Stock relationships of orange roughy, black oreo and smooth oreo in New Zealand waters

Final Research Report for
Ministry of Fisheries Research Project DEE9701
Objective 4

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7. Executive summary

Orange roughy within the New Zealand EEZ have been divided into 8 management areas, some of which have been further subdivided with catch limits as new spawning groups have been discovered. Stock relationship questions occur within the fishery management areas and are concerned with relatively small spatial scales, less than the assumed movement for adult fish. On the Chatham Rise there is a need to determine the relationships between the concentrations of spawning and non-spawning fish, in particular the spawning Box and the hills to the east and south east, and between other spawning populations at the Graveyard on the central Rise and at the Hole on northwest Rise. In Southern New Zealand the small size of the fisheries, coupled with their spatial separation, obviates the need for further stock discrimination studies. The development of orange roughy fisheries in the Bay of Plenty, along with the discovery of potential new sea-mount fisheries on the South Kermadec Ridge and the South Colville Ridge, suggests a need to determine stock relationships among the populations in the Bay of Plenty and at East Cape. The relatively few fisheries off the west coast, in ORH 7A and ORH 7B, coupled with their spatial separation preclude the need for further stock discrimination studies. Outside the EEZ there is a need to determine stock relationships among fisheries on the Louisville Ridge. In the Tasman Sea studies are being undertaken by NIWA on the stock relationships between the northwest Challenger Plateau and Lord Howe Rise fisheries; the need for further studies should be reviewed when the data are available.

Black oreo and smooth oreo have different growth rates, natural mortalities, depth and geographical distributions, and probably different population sizes, and could be managed as separate species. Management by species would create a need to determine the ecological and genetic relationships among fisheries on the Chatham Rise (OEO 3A and OEO 4) and those on Puysegur Bank and the Southland coast (OEO 1) and the Pukaki and Bounty areas (OEO 6).
8. Objectives

To determine stock relationships for orange roughy, black oreo, and smooth oreo within the New Zealand EEZ.

**Objective 4.** To recommend priority areas where stock relationships for orange roughy, black oreo, and smooth oreo need to be determined for stock assessment and management of these species.

9. Methods

Priority areas for stock determination were assessed by reviewing scientific publications and FARD’s on orange roughy and oreos, on feedback from the Deepwater Stock Assessment Working Group, and on feedback from members of the NIWA Deepwater Fisheries Group. In addition current stock discrimination studies were considered: Lord Howe Rise and Challenger orange roughy fisheries, as part of a joint Australia-New Zealand programme on stock discrimination of Tasman Sea orange roughy fisheries (MFish contract DEOR13); and the north Chatham Rise and central east coast orange roughy fisheries (MFish contract FBOR01).

10. Results

**Orange roughy**

Prior to recommending priority areas for stock discrimination of orange roughy there is a need to determine the questions to be addressed. Orange roughy within the New Zealand EEZ have been divided into 8 management areas (ORH 1, 2A, 2B, 3A, 3B, 7A, 7B and 10). Some management areas (ORH 1, 2A and 3B) have been further subdivided with area specific catch limits as new spawning groups have been discovered. There is evidence from independent ecological and genetic approaches that most of these management areas represent discrete stocks (see Objective 2), especially where the spawning sites are separated by more than 100 kilometres, although the areas ORH 2A South, 2B and 3A are assumed to be a single unit stock, the Mid-East Coast, with only one known spawning site in ORH 2A South. Most stock discrimination questions occur within the fishery management areas and are concerned with relatively small spatial scales. The questions are:

Do orange roughy return to their natal site to spawn? Do recruited orange roughy return to the same spawning site and to the same home range throughout their adult life?

Where there are genetic differences then there is clear indication that fishing on one stock will have little short term impact on other genetically different stocks. Where there are ecological differences, in acquired characters or phenotypic traits, there could be larval exchange but restricted post recruitment exchange. Fishing one ecological stock of a long lived species, such as orange roughy and oreos, may have little short term impact on other ecological stocks, but could impact over the medium term if the overall spawning biomass and recruitment were reduced. However if there are no significant differences among areas this could be due to mixing between regions, or due to similar environmental conditions whereby acquired and phenotypic characters do not diverge, but there is no exchange. This later observation, no differences, is more likely over smaller spatial scales.
The proportion of adult fish that return to their natal spawning site is unknown for most marine fishes, although early tagging studies demonstrated that recruited fish return to the same spawning site each year (Harden-Jones 1966). Even for salmonids, with a strong homing instinct to the natal stream (see summary in Objective 2), there is not complete site fidelity and wandering occurs. In spite of this wandering, genetic differences occur between river systems and even tributaries within river systems. The genetic differences between salmon populations may be generated by drift in small populations or by selection. In marine species genetic drift is unlikely to be important due to the much larger population sizes, but selection appears to act on some allozyme loci (e.g., Elliott et. al. 1998). The degree of exchange is critical to management and stock assessment; a low exchange rate (say <10% per annum) might allow management as separate units, but a high exchange rate (say >20% per generation) might allow management as one stock. The exchange rate is important for stock assessment and needs to be defined. To date there has been little modelling to determine the effective upper exchange rate per year or generation that allows management of resources as two or more discrete units. Modelling may be desirable to determine the impact of different exchange rates on stock assessments. With a theoretical level of exchange established it might be easier to select appropriate stock discrimination techniques. Punt (1993) showed that the results of stock assessments for Chatham Rise orange roughy are dependent upon the assumed number of stocks, how they migrate, and the priors assumed for the virgin biomass. It was concluded that the resource could be larger than suggested by the then single stock assessment (Punt 1993). A conservative and low risk policy is to manage each spawning aggregation or hill complex as a separate stock. Management based on a false single stock hypothesis would allow the quota to be caught with no restrictions on spatial allocation, and result in overfishing of one stock and under fishing of another; conversely management based on a false model of two or more stocks might lead to higher fishing costs (McDonald et. al. 1996) and would necessitate higher assessment costs where biomass estimates were based on egg and larval or trawl or acoustic surveys.

Priority areas for stock relationships of orange roughy.

1. Chatham Rise

The Chatham Rise orange roughy fishery is the largest orange fishery in the New Zealand EEZ (Table 1). It was originally assessed as one stock but is currently assessed as two, the northwest Rise, including the Graveyard spawning area, and the northeast Rise, including the spawning box. There is a need to determine the relationships between the spawning fisheries at the Box and the mostly non-spawning fisheries on the hills to the east and south east of the Chatham Rise. Spawning also occurs at the Hole on northwest Rise, and although current catches in this region are low, there is a need to determine the relationships between the Graveyard and Hole spawning groups. Genetic studies based on one allozyme marker have shown significant differences between samples from the northwest Rise and the Graveyard (Smith 1997a). The Arrow Plateau, to the northeast of the Chatham Rise has a separate catch limit of 500t for any one hill (Annala & Sullivan 1997).
There is evidence for serial depletion of fisheries along the Chatham Rise. The south Chatham Rise fishery has shifted eastwards over time as shown by both effort and catch data between 1980 and 1989 (Francis & Robertson 1991). Catch levels have only been maintained by the regular discovery of new hills and hill complexes. New hill complexes typically show high catches during the first year or two of discovery, followed by declining annual catch rates (Francis & Robertson 1991). This serial depletion has continued during the 1990s with declining catch rates on established hills, with no sign of recovery, and the discovery of new hills to the east of the Chatham Islands and the Graveyard complex on the North Rise (Clark 1998d, Clark et. al. 1998 in press).

Serial depletion of hills with no signs of short term recovery indicate that hill complexes do not exchange significant numbers of fish over the short term and are discreet units. However this apparent limited exchange of non-spawning fish is in contrast to evidence for pre- and post-spawning fish movement along the east coast from Kaikoura to the Ritchie Hills (Francis & Clark 1998), and to and from the spawning box on the North Rise (Coburn & Doonan 1997). If fish are moving to and from relatively few and distant spawning areas to what extent can non-spawning hills be managed as separate units? Do fish return to the same home range after each spawning event? Alternatively could there be several, as yet undiscovered, spawning areas so that hill complexes function as reproductive units? The current evidence from gonad staging and egg and larval surveys would suggest that there are not multiple spawning populations on the eastern Rise, although there is evidence for fish spawning at Smiths City.

In the absence of spawning at each hill complex then it is unlikely that groups of fish on one hill complex are reproductively isolated from groups of fish on other hill complexes. Therefore stock discrimination studies are dependent upon techniques that will detect differences in the local environment and mark or modify resident fish. Characters that are acquired post settlement offer the potential to distinguish among hypotheses: local resident hill stocks versus interchange between hill stocks. Significant differences between hill complexes would indicate lack of significant exchange of adult fish. However lack of differences could be due to movement of adult fish between hills, homogenising characters, or due to similar environmental conditions among isolated hills. Of the potential methods only mechanical tagging would permit a rigorous test of short term movement between hills, and this has not been feasible with orange roughy to date (Report 1995).

Productivity may vary among hills due to local biological and physical conditions. The more productive hills will result in faster growth rate, which would influence size and age at first reproduction, and even mean size of fish, and potentially influence otolith morphology. If roughy are not spawning each year then different hill complexes may contribute to the spawning population in different years or in different proportions each year. Life history traits such as age/size at first reproduction and mean size are potential markers for estimating isolation of hill complexes. Otolith morphology which might be influenced by diet and growth rate may vary among hills of different productivity. Fourier analyses of otoliths from Tasmanian fisheries found that southern summer and eastern winter (spawning) samples were similar, but southern summer and southern winter samples were different, indicating that some orange roughy move from the southern zone to the eastern zone in winter, but that there is a residual group that does not move (Robertson et. al. in prep, in Bax 1997).
Otolith microchemistry of the outer margin of the otolith also has potential to discriminate among stocks from different sub environments, but is dependent upon different water chemistry between sea mounts. A suitable parasite marker would require the species to have a narrow distribution or pass through an intermediate host with a restricted distribution. There are few examples in the literature of parasites differentiating fish stocks over relatively small spatial scales (with the exception of estuarine fishes, eg Burn 1980). Parasite markers that utilise an intermediate host with restricted distribution, have been successfully applied only with knowledge of the parasite life cycle and distribution of the intermediate host (eg mackerel in the North Sea - MacKenzie 1990). In orange roughy parasite markers have shown tow to tow variation within areas (Jones, pers. com.).

2. Southern New Zealand

Exploratory fishing occurred throughout ORH 3B and lead to the development of several new fisheries during the 1990s. A fishery developed on Puysegur Bank in 1990-91 (Annala & Sullivan 1996) and grew rapidly with a peak catch of 6500 t in 1991-92, but then declined. Catch limits were imposed, reducing from 5000 t in 1992-93 and 1993-94, to 2000 t in 1994-95, 1000 t in 1995-96 and 500 t in 1996-97, but annual catches never reached the catch limits and the industry introduced a voluntary closure during 1997-98.

Further exploratory fishing found new concentrations of orange roughy near the Auckland Islands, the Snares Islands, on the Macquarie Ridge, the Bounty Platform, and on the eastern Pukaki Rise (known as the “Antipodes” region). The Puysegur fishery has a separate quota, while other areas in Southern New Zealand are covered under exploratory quota allocated to ORH 3B (5000 t in 1996-97). Most fisheries in Southern New Zealand are small (see summary in Table 2) and geographically discreet. Spawning occurs at Puysegur and the Auckland Islands and may occur in other regions. The Antipodes fishery was the largest after Puysegur, at 2680 t in 1995-96, but this fishery declined to only 790 t in 1996-7 in spite of increased effort (Clark 1998e). The fishery patterns of rapid local declines are similar to those observed on the hill fisheries on the eastern Chatham Rise (Francis & Robertson 1991, Clark 1998d), and coupled with the geographical separation, suggest that the fisheries are exploiting isolated groups of adult fish. A conservative approach would be to manage these as separate units. While it is possible that exploratory fishing will find further concentrations of orange roughy the existing fisheries indicate that any new fisheries are likely to be small. In the past two years the relative size of the southern fisheries has decreased, but the proportion of oreos, mostly smooth oreos, has increased so that orange roughy is a by-catch of oreo fisheries. Given the small size of the fisheries and their spatial separation, further stock discrimination studies are not required at this stage.
Table 1. Summary of New Zealand EEZ orange roughy fisheries by area, annual catch, Total Allowable Catch (TAC) and long term Maximum Constant Yield (MCY). Data from Annala & Sullivan (1997).

<table>
<thead>
<tr>
<th>Stock area</th>
<th>virgin biomass t</th>
<th>Catch, t 1996-97</th>
<th>TAC, t 1996-97</th>
<th>MCY, t long term</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Northern North Island ORH 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>west coast</td>
<td>unknown</td>
<td>55</td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td>northeast coast</td>
<td>unknown</td>
<td>910</td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td>Mercury-Colville Box</td>
<td></td>
<td></td>
<td>1000</td>
<td>unknown</td>
</tr>
<tr>
<td>All other ORH 1</td>
<td></td>
<td></td>
<td>800</td>
<td>unknown</td>
</tr>
<tr>
<td><strong>Cape Runaway to Banks Peninsula</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC stock (ORH 2A North)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Cape</td>
<td>36 000</td>
<td>2491</td>
<td>3000</td>
<td>500</td>
</tr>
<tr>
<td>MEC stock</td>
<td>114-157 000</td>
<td>2122</td>
<td>2100</td>
<td>2000</td>
</tr>
<tr>
<td>(ORH 2A South, 2B, 3A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ritchie (ORH 2A)</td>
<td>-</td>
<td>1270</td>
<td>1261</td>
<td>1600-2200</td>
</tr>
<tr>
<td>Wairarapa (ORH 2B)</td>
<td>-</td>
<td>272</td>
<td>259</td>
<td>1600-2200</td>
</tr>
<tr>
<td>Kaikoura (ORH 3A)</td>
<td>-</td>
<td>580</td>
<td>580</td>
<td>2200</td>
</tr>
<tr>
<td><strong>Chatham Rise ORH 3B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>northwest Rise</td>
<td>98 000</td>
<td>1900</td>
<td>2250</td>
<td>1400</td>
</tr>
<tr>
<td>spawning Box</td>
<td>1289-310 000</td>
<td>1500</td>
<td>1400-4300</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>1700</td>
<td>4950</td>
<td>1400-4300</td>
<td></td>
</tr>
<tr>
<td>South Rise</td>
<td>unknown</td>
<td>2200</td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td>Waitaki</td>
<td>unknown</td>
<td>0</td>
<td>250-310</td>
<td></td>
</tr>
<tr>
<td>Puysegur</td>
<td>17 000</td>
<td>300</td>
<td>500</td>
<td>250-310</td>
</tr>
<tr>
<td>Exploratory Area (S of 46°S)</td>
<td>1400</td>
<td>5000</td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td>Arrow Plateau</td>
<td>200</td>
<td></td>
<td>unknown</td>
<td></td>
</tr>
<tr>
<td><strong>Cook canyon ORH 7B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORH 7B</td>
<td>12900-17000</td>
<td>425</td>
<td>430</td>
<td>180-240</td>
</tr>
<tr>
<td><strong>Challenger ORH 7A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inside EEZ</td>
<td>94500-99400</td>
<td>1308</td>
<td>1900</td>
<td>1260-1320</td>
</tr>
<tr>
<td>outside EEZ</td>
<td>1055</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 2. Orange roughy catches in southern areas of New Zealand. Data from (Clark 1998e).

<table>
<thead>
<tr>
<th>Area</th>
<th>Year developed</th>
<th>1994-95</th>
<th>1995-96</th>
<th>1996-97</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antipodes</td>
<td>1995-96</td>
<td>0</td>
<td>3077</td>
<td>790</td>
</tr>
<tr>
<td>Auckland Is.</td>
<td>1992-93</td>
<td>1260</td>
<td>430</td>
<td>87</td>
</tr>
<tr>
<td>Bounty</td>
<td>1993-94</td>
<td>55</td>
<td>240</td>
<td>120</td>
</tr>
<tr>
<td>Macquarie</td>
<td>1995-96</td>
<td>0</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Puyssegur</td>
<td>1990-91</td>
<td>1550</td>
<td>800</td>
<td>321</td>
</tr>
<tr>
<td>Snares</td>
<td>1990-91</td>
<td>30</td>
<td>9</td>
<td>55</td>
</tr>
</tbody>
</table>

3. East coast, Cape Runaway to Banks Peninsula

The Cape Runaway to Banks Peninsula includes 3 management areas, ORH 2A, 2B, and 3A. ORH 2A was sub-divided into two: ORH 2A North (north of 38°23'S) and ORH 2A South (south of 38°23'S) following the discovery of spawning fish at East Cape. No spawning has been recorded from the more southerly QMAs, areas 2B (Wairarapa) and 3A (Kaikoura), and it is believed that fish from these areas migrate to the Ritchie Hills to spawn (Annala & Sullivan 1996). The Cape Runaway to Banks Peninsula area has been treated as two stocks, and separate quotas were allocated to the East Cape (ORH 2A North) and the Mid-East Coast (ORH 2A South, ORH 2B and ORH 3A) from 1994-95 (Table 1), based on the spatial separation between the two spawning areas, although this is less than the distance over which fish are assumed to migrate from Kaikoura to the Ritchie Hills. Biological parameters such as the size at maturity indicate that fish from the Bay of Plenty mature at a larger size than those from the Ritchie Hills (Horn et al. in prep). Clearly this trait should be tested in East Cape samples. Genetic studies based on allozymes showed no differences between samples from the Bay of Plenty, East Cape and Ritchie Hills (Smith & Benson 1997).

4. Bay of Plenty

The northern North Island, from west of Wellington around to Cape Runaway was treated as one QMA, ORH 1, and landings were small until 1994 when a fishery developed in the western Bay of Plenty, in an area known as the Mercury-Colville Box. From 1995-96 ORH 1 was subject to a five year adaptive management plan with a limit of 1 000 t applied to the Mercury-Colville Box and 190 t to the rest of area ORH 1. For 1996-97 an additional 800 t was allocated to designated areas, with catch limits on any one area (Annala & Sullivan 1997). Off the west coast few sea-mounts are known, although a small fishery has developed on the Tauroa knoll. If additional fisheries are developed in the western region it will be important to determine the relationships between the west coast and Challenger fisheries.
Exploratory fishing and bathymetry surveys in area ORH 1 and the northern part of ORH 2A north are finding additional orange roughy resources and potential new grounds, particularly sea-mounts on the South Kermadec Ridge and the South Colville Ridge. There will be a need to determine stock relationships between these new and established resources if additional sea-mount fisheries develop. Special permits are issued to fishers with one condition being that not more than 100 tonnes (greenweight) of orange roughy is taken from any single topographic feature, defined as a prominent and definable undersea geographic unit elevated from the surrounding seabed and similar in shape to a mountain or large hill, including all the area within a 10 nautical mile radius of the shallowest point.

5. Challenger Plateau and Lord Howe Rise

The main orange roughy fishery on the Challenger Plateau has been on the southwest of the Plateau (ORH 7A) in an area that straddles the 200 mile EEZ. Fisheries also occur on the northwest Challenger Plateau (36°50'S - 38°0'S) and on the Lord Howe Rise (35°0'S - 36°45'S) outside the EEZ. Evidence from parasites and genetics indicate that the southwest fishery is separate to the Cook Canyon spawning stock to the south (ORH 7B). The relationships between the southwest and northwest Challenger fisheries are less clear; there are no size differences (Clark & Tilzey 1996), but there are differences in allele frequencies at one allozyme marker (Smith 1997b), although this marker shows temporal variation in other areas. The geographic distance between the southwest and northwest spawning areas (about 300 km) is greater than that between stocks in other parts of the EEZ, but within the presumed migratory distance of adult fish.

The northwest Challenger Plateau and the Lord Howe Rise fisheries have been treated as separate management units based on size structure and geographical separation (Clark & Tilzey 1996), although the initial size differences reported in early years are not verified by recent data (Clark 1998b). Genetic data at one allozyme marker indicate differences among the areas, but this marker exhibits temporal variation in other regions (Smith 1997b). Additional studies are being undertaken on the stock relationships between the northwest Challenger Plateau and Lord Howe Rise fisheries (Ministry of Fisheries Project ORH9703). The need for further studies should be reviewed when the ORH9703 data are available.

6. Louisville Ridge

The fisheries on the Louisville ridge are assumed to be discreet from stocks within the EEZ, based on geographic separation. Within the region the Louisville fisheries occur over a wide area (greater than Chatham Rise) and there is limited biological evidence from fish size that there are regional differences in the Louisville fishery (Clark 1998c). If New Zealand is to assume responsibility for managing the Louisville fisheries then there will be a need to undertake stock discrimination studies within this area. The Ministry of Fisheries project ORH9703 includes an objective to determine the stock relationships of orange roughy between the Louisville Ridge and the Chatham Rise. Genetic markers from this project should be applied to stock discrimination within the Louisville Ridge, along with a continuation of biological monitoring on fish size, spawning areas and times.
Management units of black and smooth oreos

Three species of oreo, black oreo, smooth oreo and spiky oreo (*Neocyttus rhomboidalis*) are managed together under a combined quota and divided into five management areas. The Chatham Rise has supported the main oreo fisheries and is sub-divided into two areas separated by about 100 nautical miles: a western fishery targeting black and smooth oreo (OEO 3A), which have been caught in approximate equal quantities over the past 5 years, with a minor by-catch of orange roughy, and an eastern fishery (OEO 4) targeting orange roughy with a by-catch of smooth oreo and small quantities of black oreo. There are also several spatially isolated oreo fisheries in Southern New Zealand including the Puysegur, Snares, Macquarie Ridge (area OEO 1) and the Bounty and Pukaki Rise (OEO 6).

Black oreo and smooth oreo have different growth rates, natural mortalities (Table 9, Objective 1), depth and geographical distributions (Figs 2 & 3, Objective 1) and probably different population sizes and therefore could be managed as separate species. If black and smooth oreos were managed as separate species then the management areas could be reviewed. Few stock discrimination studies have been carried out on black and smooth oreos. For black oreos genetic and ecological approaches have indicated differences between samples from the Chatham Rise and southern Tasmania, while for smooth oreos one meristic character showed significant differences between samples from Western Australia, and southern Tasmania (Ward et al 1996). There is a need for a pilot survey to develop suitable stock markers to determine relationships between the OEO 3A and OEO 4 fisheries, as discussed in Objective 3. Such a pilot study requires out-group samples from Southern New Zealand to determine the ecological and genetic relationships between fisheries in OEO 1, OEO 3A, OEO 4, and OEO 6.

11. Conclusions

1. Orange roughy within the New Zealand EEZ have been divided into 8 management areas, some of which have been further subdivided as new spawning groups have been discovered. For the most part the stock relationship questions occur within the fishery management areas and are concerned with relatively small spatial scales, less than the assumed movement potential for adult fish.

2. On the Chatham Rise (ORH 3B) there is a need to determine the relationships between the concentrations of spawning and non-spawning fish, in particular between the Box and the hills to the east and south east, and between spawning groups at the Graveyard on the central Rise and at the Hole on the northwest Rise.

3. In Southern New Zealand (ORH 3B) the small size of the fisheries coupled with their spatial separation, obviates the need for further stock discrimination studies.

4. In the Bay of Plenty (ORH 1) exploratory surveys have revealed potential new sea-mount fisheries. There will be a need to determine the relationships among these sea-mounts, if new fisheries develop, and with those on the south Kermadec Ridge and at East Cape (ORH 2A north).
5. The spawning population at East Cape (ORH 2A North) is managed as a separate stock to the spawning population at Ritchie Hills (ORH 2A South) based on spatial separation, but this is less than the distance over which fish are assumed to migrate from Kaikoura (ORH 3A) to the Ritchie Hills. There is a need to determine the relationships between the concentrations of spawning and non-spawning fish off the east coast.

6. The Challenger fisheries (ORH 7A) are spatially isolated from other west coast fisheries (ORH 7B) and there are no urgent stock relationship questions.

7. Outside the EEZ there is a need to determine stock relationships among fisheries on the Louisville Ridge. In the Tasman Sea studies are being undertaken on the stock relationships between the northwest Challenger Plateau and Lord Howe Rise fisheries (Ministry of Fisheries Project ORH9703); the need for further studies should be reviewed when the ORH9703 data are available.

8. Black oreo and smooth oreo have different biological parameters, depth and geographical distributions, and probably different population sizes and therefore could be managed as separate species. If black and smooth oreos are managed as separate species then the management areas could be reviewed and stock relationships determined between fisheries in OEO1, OEO 3A, OEO 4 and OEO 6.

12. Publications


13. Data storage

Electronic copy of report held at NIWA Greta Point
Project Title: To determine stock relationships for orange roughy, black oreo, and smooth oreo in New Zealand waters.

Project Code: DEE9701

References for Objectives 1, 2, 3, and 4


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