunnath, CSIRO Environment, email haris.kunnath@csiro.au