Ecological risk assessment of the New Zealand hoki fisheries

Report for Deepwater Group Limited, Nelson

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Executive summary

A risk assessment framework appropriate for ecological risk assessments of the effects of fishing was adopted for the 2010 hoki ecological risk assessment (2010 hoki ERA). This framework divides the ecosystem into five broad ecological components as follows:

i. The target species (in this case, target hoki)
ii. Bycatch species
iii. Protected, endangered or threatened species
iv. Habitats (in this case, the benthic habitat)
v. Ecosystem (Trophic) impacts affecting ecosystem structure and function)

The method adopted for the hoki ERA was to assemble a panel of experts to undertake a qualitative risk assessment in a workshop setting, with the workshop open to stakeholders. Risks were to be assessed for each of the four hoki fisheries (Chatham Rise, Sub-Antarctic, WCSI, Cook Strait) separately. Initial discussions with stakeholders commenced in December 2009. Work to organise the 2010 hoki ERA proceeded over the period August to November 2010. This included engaging stakeholders and consulting them on the details of the ERA method, terms of reference and protocols and selecting an Expert Panel. The 2010 hoki ERA workshop took place in Wellington on 13 and 14 December 2010.

The Expert Panel assessed the risks to each ecological component that might be impacted by target hoki fishing and fishing related activities. Risk (the level of consequence) was assessed on a scale from 0 to 5 (negligible to catastrophic). The Expert Panel noted that the boundary between what was generally considered an acceptable level of consequence and an unacceptable level of consequence lay between a score of 2 (moderate consequence) and 3 (major consequence).

With three exceptions the Expert Panel assessed the risks of the target hoki fisheries to all of the ecological components as being of no more than moderate consequence. These include the risks to hoki populations, the risks to all of the major and minor bycatch fish species including sharks, risks to fur seals, other marine mammals, and protected fishes including basking sharks, risks to the benthic environment (with one category excepted, below) and trophic impacts (with two fisheries potentially excepted, below).

The target hoki fishery was assessed as having a major consequence to the benthic habitat (BOMEC class 9) in the Chatham hoki fishery. The assessment was based on the twenty year hoki trawl footprint that shows only 33.99% of BOMEC class 9 has not been trawled in the past 20 years. It was noted that the trawl footprint of the present hoki fishery has reduced significantly with 83.39% of BOMEC class 9 not trawled in 2008-09.

The Expert Panel did not reach agreement on whether trophic (ecosystem) impacts were moderate or major in the Chatham Rise and the Sub-Antarctic areas. Data from an as-yet unpublished trophic model for the Chatham Rise using research trawl survey and commercial catch data together with

fish dietary studies shows that there is evidence of an ongoing reduction in mean trophic level. There is no trophic model covering the area in which the hoki fishery occurs in the Sub-Antarctic. The Expert Panel members did not reach consensus on the level of risk to ecosystems/trophic impacts for the Chatham Rise and Sub-Antarctic – scoring risks and consequences as either moderate or major.

1 Introduction

1.1 Background to the 2010 hoki ecological risk assessment

It is increasingly accepted that fisheries need to be managed not only to ensure the sustainability of fishery resources but also to limit their effects on the wider ecosystem. The awareness of the need to manage the potential impacts of fisheries on the wider ecosystem has developed concurrently with the concept of a precautionary approach to managing fisheries in the absence of complete information. One response to this has been the increasing use of formal risk management approaches adapted from other sectors as a means of identifying the risks (the likelihood and extent of potential harm) to ecosystems that might be impacted by fishing (Fletcher, 2005).

In 2005, the Ministry of Fisheries adopted a strategy for the management of potential adverse environmental effects of fishing on the environment (Ministry of Fisheries, 2005). Included in the strategy is the development of environmental standards and frameworks to achieve those standards through such vehicles as fishery management plans. In 2010, the Hoki Fisheries Plan was adopted as part of the Ministry of Fisheries' The National Fisheries Plan for Deepwater and Middle-depth Fisheries, Hoki Fishery Plan ('Hoki Fishery Plan') (Ministry of Fisheries 2010). The Hoki Fisheries Plan sets out the operational objectives and performance criteria for the hoki fishery and key bycatch fisheries as well as for addressing the management of adverse environmental effects caused by hoki fishing activity. One of the operational objectives of the Hoki Fisheries Plan is to complete an ecological risk assessment on non-fish species and the 2010 hoki ecological risk assessment (2010 hoki ERA) addressed that objective.

The 2010 hoki ERA is also aimed at identifying risks that need to be managed in order to comply with Marine Stewardship Council (MSC) requirements for continued certification of the hoki fishery. A condition of MSC Certification of the hoki fishery was to undertake a new ERA to update the initial hoki ERA (URS 2002, 2003) that was undertaken in 2002 when the hoki fishery first received MSC certification.

Fletcher et al. (2002) and Fletcher (2005) describe the use of qualitative risk assessment as a means of prioritising issues in fisheries management and its application in a number of Australian fisheries. Hobday et al. (2007) describe an hierarchical approach to ecological risk assessments of fisheries in which assessments move sequentially through three levels from a largely qualitative approach (Level 1) to a fully quantitative approach (Level 3). The hierarchical approach has the advantage that at Level 1, lower risk elements can be screened out and higher risk elements identified for further work and management responses. This is the approach broadly adopted for the 2010 hoki ERA – a Level 1 qualitative assessment of risks across the ecological spectrum in order to provide the information required by managers to identify and prioritise management needs and set management objectives and priorities. A similar Level 1 approach has recently been used to assess the risks to seabirds from interactions with New Zealand fisheries (Rowe 2010).

Since the 2002 hoki risk assessment considerable work has been undertaken to address the impacts of fisheries (including the hoki fishery) on non-fish species and the ecosystem. Examples include

assessments of fisheries risks to seabirds (e.g., Sharp, 2009, Baird & Gilbert 2010, Rowe 2010), a national plan of action for sharks (Ministry of Fisheries 2008), development of a marine environment classification and its subsequent refinement for assessing the benthic impacts of fishing (Leathwick et al. 2009), and development of trophic models for the Chatham Rise ecosystem. The 2010 hoki ERA uses this improved knowledge of fisheries and ecosystem interactions as a platform for the new assessment. It is a new qualitative risk assessment that updates the 2002 hoki risk assessment using current knowledge.

The overall objective of the 2010 hoki ERA was to assess the potential risks to all components of marine ecosystems from the target hoki fisheries as a means of identifying future management needs. It addresses both the MSC Conditions of Certification in place in the hoki fishery and the operational objectives of the Hoki Fisheries Plan. In the 2010 hoki ERA, the term "risk" is not used in the sense of the risk (probability) of an undesirable outcome; rather it is the expected magnitude of an impact (the consequence), and whether this level of impact is considered acceptable.

1.2 Steps in the development of the 2010 hoki ERA

1.2.1 Background

The development of the 2010 hoki ERA commenced with a workshop in 2009 (Stocklosa, R. 2010) to discuss available information and potential ERA methods. That workshop and related discussions with stakeholders and scientists covered what fishery managers needed to inform decision making, what information and expertise was available, and the types of ERA methods that could be considered. Following the workshop, Deepwater Group Limited (DWG) sought proposals for undertaking the 2010 hoki ERA but found that the proposal received would be too complex, resource intensive, and time consuming and would ultimately not be able to be completed within an acceptable time frame to meet MSC requirements for updating the 2002 ERA.

A new proposal to develop a method and facilitate the hoki ERA was sought in July 2010 from Boyd Fisheries Consultants Ltd and this report is the culmination of the work undertaken and presents the results of the 2010 hoki ERA. Over the period August to November 2010, stakeholders were consulted on the process and proposed ERA method for the updated hoki ERA. This was followed by the ERA workshop in mid December at which a panel of experts assessed the ecological risks associated with the hoki fisheries. Notes from the workshop were then circulated to the Expert Panel members for correction and form the basis of the assessments presented in this report. A draft of this report was then circulated to the Expert Panel for comment and correction.

Appendix 1 provides a timeline and description of the overall process for the 2010 hoki ERA as at 16 December 2010.

2 Methods

2.1 The ERA method

2.1.1 Background to the selection of a method

Consultation with stakeholders on the method for the 2010 hoki ERA indicated that some stakeholders preferred adopting a Level 2 ERA PSA (productivity, susceptibility, analysis) or the so-called SICA (scale, intensity, consequence analysis) Level 1 approaches of Hobday et al. (2007). While these methods had potential advantages of providing more detailed results, they also required more time, information and resources than available. It was determined that the objectives for the 2010 hoki ERA could be met using a likelihood-consequence approach such as that described in Fletcher et al (2002) and Fletcher (2005) for the application of qualitative (Level 1) risk assessment in Australian fisheries. The information requirements of a Level 1 assessment using the method of Fletcher (2005) are much less demanding and allowed all ecological categories to be assessed in line with the objective for the 2010 hoki ERA. That method has been used as a means of identifying issues and setting priorities for fisheries management in Australia. A recent Level 1 risk analysis of seabird interactions with New Zealand fisheries had also been successfully undertaken using the same approach (Rowe 2010).

2.1.2 Method adopted for the 2010 hoki ERA.

The 2010 hoki ERA closely follows the ecological risk assessment method for fisheries that is described in Fletcher (2005). In this method expert opinion is used in a structured workshop setting in to identify issues and assess the risks across the full spectrum of ecosystem components. In order to effectively cover all ecosystem issues potentially at risk from fishing impacts, the ecosystem is divided into its components. The five ecosystem components are (i) target species, (ii) bycatch species, (iii) protected species, (iv)benthic habitats and (v) the overall ecosystem. The evaluation process considers the possible sources of risk, the potential impacts or consequences of that risk and the likelihood that a particular level of impact will occur. Fletcher's (2005) method was developed from the Australian and New Zealand risk assessment standards and has been adopted in a number of Australian fisheries.

Fletcher (2005) notes that a key element in risk analysis is having adequate descriptions of the consequences and likelihood and for qualitative assessments, this requires having suitable criteria or descriptions for each consequence or likelihood that are relevant to the environmental category being evaluated. The proposed method, including descriptions of consequence and likelihood, was circulated to stakeholders for comments and a number of improvements and refinements were incorporated through this process.

2.1.3 The 2010 hoki ERA

The 2010 hoki ERA was based on the most up to date information available on the hoki fishery, including knowledge of the target fishery and methods, bycatch, benthic impacts and ecosystem information. The most recent hoki plenary document (Ministry of Fisheries, Science Group (Comps.)

(2010)) gives a summary of the fishery (including history, areas and methods), hoki biology, hoki stocks and areas and a summary of the incidental bycatch of fish and invertebrates, marine mammals and seabirds, and benthic interactions in hoki fisheries as well as a bibliography of references.

In summary, hoki (*Macruronus novaezelandiae*) supports New Zealand's largest fishery. Hoki are widely distributed throughout New Zealand waters, but are most abundant on the Chatham Rise and the Southern Plateau between the depths of 200 – 600 m. Hoki form spawning aggregations of the west coast of the South Island and in Cook Strait. Hoki are targeted by trawling, with midwater trawls, single bottom trawls and twin-rig bottom trawls all in use. Bottom trawling or mid-water trawling with seabed contact potentially impacts the benthic environment with potential consequences to its habitats and associated fauna. Mid-water trawling is mostly used in the spawning area fisheries.

A series of research trawl surveys of hoki on the Chatham Rise and Southern Plateau spans the past twenty years and together with commercial catch data provides a robust data set on the catch of both target and non-target fish species. There is a comprehensive scientific observer programme in place on hoki fishing vessels giving a good knowledge of the level of interactions with protected and threatened species including seabirds and marine mammals as well as the incidental catch of non-fish species such as corals, sponges and other benthic organisms. Based on the knowledge of the fishery, stocks and areas, the 2010 hoki ERA assessed the ecosystem effects of each of the four target hoki fisheries individually; Chatham Rise (including the East Coast of the South Island), Sub-Antarctic (including Southland), West Coast South Island (WCSI) and Cook Strait (Figure 1).

2.1.4 The 2010 hoki ERA method.

The full method for the 2010 hoki ERA is set out in Appendix 2. For each of the hoki fisheries, the five ecosystem components were (i) target species, (ii) bycatch species, (iii) protected species, (iv) benthic habitats and (v) the overall ecosystem. The evaluation process considers the possible sources of risk, the potential impacts or consequences of that risk and the likelihood that a particular level of impact will occur in each of the four fisheries.

The risk assessments were undertaken in a workshop setting by an Expert Panel. The Expert Panel members (Table 1) incorporated expertise in all of the five ecological components.

For each fishery and each of the five ecological components, the Expert Panel assessed the level of consequence (or impact) of the hoki target fishery using a scale that had 6 levels of potential consequence ranging from negligible to catastrophic. It was initially proposed to also score the level of likelihood of the consequence score using a scale from remote to likely. However, at the hoki ERA workshop the Expert Panel determined that in the case of the hoki fishery the likelihood of a consequence was implicit in the consequence score. Therefore likelihood was not scored and this represents a significant variation in the method of Fletcher (2005). The confidence of each assessment was also scored.

Figure 1: The four target hoki fishery areas (base map from NABIS, Ministry of Fisheries)

Table 1: Expert Panel members for the 2010 hoki ERA

Laura Boren	Scientist, Marine Conservation Unit, Department of Conservation
Clinton Duffy	Scientist, Marine Conservation Unit, Department of Conservation
Jeremy Helson	Senior Policy Analyst, Ministry of Fisheries
Rosie Hurst	Chief Scientist (Fisheries) NIWA
Craig Loveridge	Research Data Management, Ministry of Fisheries
Aoife Martin	Deepwater Fisheries Manager, Ministry of Fisheries
David Middleton	Chief Scientist, SeaFIC
Richard O'Driscoll	Group Manager, Middle Depth Fisheries, NIWA
Matt Pinkerton	Scientist (Ecosystem modelling) NIWA
Ian Tuck	Principal Scientist (Fisheries) NIWA
Richard Wells	Fisheries Specialist, Deepwater Group Limited
Bob Zuur	Marine Advocate, WWF NZ

Each of the five ecological categories assessed had six specific descriptions of consequence (or impact) directly relevant to the nature and vulnerability of that component of the ecosystem. This means there are a number of different, but parallel, sets of descriptions of consequences, one set being used for each ecological category.

The full descriptions of the consequences used for the hoki ERA are set out in Appendix 2, Tables A1 – A5. The consequence descriptions in Tables A1 – A5 were adapted from Fletcher (2005) and Hobday et al. (2007). The confidence scores in Table A6 are from Hobday et al. (2007). In the workshop setting, the Expert Panel normally referred to the consequence score and the confidence score by number.

The consequence descriptions in Appendix 2, Tables A1 to A5 were used for assessing the five ecological components as follows:

- Target species and major bycatch – consequence descriptions in Appendix 2, Table A1
- Minor bycatch species – consequence descriptions in Appendix 2, Table A2
- Protected species – consequence descriptions in Appendix 2, Table A3
- Benthic habitat – consequence descriptions in Appendix 2, Table A4
- Ecosystem/trophic impacts – consequence descriptions in Appendix 2, Table A5

To simplify reading this report, the consequence levels by number and descriptor are given in Table 2 and the confidence scores are given in Table 3. The descriptor terms *major* and *severe* for levels 3 and 4 in Table 2 below and in Appendix 2, Tables A1 – A5 have been reversed compared to their use in Fletcher (2005) as this seemed a more logical hierarchy of the terminology.

Table 2: Consequence levels by number and name (Appendix 2, Tables A1 – A5)

Level	Descriptor
0	Negligible
1	Minor
2	Moderate
3	Major
4	Severe
5	Catastrophic

Table 3: Confidence scores with descriptions (Appendix 2, Table A6)

Confidence rating	Score	Rationale for confidence score
Low	1a	Data exists, but is considered poor or conflicting.
	1b	No data exists.
	1c	Agreement between experts, but with low confidence
	1d	Disagreement between experts
High	2a	Data exists and is considered sound.
	2b	Consensus between experts
	2c	High confidence - exposure to impact cannot occur (e.g. no spatial overlap of fishing activity and species distribution)

2.2 ERA Process and workshop preparation

Stakeholders involvement was a key element of the 2010 hoki ERA. As noted in the introduction, development of the hoki ERA commenced in late 2009. This included engaging stakeholders and consulting them on the details of the ERA method, terms of reference and protocols. A comprehensive library of background information and relevant research was compiled and made available on the DWG website to inform the risk assessment. A number of one-on-one meetings were held between the ERA convenor and stakeholder groups to discuss the method and to seek their input to the ERA.

There is an extensive literature on hoki and on the various ecosystem components. Although Expert Panel members were selected based on their individual expert knowledge of the hoki fishery, ecological components, and risk assessment, a core library of recent and relevant published and some unpublished documents was assembled and made available to the Expert Panel through the DWG website. The references for the documents made available in this way are cited in Appendix 3 and a copy of the documents and other information made available (including recent scientific observer data of all fish and non-fish bycatch from the four hoki fisheries except for seabirds and marine mammals) are provided on a separate CD which forms part of this report and is cited elsewhere in this report as '2010 hoki ERA CD attachment'. Most of the documents on the CD represent results of research reports derived from Ministry of Fisheries' research projects that were in the public domain. A small number of documents on the CD were new and had not been peer reviewed but provided important and useful information to the Expert Panel. These core documents represent only a fraction of the available literature and research knowledge of the hoki fishery and its ecological interactions.

Scientific names are not given in this report which uses common names. Latin names can be found in Appendix 4. Additional information on species, together with the type of organism or phyla, Class, Family and other information concerning vulnerability can be found in the spreadsheets file **HOK_All_Observer_Data-2006-7_2008-9.xlsx** (see 2010 hoki ERA CD attachment).

2.3 The 2010 hoki ERA workshop

The 2010 hoki ERA workshop took place over a two day period on 13 and 14 December 2010. A number of stakeholder observers attended the workshop. Appendix 5 gives the workshop programme and Appendix 6 gives the protocols developed for the workshop and the guidance of the Expert Panel.

The workshop commenced with a general discussion amongst the Expert Panel members. The purpose of this discussion was to clarify the objectives of the risk assessment workshop, the risk assessment method and related procedural matters to reach a common understanding of the method and process. The following points were discussed.

- Risk assessment is a process of evaluating the nature and extent of interactions (of the target hoki fisheries in this case) with the ecological environment with the objective of determining whether these interactions pose an acceptable risk.
- The overall aim of the hoki ERA is not to manage the ecosystem, but to provide information to help manage the impacts of the interactions of the hoki fishery on the ecosystem.
- The Expert Panel is not operating in an information vacuum; there is a substantial knowledge base. In addition to a significant research effort and ongoing stock monitoring there is a comprehensive observer programme.
- The objective of the 2010 hoki ERA is to use an agreed process to determine the risk or consequences to ecosystems from the hoki fisheries in order to inform managers about the management issues they may need to consider as a result of the assessment.
- The hoki ERA is being conducted at Level 1 to enable all ecological components to be considered at one point in time in order to assess the risks and to inform managers where priorities might be for future management responses. It is a broad priority setting (or re-setting) exercise.
- The hoki ERA addresses Marine Stewardship Council (MSC) requirements to update the 2002 hoki risk assessment which is now out of date. While there have been ongoing management responses in a number of areas to address specific risks identified in the earlier hoki ERA, it is time to reassess the risks across the full ecological spectrum.
- The hoki ERA would be undertaken using the mitigated risk as mitigation measures had been in place in the fishery for a number of years and there was no value in assessing unmitigated risk.
- ERAs are now planned for all the major deepwater fisheries and the outputs from the hoki ERA process will help inform later ERAs. Future ERAs will be contracted by the Ministry of Fisheries as part of the 10 Year Research Plan for Deepwater Fisheries.
- A concern was expressed by some of the Expert Panel that the hoki ERA process was too compressed and there may not be enough experts present to truly comprise an expert panel.
- Although a true Level 1 ERA is mainly qualitative, it was agreed that in this case the Expert Panel would utilize the considerable quantitative data available as part of the assessment process.

- All ecological components likely to be impacted by hoki fishing and fishing related activities are to be included in the hoki ERA. Impacts governed by legislation other than the Fisheries Act 1996; for example impacts from pollution, navigation and shipping are out of scope.
- The Expert Panel agreed that this is an ecological risk assessment, not an environmental assessment.

The ERA method used by the ERA Panel is set out in Appendix 2. As described earlier, the methodology had been pre-circulated to the Expert Panel and stakeholder groups. Following a discussion about the method the following amendment to the proposed hoki ERA method was agreed by the Expert Panel.

> The likelihood scoring is implicit to the consequence score. It is therefore unnecessary for the hoki ERA to score each category separately for both consequence and likelihood. A single consequence score for each ecological component will be given based on the consequences descriptions in Appendix 2, Tables A1 – A5.

It was agreed that an informal distillation process had taken place prior to the workshop, so that the ecological categories to be assessed have already been identified as requiring assessment.

The Expert Panel also discussed whether the consequence score should be scaled in terms of both positive and negative impacts. This was not considered necessary given that the objective of the ERA is not to attribute positive and negative impacts, but to identify impacts which may require future management action.

The Expert Panel agreed that the boundary between acceptable and unacceptable consequence lay between consequence scores 2 (moderate) and 3 (major) for all ecological categories being assessed.

An Expert Panel member noted the overlap between hoki, hake, and ling in the trawl fishery (including the definition what is the actual target for each tow) and the difficulty of allocating risk between these species. Some Panel members considered that there would be merit in considering this multispecies fishery as a group.

The hierarchical risk assessment approach, which starts with a Level 1 assessment, is intended to be precautionary (i.e. it should not dismiss potential risks through lack of information). As a result, if in doubt, the Expert Panel agreed it would choose the higher of proposed scores. If there is doubt over whether a particular species or category should be assessed, this species or category would be included. It was agreed that conflating risk and uncertainty should be avoided.

3 Results

3.1 Assessment of the target and major bycatch fish species

3.1.1 Target hoki

Table 4: Consequence scores for the four target hoki fisheries

		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Hoki	Consequence	Moderate	Moderate	Moderate	Moderate
	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	High (data exists and is considered sound)	High (data exists and is considered sound)

3.1.2 Expert Panel rationale for scoring target hoki:

The Expert Panel assigned a consequence score of 2 (moderate) for the four hoki fisheries – the stocks are fully exploited, with hoki ranking as New Zealand's most important deepwater species but current management measures ensure the long-term recruitment and dynamics of hoki populations are not adversely impacted.

The confidence scores are high, as there is a large amount of information available and a good understanding of hoki life-history and population dynamics.

3.2 Major fish bycatch species of the hoki target fishery

3.2.1 Expert Panel initial discussion of major and minor bycatch species of the hoki target fisheries

The Expert Panel agreed that the hoki bycatch estimates by Ballara et al. (2010) should be used to inform the assessment as this data spanned 7 years and had been peer reviewed and published. Observer data from all four hoki fisheries over the last 3 fishing years was also available to the Expert Panel.

The Expert Panel noted that deepwater sharks featured in ERAs performed in Australia. Although not itself an indication that these species were at risk from the hoki fishery, it is beneficial to assess these species, given the overseas concerns.

Important factors for consideration during assessment of the risks to bycatch species were as follows:

- The level of interaction of the bycatch species with the hoki fishery and the contribution of the target hoki fishery to the total catch of the bycatch species. If most of the catch of the bycatch species is taken in other fisheries, and the hoki fishery is not having a material impact, the risk to the bycatch species would not be considered as part of the hoki ERA.
- The status of the bycatch fishery (QMS or non-QMS).
- If it is a QMS species and is managed within the TACC.
- If it is a QMS species is the catch in excess of the total allowable commercial catch (TACC)?
- Future management decisions such as an increase or decrease in the hoki TACC that could increase or decrease the risks to bycatch species

The QMS/non-QMS distinction was considered useful given that risk to QMS species could be assessed using any overfishing of the TAC as an indicator of risk. Although not always a meaningful metric, this could be a good indicator to start analysis.

The Hoki Fishery Plan (Ministry of Fisheries 2010) identified 26 key bycatch species that typically occurred in a hoki trawl. Most of the 26 species have economic value and are explicitly managed under the quota management system (QMS). The Hoki Fisheries Plan (Ministry of Fisheries 2010) also identified incidental bycatch species that are largely discarded or have no current economic value.

The Expert Panel considered the bycatch information in the Hoki Fisheries Plan and determined that the following species were major bycatch species or species groups requiring assessment for the purposes of the 2010 hoki ERA. This was based on a number of factors, including the overlap of the hoki, hake, and ling target fisheries, the size of the bycatch and the proportion of the total catch of the species taken as a bycatch in the hoki fisheries. The risks to the following species would be assessed using the descriptions of consequences in Table A1 of Appendix 2.

- Hake
- Ling
- Silver warehou
- Lookdown dory
- Spiny dogfish
- White warehou
- Frostfish
- Rattails and other Macrouridae (approx. 12+ species)
- Javelinfish

Table 5: Consequence scores for major fish bycatch species of the hoki target fishery

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Ling	Consequence	Moderate	Minor	Moderate	Moderate
Ling	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)
Hake	Consequence	Moderate	Moderate	Moderate	Minor
Hake	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	Low (agreement between experts but with low confidence)	Low (data exists but considered poor or conflicting)
Silver warehou	Consequence	Moderate	Moderate	Moderate	Negligible
Silver warehou	Confidence	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	Low (agreement between experts but with low confidence)	-
Lookdown dory	Consequence	Minor	Minor	Minor	Negligible
Lookdown dory	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	Low (data exists but considered poor or conflicting)	-
Spiny dogfish	Consequence	Minor	Minor	Minor	Minor
Spiny dogfish	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	High (consensus between experts)	High (consensus between experts)
White warehou	Consequence	Minor	Moderate	Minor	Negligible
White warehou	Confidence	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	-

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Frostfish	Consequence	Negligible	Negligible	Minor	Negligible
Frostfish	Confidence	-	-	Low (data exists but considered poor or conflicting)	-
Rattails & other macrourids	Consequence	Moderate	Moderate	Moderate	Minor
	Confidence	High (data exists and is considered sound)	Low (data exists but considered poor or conflicting) (Note, data exists but has not been analysed)	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)
Javelinfish	Consequence	Minor	Minor	Minor	Negligible
	Confidence	High (data exists and is considered sound)	High (data exists and is considered sound)	Low (data exists but considered poor or conflicting)	-

3.2.2 Expert panel rationale for scoring hake and ling

The Expert Panel considered and discussed these two species together.

The Hoki Fishery Plan (Ministry of Fisheries 2010) lists both of these species as major bycatch of the hoki fishery. Given that major target fisheries operate for both ling and hake, the Expert Panel agreed that the hoki fishery is not currently considered a significant source of risk for these species in any area. However, there is the potential that changing management measures for hoki (e.g., an increase in the TACC) will impact on both hake and ling in the future. For example, hake has been a major bycatch of the hoki fishery on WCSI in the past.

The Expert Panel assigned a consequence score of 2 (moderate) for ling for all of the fisheries except the Sub-Antarctic where the consequence was scored as 1 (minor). The Sub-Antarctic ling fishery is more targeted with a long line component. There is good information on the status of ling stocks from the trawl survey data for the Chatham Rise and Sub-Antarctic areas to support the risk assessment in these areas but relatively poor data for ling within the WCSI and Cook Strait hoki fishery areas.

The Expert Panel assigned a consequence score of 2 (moderate) for hake for the Chatham Rise, Sub-Antarctic and WCSI fishery areas. The hake fisheries are considered to be fully exploited in these areas. The score for Cook Strait was 1 (minor) because there is very little hake bycatch in this area.

For both ling and hake, the confidence scores of 2a were higher for the Chatham Rise and the Sub-Antarctic hoki fisheries as the trawl survey time series in these areas provides reliable data. There is less data available for the WCSI hake fishery and the Expert Panel had lower confidence in its score for this fishery.

3.2.3 Expert panel rationale for scoring silver warehou (SWA)

With regards to the Chatham Rise and Sub-Antarctic fisheries: the Expert Panel was undecided between assigning a consequence score of 1 (minor) or 2 (moderate), but decided to be precautionary. Although SWA3 and SWA4 were consistently over-caught prior to the Ministry of Fisheries' deemed value review in 2007, the stocks have not been significantly over-caught since 2007. CPUE data for these two SWA stocks exist, but are not considered reliable. Trawl survey indices have high c.v.s. Given the uncertainty in the CPUE data, and the lack of additional information with which to monitor the stocks, the confidence score was low.

The same consequence score was assigned for SWA1 as it overlaps with the WCSI hoki fishery. However, more information is available for this stock - there are age-based mortality data, but not a full stock assessment, so the Expert Panel was slightly more confident in the score.

3.2.4 Expert panel rationale for scoring lookdown dory (LDO)

LDO is not found in Cook Strait; therefore a zero score (negligible) was assigned for this fishery.

The Expert Panel assigned a consequence score of 1 (minor) but noted that there is less information to support this score (only CPUE, which is not considered to be reliable).

The Chatham Rise and Sub-Antarctic trawl surveys probably provide reliable indices of LDO and trends are relatively flat over the time series. The Expert Panel therefore has higher confidence in the consequence score of 1 (minor) for both the Chatham Rise and the Sub-Antarctic hoki fisheries.

3.2.5 Expert panel rationale for scoring spiny dogfish (SPD)

There is little information on stock structure. Spiny dogfish are also caught in most areas around mainland New Zealand and shallower parts of the Chatham Rise of New Zealand, and less frequently across the southern plateau. It is more abundant in inshore waters around the South Island and is taken in many fisheries other than hoki. Larger mature females occur in deeper waters that overlap with the hoki fishery.

Evidence from RV *Tangaroa* trawl surveys on the Chatham Rise and from inshore trawl surveys indicates that spiny dogfish abundance increased during the mid 1990s. Trends in CPUE are difficult to interpret due to unknown trends in discarding. This, together with occurrence of spiny dogfish in

other fisheries, resulted in the Expert Panel being confident that the hoki fishery was having a minor impact on spiny dogfish throughout New Zealand.

3.2.6 Expert panel rationale for scoring white warehou (WWA)

This species is not caught in Cook Strait; therefore the Expert Panel assessed a consequence score of 0 (negligible).

WWA is caught on Chatham Rise and Sub Antarctic trawl surveys, but the fluctuations in abundance are large and the c.v.s are moderate to high.

Some unpublished CPUE analyses have been undertaken but used a data roll-up method not best suited to these fisheries and the time series was short.

There was consensus within the Expert Panel that the impact of the hoki target fishery on WWA in the Sub-Antarctic would be greater than in other areas, therefore this fishery should be given a higher consequence score than the Chatham Rise and WCSI fisheries.

The lack of information precludes higher confidence scores for this species.

3.2.7 Expert panel rationale for scoring frostfish (FRO)

Frostfish distribution mainly overlaps with the WCSI hoki fishery, but is occasionally caught in Cook Strait.

The impact is likely to be minor given that FRO is generally found in shallower water than hoki.

The low confidence scores were assigned due to a lack of information on frostfish.

3.2.8 Expert panel rationale for scoring rattails and other Macrouridae

At least 12 known species of Macrouridae are known to be taken as bycatch in the hoki fishery. As a group, these species overlap with the four hoki fisheries in differing proportions. The species mix also varies with depth.

Only the macrourid species with similar depth ranges to hoki (e.g., Bollons' rattail) are well sampled by the trawl surveys. Information from the trawl surveys is less reliable for the other macrourid species. Bollons' rattail is one of the most common species and could therefore be used as an indicator species for the group.

Abundance indices are available for the more common rattails species on Chatham Rise and Sub-Antarctic surveys. Trends are variable, with no consistent patterns apparent.

However, these macrourid species have relatively low productivity and will be more vulnerable to impact from the hoki fishery. For this reason, a moderate consequence score (2) was assigned to this group of species in all for hoki fishery areas.

On the Chatham Rise, the trawl survey analysis has not shown any apparent declines, but in other areas the information is not available. Confidence in these areas is therefore lower.

3.2.9 Expert panel rationale for scoring javelinfish

This species generally has higher productivity than other rattail species and is therefore likely to be more resilient to impact from the hoki fishery. This species is a major bycatch of the hoki fishery in all of the hoki target fisheries bar Cook Strait.

The available Chatham Rise and Sub-Antarctic trawl survey data do not show any declining trends in javelinfish abundance. This results in higher confidence scores for these areas. Abundance may have increased on the Chatham Rise.

3.3 Assessment of the minor bycatch species of the hoki fishery

The Expert Panel discussed minor bycatch species that should be assessed as part of the hoki ERA. They determined that the following species were minor species or species groups requiring assessment for the purposes of the hoki ERA:

- Deepwater dogfish
- Deepwater skates and rays
- Pale ghost shark

Table 6: Consequence scores for minor fish bycatch species of the hoki target fishery

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Deepwater dogfish	Consequence	Moderate	Moderate	Minor	Negligible
Deepwater dogfish	Confidence	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	-

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Deepwater skates and rays	Consequence	Minor	Minor	Negligible	Negligible
Deepwater skates and rays	Confidence	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	-	-
Pale ghost shark	Consequence	Moderate	Moderate	Negligible	Negligible
Pale ghost shark	Confidence	High (data exists and considered sound)	High (data exists and considered sound)	-	-

3.3.1 Expert panel rationale for scoring deepwater dogfish

Several species of deepwater dogfish are taken as bycatch in the hoki fishery. A list of species included in this group is listed in Appendix 7.

Although data from the Chatham Rise and Sub-Antarctic trawl surveys may provide some indications of abundance, the surveys only sample to 800m depth, and the depth range of most deepwater dogfish species extends considerably deeper than this. Trawl surveys therefore only index the shallower portion of the distribution of these species.

The Expert Panel proposed the same scores for deepwater dogfish as for the rattails: Even though the overlap between deepwater dogfish distribution and the hoki fishery is less than the rattails, the productivity of the deepwater dogfish species is the same or lower than rattails, increasing their vulnerability.

Deepwater dogfish are not caught in Cook Strait (scored 0), and are infrequently caught on the WCSI, unless the vessels fish in deeper water. The Expert Panel agreed the WCSI fishery had a minor impact on deepwater dogfish, whereas a moderate consequence score was assigned for the Sub-Antarctic and Chatham Rise hoki fisheries.

Confidence in the risk scores for deepwater dogfish in the Chatham Rise, Sub-Antarctic and WCSI fisheries were low. Trawl survey data, while available for the Chatham Rise and Sub-Antarctic, did not sample the entire depth range of the deepwater dogfish species. In addition, time series data from the Sub-Antarctic trawl surveys has not yet been analysed.

3.3.2 Expert panel rationale for scoring deepwater skates and rays

Deepwater skates and rays are listed in Appendix 7.

Rough skate and smooth skate are not included in this group as they are QMS species which are not caught in significant volumes by the hoki fishery.

Negligible quantities of deepwater skates are caught in the hoki fishery. The Chatham Rise and Sub-Antarctic trawl surveys also catch small volumes of approximately a dozen species of deepwater skate. The trawl survey data from the Chatham Rise did not indicate any trends in abundance, although it is unlikely that the trawl gear used in the survey is effective for catching skates.

3.3.3 Expert panel rationale for scoring pale ghost shark

This species was assessed as the Expert Panel considered the volume of bycatch by the hoki fishery warranted its inclusion. For both the Chatham Rise and the sub-Antarctic trawl surveys, the abundance indices are flat. These are the main areas where this species is caught.

Although the time series show no trends, there is little information to indicate what the effect of the hoki fisheries is on pale ghost sharks or whether catches are sustainable. Confidence scores for pale ghost shark are therefore low.

3.3.4 Giant squid and other squid species

The impact of the hoki fisheries on the giant squid (*Architeuthis* sp.) was discussed by the Expert Panel but no score was decided on due to a lack of information. No giant squid are reported in the Observer data down to 0.01% of observed catch raw data given in Appendix 1 of Ballara et al. (2010).

Other species of squid are not caught in significant volumes and the Expert Panel agreed that it was not necessary to assess the other squid species.

3.4 Assessment of protected species

Table 7: Consequence scores for protected species

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
New Zealand fur seal	Consequence	Minor	Minor	Minor	Moderate
New Zealand fur seal	Confidence	Low (data exists but considered poor or conflicting)	High (consensus between experts)	Low (agreement between experts but with low confidence)	Low (data exists but considered poor or conflicting)

Species		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
New Zealand sea lion	Consequence	Negligible	Minor	Negligible	Negligible
New Zealand sea lion	Confidence	-	High (data exists and considered sound)	-	-
Basking Shark	Consequence	Moderate	Moderate	Moderate	Negligible
Basking Shark	Confidence	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)	-
Whales and dolphins	Consequence	Negligible	Negligible	Negligible	Negligible
Whales and dolphins	Confidence	-	-	-	-

3.4.1 Seabirds

The Expert Panel did not assess the risks of the hoki fishery to seabirds.

A Level 1 seabird ERA from fishing has been undertaken by Rowe (2010). It is recent and considered the impacts of all middle depth trawl fisheries together. A Level 2 seabird ERA (Richard et al. in press) has also been completed that the impacts to seabirds of New Zealand fisheries but the report is still a draft and the final report has not yet been released by the Ministry of Fisheries. Additional risk assessment work on seabirds has been published by Baird & Gilbert (2010).

The Expert Panel agreed it could add little to the risk assessments in these published and draft reports.

Table 21 in the Level 1 seabird ERA (Rowe 2010) reproduced in Appendix 8 of this report shows those bird species identified as potentially at risk from the middle-depth trawl finfish fisheries.

Both the Level 1 (Rowe 2010) and draft Level 2 (Richard et al. in press) seabird risk assessments do not assess the risks to seabirds from the hoki fishery on its own but combine the impact of the middle depth fisheries. This is likely to overestimate the risk to seabirds from the target hoki fisheries, but this is not inconsistent with the conservative approach required of a Level 1 risk assessment.

The results from the Level 2 draft seabird ecological risk assessment (Richard et al. in press) would be useful and the Expert Panel requested that this work to be finalised and released by the Ministry of Fisheries as soon as possible.

While there is good information on net captures of seabirds, the Panel also identified that there is a need to better quantify cryptic mortality (e.g. through warp strikes).

3.4.2 Expert panel rationale for scoring the New Zealand fur seal

The Expert Panel agreed that it was appropriate to assess New Zealand fur seal interactions with each of the four hoki fisheries individually, given the differing conditions in each fishery.

The research report prepared for DWG by Latitude 42 (Baker & Hamilton 2010) uses the potential biological removal (PBR) approach, which is considered appropriate to use as a guide to this assessment. The Expert Panel considered that the level of current captures in relation to the PBR approach would convert to the following consequence scores (using Appendix Table A3 of the ERA methodology):

- If the removals are below the PBR, then score = 1 (minor)
- If the removals are at the PBR, then score = 2 (moderate)
- If the removals are above the PBR, then score = 3 (major)

The Expert Panel also noted that a population estimate is required to calculate a PBR.

There are indications of an increasing New Zealand-wide population of the New Zealand fur seal but there are reports that there may be some local declines in numbers on the WCSI in particular.

3.4.3 Expert Panel rationale for fur seal assessment for the WCSI fishery

The fur seal population estimate on the WCSI is uncertain. There are two sets of information, neither of which has completed a peer review process.

A research report from Latitude 42 (Baker & Hamilton 2010) found that the estimated captures of New Zealand fur seals on the WCSI do not exceed the PBR. This report assumes all fishery captures are mortalities, which may overestimate the actual impact on the population, as some captures are released alive. A PBR that is not exceeded is consistent with a declining population provided that the cause of the decline is other than human related mortality.

Unpublished Department of Conservation New Zealand fur seal pup count estimates from three WCSI rookeries show annual variation with an overall declining trend in population size since 1991. These estimates and data collection methods have not been peer reviewed.

There is also some work in progress which may elucidate correlations between the apparent decline in WCSI pup counts and El-Niño Southern Oscillation.

The Expert Panel agreed that the first action required for the WCSI will be to consolidate and analyse all the information that is available. This area was therefore flagged as requiring further analysis, to fully understand the risk of the apparent interactions.

Given that the PBR is not exceeded, the Expert Panel assigned a consequence score of 1 (minor) for fur seal interactions in the WCSI hoki fishery. However, a confidence score of 1c was assigned given that the information used for the assessment has been provided by unpublished research reports.

3.4.4 Expert panel rationale for fur seal assessment in the Cook Strait fishery

There are no reliable fur seal population estimates for this area and a reverse PBR is not possible due to the relatively low observer coverage in Cook Strait.

This fishery has one of the highest fur seal capture rates per 100 tows of the four hoki fisheries, according to the estimation of fur seal bycatch to the 2008-09 fishing year. This, combined with the lack of information on New Zealand fur seals from this region, suggests a consequence score higher than the WCSI is appropriate.

There is no indication that captures are affecting recruitment of New Zealand fur seals in the Cook Strait area, therefore the Expert Panel considered that a consequence score of 2 (moderate) is appropriate.

Given that there is limited information available for this area, the Expert Panel assigned a low confidence score of 1a.

3.4.5 Rationale for fur seal assessment in the Chatham Rise fishery

New Zealand fur seal population estimates on the east coast South Island (ECSI) are limited to annual pup counts at 2 colonies, one of which appears to be stable, and the other appears to be increasing in size.

Anecdotal evidence suggests that the number of New Zealand fur seal colonies on the ECSI appear to be increasing.

The Expert Panel agreed that a consequence score of 1 (minor) was appropriate, but with low confidence given the lack of information.

3.4.6 Expert panel rationale for fur seal assessment in the Sub-Antarctic fishery

Population estimates are available from one fur seal colony on Solander Island, although this data has not been published.

Anecdotal evidence from Titi Island suggests an increasing population impacting on customary mutton-bird harvesting. There is thought to be a wide distribution of the New Zealand fur seal across this area and there are a large number of colonies. The capture rate of New Zealand fur seals

per 100 tows is relatively low for this fishery. The lack of published reports on New Zealand fur seals for this area was a concern, but the Expert Panel agreed it was less problematic given the low capture rates of fur seals reported from observer data.

The Expert Panel agreed to score this fishery as having a low impact on New Zealand fur seals, with high confidence given the low capture rate.

3.4.7 Expert panel rationale for the New Zealand sea lion assessment

The only interaction between the hoki fishery and the New Zealand sea lion occurs in the Sub-Antarctic, therefore the Expert Panel assigned as consequence score of 0 to the Chatham Rise, WCSI and Cook Strait fisheries.

The "critically endangered" status of the New Zealand sea lion population is a consideration. The New Zealand sea lion is classified as Vulnerable (VU) by the IUCN Red List 2007 and listed as a threatened species under New Zealand's Marine Mammals Protection Act.

There have been low numbers of sea lion captures by the hoki fishery – the annual estimate of total captures from the Sub-Antarctic hoki fishery has varied between 0 and 5 animals every year in the last 10 years. The Expert Panel therefore scored the consequence to sea lions from the Sub-Antarctic hoki fishery as 1 (minor).

Assigning a consequence score of 2 would imply that the impact to the NZ seal lion from the Sub-Antarctic hoki fishery is at the maximum possible level. While we know that the total impact from all New Zealand fisheries may be near this maximum allowable level, almost all of the impact is the result of fisheries for other species, especially the trawl fishery for squid. The impact from the hoki fishery is minor as it captures very few New Zealand sea lions.

The Expert Panel was therefore confident (2a) that the impact to the New Zealand sea lion as a result of the Sub-Antarctic target hoki fishery is minor.

3.4.8 Expert panel rationale for assessment of whales and dolphins

There have been no captures of whales or dolphins reported through the Conservation Services Observer Programme.

These species were not considered to be impacted by the hoki fishery by the Expert Panel and were therefore given a consequence score of 0 (negligible).

3.4.9 Expert panel rationale for scoring basking sharks

This species is highly vulnerable to exploitation, given its extremely low productivity and fecundity. It is classified as Vulnerable (VU) on the IUCN Red List and listed on Appendix II of CITES and Appendices I and II of the Bonn Convention on Migratory Species (CMS).

Stock structure is uncertain, with evidence suggesting one global population, or at least a southern hemisphere population (which is centred on New Zealand) with a low level of mixing between hemispheres

Anecdotal evidence suggests captures and sightings of basking sharks around New Zealand have become less frequent in recent years. Hectors dolphin aerial surveys, flown annually around Banks Peninsula from 1990 to 1997 sighted schools of up to 100 basking sharks. The same aerial transects were re-flown in January and February 2010 and no basking sharks were sighted.

Francis & Smith, (2010) found that a total of 50 observed captures have occurred in the hoki fishery since 1994-95. Table 2 in Francis & Smith (2010) shows that the hoki fishery contributed 50 of the total 99 observed captures over the study period. Table 2 in Francis & Smith (2010) also shows that more than 40% of observed basking shark captures from the target hoki fisheries occurred in 1997-98 and 1998-99 when it was suggested that some targeting of basking shark may have occurred. If targeting did occur in the past, it would overestimate the present contribution of the hoki fishery to total basking shark captures.

The Expert Panel commented that very high water temperatures were recorded during 1997-98, and questioned whether this may have impacted basking sharks distribution and vulnerability to the fishery over this period. The Expert Panel requested further information be obtained on the spatial pattern of the captures, the influence of sea temperature on captures, and whether the risks to basking sharks during the late 1990's have been ameliorated in any way by changing hoki fishing practices, or the nationality of the boats in the current fleet.

Future monitoring of basking shark capture by the target hoki fisheries was recommended.

The Expert Panel discussed assigning a consequence score of 2 to basking sharks in order to maintain attention on the bycatch issue given the high rate of captures in the past. The Expert Panel discussed whether assigning such a score to the hoki fishery inferred an unacceptable level of total risk to basking sharks from all New Zealand trawl fisheries. Some panel members considered that such a consequence score of the risks to basking sharks from the effects of all New Zealand fishery impacts could well be appropriate given the low resilience of this species.

Agreement was reached on a assigning a consequence score of 2 (moderate) for the interactions of basking sharks with all hoki fishery areas except Cook Strait, where no catches of basking shark have been reported.

A confidence score of 1a was appropriate, given there were several areas the Expert Panel requested further information was needed.

3.4.10 Expert panel rationale for assessment of whales and dolphins

There have been no captures of whales or dolphins reported through the Conservation Services Observer Programme. These species were not considered to be impacted by the hoki fishery and the Expert Panel assessed a consequence score of 0 (neglible).

3.4.11 Protected corals

The Expert Panel considered that there is limited information the spatial extent of coral distribution in the NZ EEZ that is available for an assessment. Coral distribution could well extend well beyond the depth range of the hoki fishery, but there is no information to support this.

Corals do not appear in the total estimated observer recorded catch weights of bycatch species from 1 Oct 2000 to 30 Sept 2007 reported in Appendix 1 of Ballara et al. (2010) which gives the raw Observer bycatch data down to 0.01% of the total observed catch from all Observer records over 7 years. Protected corals are listed in Appendix 9. While Observer information gives an indication of the presence or absence of protected corals it does not indicate the extent of their distribution.

In order to fully assess the impacts of the target hoki fisheries on protected species, it is necessary to have an estimate of the population size and distribution of corals. The observer data is not sufficient to make this assessment.

The Expert Panel determined that the fisheries targeting mid water spawning aggregations of hoki will have lesser impact on corals than fisheries targeting hoki near the bottom, and therefore the Cook Strait and WCSI fisheries are likely to have a lesser impact on corals than the Sub-Antarctic and Chatham Rise hoki fisheries.

The Expert Panel noted that the Ocean Survey 20/20 Chatham-Hydrographic, Biodiversity and Seabed Habitats Project (OS 20/20 Project) may provide further information in terms of coral spatial distribution. However, the sampling from this survey may not be intensive enough to establish a fine scale distribution of corals due to the patchiness of corals. There may be some data that can be modelled, but physical conditions that these corals rely on are not yet well understood, so it was suggested that any modelling is likely to be fairly uncertain.

The Expert Panel agreed that an appropriate way forward for the future would be to explore the results of the OS 20/20 Project and the information it can provide.

The Expert Panel used the BOMEC to identify risks to all benthic fauna, in full knowledge of its potential limitations. However the BOMEC is not necessarily a robust indicator of the distribution of any particular class of benthic invertebrates.

With this in mind, the Expert Panel agreed that the benthic risk assessment scores would therefore include its assessment of impacts to protected coral species, but noted that further information is required on protected corals before a specific risk assessment on protected corals can be made. The Expert Panel queried whether it may be possible to collate existing information in order to assess any relationship between BOMEC classes and the distribution of protected corals.

3.4.12 Other protected species

The Expert Panel discussed whether any species had not been addressed during this assessment, which were potentially impacted by the hoki fishery

The following protected species were discussed by the Expert Panel and the decision was taken that the impact of the target hoki fishery to these species was negligible in all of the four areas (a consequence score of 0):

- Deepwater nurse shark or small tooth sand tiger shark (*Odontaspis ferox*)
- White pointer shark (*Carcharodon carcharias*)
- Whale shark (*Rhincodon typus*)
- Manta ray (*Manta birostris*)
- Spinetail devil ray (*Mobula japanica*)
- Giant grouper (*Epinephelus lanceolatus*)
- Spotted black grouper (*Epinephelus daemelii*)
- Marine turtles
- Other marine reptiles (e.g., marine snakes)

3.5 Assessment of the benthic impacts of the hoki fisheries

3.5.1 Expert Panel initial discussion

The Expert Panel first reviewed the available information which could be used to inform this assessment. This included the Marine Environmental Classification (MEC) (Snelder et al. 2005) and the Benthic-Optimised Marine Environment Classification (BOMEC) (Leathwick et al. 2009). BOMEC is the biologically optimized marine environment classification. Distributional data for eight taxonomic groups[1] and a variety of environmental variables[2] were transformed using Generalised Dissimilarity Modeling to develop groups of cells based on their environmental similarities. Fifteen levels of classification were used as appropriate for a whole-of-EEZ scale.

Protected coral species and other attached benthic fauna were also discussed during this session, along with non-attached benthic fauna. The Expert Panel agreed that the term benthic impacts included effects of the hoki fisheries on the physical habitat, the biogenic habitat, and non-habitat forming species closely associated with or attached to the seabed (excluding most fishes and cephalopods).

[1] Asteriods, bryozoans, benthic foraminiferans, octocorals, polychaetes, matrix-forming scleractinian corals, sponges and benthic fish

[2] Including depth, temperature, salinity, sea surface temperature gradient, surface water productivity, suspended sediment, tidal currents, and seafloor sediments and slope(

The Expert Panel first clarified the aim of the session was to better classify the risk to the benthic marine environment within the NZ EEZ from hoki fishing. Hoki fishing uses bottom trawls that contact the seabed, and mid water trawls that may occasionally make contact the seabed.

The Expert Panel notes that the New Zealand EEZ is not homogenous, and that different areas will be more vulnerable to impact than others. Having the different benthic habitats defined in relation to their physical and biological characteristics is a good place to start this assessment.

3.5.2 Expert Panel discussion of the hoki trawl footprint (hoki fishing grounds)

This information is available (Black & Wood 2010, Wood 2010) and has been analysed both in terms of the hoki footprint and the footprint of the fisheries for all Tier 1 deepwater and middle-depth species. The nine Tier 1 deepwater and middle depth species are hake, ling, hoki, southern blue whiting, oreo, jack mackerel, orange roughy, squid and scampi.

In the analysis undertaken to plot the seabed area impacted by trawling the following methods were adopted:

- The distance between trawl doors was used, which may overestimate the seabed area that is impacted by the trawl gear.
- Trawl tows were assumed to be straight lines between start/end points which is not always true and will therefore underestimate the size of the area that is impacted.
- All bottom trawls were included, along with all mid-water trawls which occurred within 50m of the seabed. This will overestimate the seabed area impacted.

These assumptions mean that the method used to calculate the trawl footprint is likely to overestimate the area directly impacted by contact from the trawl gear. However, as the trawl footprint analyses do not consider the indirect impacts of trawling on the seabed, such as sediment disturbance and drift, the trawl footprint analysis may underestimate the total area that is affected, although indirect impacts are difficult to quantify.

The methodology used to calculate impacted area may therefore lead to under or over estimates of the overall seabed area impacted. Some experts at the workshop considered it likely that the measure of area directly impacted is more likely to be overestimated than underestimated.

The difference between the 20 year footprint, and the 1 year footprint was noted by the Expert Panel which shows that the 1 year hoki footprint is much smaller. The difference between the two is principally due to a reduction in the areas fished as the hoki fishery has progressed from its initial expansion and development phase to the present state of a mature fishery with highly targeted effort.

The current hoki fishery is based on efficiency. Vessels now operate only where they know hoki are likely to present in commercial quantities. Current annual harvests are half of the peak quantities taken in the early phase of the fishery. The number of full time hoki fishing vessels (vessels fishing hoki year round) has dropped from 12 or 13 vessels to 6 at present. A similar reduction in scale has

occurred in the numbers of deepwater vessels fishing hoki seasonally. All current target hoki fishing effort occurs well within the boundaries of the 20 year hoki footprint. A number of areas that are within the 20 year hoki footprint are no longer fished.

Trawling occurs on a range of different habitats, and these habitats may also be represented in areas that have not been trawled – the proportion of un-trawled areas in each BOMEC class is therefore an important metric for this assessment. Knowledge of the amount of trawlable benthic habitat in untrawled areas would also be a useful metric but is not known.

The majority of hoki tows take place on the continental slope, between 450 and 750 metres. Hoki also school by size at different depths. Hoki of different sizes have different market values and vessels may preferentially target specific sizes of hoki that are found at different depths.

The GNS analysis of the hoki footprint data and BOMEC classes (Wood, 2010) shows that some hoki trawling has occurred in all 15 BOMEC classes in the past 20 years. The majority of hoki trawling has taken place in a few BOMEC classes.

The maps showing the hoki footprint overlaid on the BOMEC classes do not show the difference between areas that have been trawled once or multiple times.

3.5.3 Expert Panel discussion of the BOMEC

The Expert Panel then discussed several limitations to the BOMEC that may restrict its usefulness as a tool to assess impact on the benthic environment:

- BOMEC has been optimised on a number of species and groups (Leathwick et al 2009) as benthic communities have not been fully mapped throughout the EEZ.
- BOMEC has the highest explanatory power for benthic fish and foraminifera with more than 40% of the deviance explained.
- The BOMEC does not partition areas using sediment classification but used sediment particle size information derived from sediment charts in the classification process.
- Analysis of benthic communities in relation to BOMEC as part of the OS 20/20 Project is currently underway. Once complete, this work is likely to be relevant to the risk assessment and should be evaluated.
- The trawl footprint shown in Cook Strait north of the prohibited fishing zone around the Cook Strait power cable does not correspond to the Expert Panel's knowledge of trawling in the areas there may be some issues with the data in this area.

Overall, there were conflicting views on how well the classification represents benthic communities in the EEZ, but the Expert Panel agreed that the BOMEC is the best benthic classification currently available for the hoki ERA. There is limited information on benthic communities in the EEZ which requires working at the indicator species level or relatively coarse taxonomic grouping which the BOMEC does.

Given the possible limitations of BOMEC, the Expert Panel indicated it would use information from other sources to supplement the BOMEC. It was suggested that benthic bycatch from the fishery is useful as the fishery operates on a wider scale than much of the benthic research sampling undertaken within the NZ EEZ to date.

The Expert Panel agreed that that although there are data limitations this should not prevent making an assessment based on the information that is available.

While the BOMEC may not explain the distribution of benthic invertebrates other than foraminifera very well, the Expert Panel considered it unlikely that species like corals which require hard substrate would be present in the areas where hoki fishing effort is at highest intensities as these areas tend to be comprised of mud or other soft sediment. Invertebrates such as asteroids, polychaetes, and sponges do not need a hard substrate and are likely to be present in soft sediments along with infaunal benthic organisms.

The Expert Panel agreed that exposure could be measured in terms of the proportion of each BOMEC class that had been swept by bottom trawl. The consequence would be the impact on that habitat once it had been trawled. A single consequence score would integrate exposure, potential vulnerability to bottom trawling and ability to recover.

The Expert Panel discussed using observer data on benthic bycatch to provide more information on the distribution of benthic fauna, but the Expert Panel was not in full agreement whether this data was useful. Benthic species may have already been largely removed from areas that had been previously trawled and observers had limited training in the identification of benthic species.

The Expert Panel also noted that expert judgement could be used to assess any suspected differences that may exist in the benthic communities within a particular BOMEC class in the different hoki fishery areas. For example, there may be differences between the Chatham Rise and the Sub-Antarctic in BOMEC Class 7.

The Expert Panel also requested further work to show separately the breakdown of the proportion of each BOMEC class covered by the hoki footprint, by each of the four hoki fishery areas. DWG indicated that this information will be obtained and made available to the Expert Panel to confirm their assessment.

The percentage of each BOMEC class that had not been trawled by the target hoki fisheries from 1989-90 to 2008-09 was available from Wood (2010). The Expert Panel chose the 20 year hoki trawl footprint in order to be precautionary and to account for the unknown level of recovery within areas included in the 20 year footprint but not impacted in more recent years. It noted that the percentage not trawled in each BOMEC Class in the 2008-09 fishing year (Wood 2010) was significantly greater.

Table 8: Percentage of each BOMEC Class not trawled by the target hoki fisheries over 20 years (from Wood, 2010)

BOMEC class	Area not trawled (20 year hoki footprint)
1, 2, 3, 4, 5, 6, 11, 13, 14 and 15	< 95%
5	92.34%
7	68.66%
8	72.66%
9	33.99%
10	88.66%
12	82.94%

3.5.4 Assessment of the benthic impact of the hoki fishery

Table 9: Consequence scores for benthic impacts

B OMEC Class		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
BOMEC Classes 1, 2, 3, 4, 5, 6, 11, 13, 14 and 15	Consequence	Negligible	Negligible	Negligible	Negligible
	Confidence	-	-	-	-
BOMEC Class 5	Consequence	Minor	Minor	Negligible	Negligible
	Confidence	High (data exists and considered sound)	High (data exists and considered sound)	-	-

B OMEC Class		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
BOMEC Class 7	Consequence	Negligible	Negligible	Minor	Moderate
	Confidence	-	-	Low (data exists but considered poor or conflicting)	Low (data exists but considered poor or conflicting)
BOMEC Class 8	Consequence	Moderate	Moderate	Moderate	Moderate
	Confidence	High (data exists and considered sound)	High (data exists and considered sound)	High (data exists and considered sound)	Low (data exists but considered poor or conflicting)
BOMEC Class 9	Consequence	Major	Moderate (to be confirmed)	Negligible	Negligible
	Confidence	Agreement between experts, but with low confidence	Agreement between experts, but with low confidence	-	-
BOMEC Class 10	Consequence	Minor	Minor	Minor	Minor
	Confidence	High (data exists and considered sound)	High (data exists and considered sound)	High (data exists and considered sound)	High (data exists and considered sound)
BOMEC Class 12	Consequence	Negligible	Minor	Negligible	Negligible
	Confidence	-	High (data exists and considered sound)	-	-

3.5.5 Expert panel rationale for scoring BOMEC Classes 1, 2, 3, 4, 5, 6, 11, 13, 14 and 15

BOMEC classes 1, 2, 3, 4, 5, 6, 11, 13, 14 and 15 were assigned a consequence score of 0 (negligible impact) as less than 5% of their area was within the 20 year hoki footprint.

3.5.6 Expert panel rationale for scoring BOMEC Classes 5, 10 and 12

BOMEC classes 5, 10 and 12 had the smallest proportions of their area within the trawl footprint (Table 7).

The Expert Panel assessed the consequences as minor in these three BOMEC classes as between 83% and 92% of these BOMEC classes have not been trawled by the target hoki fishery in the past 20 years.

The Expert Panel agreed that the BOMEC and footprint information used in this assessment provide sufficient information to warrant a high confidence score for these three BOMEC classes.

There was slight disagreement over assigning a 2a confidence score for BOMEC Class 10 in Cook Strait, given that this area has a more complex bathymetry. However, the Expert Panel noted that this BOMEC class occurs in many other areas around the New Zealand coast and for this reason it was agreed that the bathymetric complexity of Cook Strait was not particularly important for assessing this BOMEC class.

3.5.7 Expert panel rationale for scoring BOMEC Class 7

BOMEC Class 7 has the second largest proportion of its area included in the 20 year hoki trawl footprint

It appeared that most of the 32% of BOMEC Class 7 that has been fished in the 20 year footprint occurred in Cook Strait. There is also a small overlap between the hoki trawl footprint and BOMEC Class 7 on the WCSI.

The Chatham Rise and Sub-Antarctic fisheries were assigned a consequence score of 0. The impact was considered minor on the WCSI, and moderate in Cook Strait as the majority of the impact of the target hoki fisheries to BOMEC Class 7 occurs in Cook Strait.

Cook Strait was not assigned a higher consequence score as the Expert Panel took into account the areas which are closed to fishing. The cable-protection zone and the hoki management area prevent the footprint from extending further north.

It would be informative to get information on what percentage of BOMEC Class 7 in Cook Strait is closed to fishing or has not been fished. It was suggested that further information on the benthic community in Cook Strait may be able to be sourced from those who monitor the cable protection zone.

There was general agreement that BOMEC Class 7 in Cook Strait should be assigned a consequence score of 2, but with higher uncertainty – 1a.

3.5.8 Expert panel rationale for scoring BOMEC Class 8

This BOMEC class has the third largest proportion of its area included in the hoki trawl footprint

The Expert Panel agreed that a moderate consequence score was appropriate as a significant proportion of the BOMEC class had been impacted across all four hoki fisheries.

The information available allowed a high confidence score for all areas bar Cook Strait, which was assigned a lower confidence score given the hydrodynamic and bathymetric complexity of this area.

3.5.9 Expert panel rationale for scoring BOMEC Class 9

BOMEC Class 9 has the highest proportion of its area within the 20 year hoki trawl footprint. The majority of the area of benthic habitat in this BOMEC class has been impacted by the 20 year hoki trawl footprint.

For all Tier 1 deepwater and middle depth species, 28.31% of BOMEC Class 9 has not been bottom trawled in the past twenty years, compared to 33.99% that has not been trawled by the target hoki fisheries.

BOMEC Class 9 does not occur in Cook Strait or on the WCSI, so these areas were assigned a zero score.

Given the significant impact to this class on the Chatham Rise over the past twenty years, the Expert Panel assessed a consequence score of 3 (major). In the Sub-Antarctic, a smaller proportion of the BOMEC class appeared to be impacted, but the Expert Panel disagreed whether the difference in the area impacted was enough to reduce the score in the Sub-Antarctic to moderate.

The large scale of the BOMEC/footprint maps used in the assessment made it difficult for the Expert Panel to assess the actual area impacted in the Sub-Antarctic. On the basis of the maps, the Expert Panel suspected that there was a different proportion of BOMEC Class 9 within the hoki footprint between the Chatham Rise and the Sub-Antarctic areas.

The Expert Panel requests the following information in order to better evaluate the impacts to BOMEC Class 9.

- Spatial impact of the footprint on BOMEC Class 9 separately for each of the four hoki fisheries.
- Information that may be available on differences, if any, between the benthic environments in this BOMEC class between the Chatham Rise and the Sub-Antarctic?
- What benthic assemblages are found in BOMEC Class 9?

It was suggested that the OS 20/20 Project data could contribute useful information to ground-truth the BOMEC classes.

Given that the Expert Panel is requesting further information on BOMEC Class 9, in both the Chatham Rise and the Sub-Antarctic, a low confidence score of 1c was assigned.

With further information, the Sub-Antarctic score can be re-assessed by the Expert Panel.

3.5.10 Expert Panel suggestions for future work on benthic impacts

The BOMEC is the first lens with which to assess impacts of the hoki fishery on benthic habitats. Specific areas requiring future investigation are BOMEC Class 9 and Cook Strait

The Expert Panel suggested that any consequence scores of 2 (moderate) or higher should be identified as areas for future research to ground-truth the particular benthic habitats and species within the affected BOMEC class.

The Expert Panel agreed that that the benthic assessments it has made based on BOMEC are not a fine-scale risk assessment. For example BOMEC does not identify differences in benthic environments that may exist within a particular BOMEC class.

More needs to be known about what benthic assemblages occur in BOMEC Class 9, and the impacts of trawling on these assemblages. The BOMEC classification does not provide information on the vulnerability of the different benthic environments.

3.6 Assessment of the impact of the hoki fishery on the ecosystem/trophic interactions

3.6.1 Discussion of ecosystem/trophic impacts on the New Zealand fur seal

Laura Boren summarised existing information on the diet of New Zealand fur seals. Most studies into the diet of New Zealand fur seals have focussed around Otago and Southland and date from the 1950s and 1960s. There have also been studies on the WCSI, Banks Peninsula and at Ohau Point in Kaikoura (in the 1990s). A recent study took place at Tonga Island in Tasman Bay, and provides the first information on their diets in a shallow water environment. We know that New Zealand fur seals are opportunistic feeders, and that their diet varies a lot, depending on the area, time of year, and sex (males dive deeper and are not tied to rookeries as females are). Around Southland there are a variety of fish in the diet. Lantern fish is the dominant prey item where deepwater is nearby, and squid occurs seasonally. Some hoki otoliths have been recovered from scat samples.

All studies to date have used traditional methods such as scat, regurgitate, and stomach content analysis. New methods, such as fatty acid signature analysis, have been used overseas, and for the New Zealand sea lion, and one current study is utilising these methods.

DNA from scat samples could also help provide further information on diet, and DOC is currently exploring different methods of analysis, and tagging studies to elucidate foraging ranges etc.

The Expert Panel agreed that each of the hoki fisheries should be assessed separately, given the regional differences in diet.

An appropriate assumption would be that New Zealand fur seals are not relying on hoki, but feed opportunistically around vessels and nets. Therefore, the level of interaction will vary by location.

In terms of the impact of the removal of hoki on the New Zealand fur seal – the Expert Panel considered it more likely that the indirect impact was more important rather than a direct impact

The estimated fur seal diet is around 5.6kg per day – and this has been averaged across sexes, various ages and sizes, over the course of a year.

There is very little information on the level of opportunistic feeding from hoki fishing gear, but, based on knowledge of behaviour, this would be isolated to certain regions, and more likely to occur with bigger males.

Industry members suggested that as soon as winching starts to haul gear, they appear around the vessel, suggesting a learned response. In Australia there is evidence of male seals travelling long distances to reach vessels operating in hoki spawning grounds. Hoki do not appear to form part of the normal diet of New Zealand fur seals.

The Expert Panel concluded that the risk to New Zealand fur seals on WCSI and Cook Strait due to the reduction in hoki biomass as a result of the spawning fisheries having an effect on the availability of hoki for consumption by seals is minimal.

3.6.2 Expert Panel discussion of ecosystem/trophic impacts of the four target hoki fisheries

This session commenced with a presentation by Matt Pinkerton of the current state of knowledge of the ecosystems in each of the four hoki fishery areas. This presentation (2010 hoki ERA CD attachment) outlined how scientific knowledge into how marine systems function is limited and consequently so is our ability to predict how the ecosystem will change as a result of fisheries impacts.

It is clear that fishing can affect some components of ecosystems but determining what effects are acceptable is difficult. Fishing can change variability within the different components of the ecosystem, potentially reducing its resilience.

Modeling tools to predict what might happen in the future are not available. Rather than trying to predict impacts the present approach is to monitor change using a suite of indicator species.

In New Zealand, the Chatham Rise has been more comprehensively studied and work has been done to identify indicator species. Given the increased knowledge base, this area was assessed first.

The Expert Panel also noted that hoki are more fully incorporated into the food webs on the Chatham Rise and Sub-Antarctic than in the spawning fishery areas where hoki are present for short periods each year.

3.6.3 Assessment of ecosystem/trophic impacts

Table 10: Consequence scores for ecosystem/trophic impacts

Ecosystem		Chatham Rise	Sub-Antarctic	WCSI	Cook Strait
Ecosystem/trophic impacts	Consequence	Major or moderate	Major or moderate	Minor	Minor
	Confidence	Low (disagreement between experts)	Low (disagreement between experts)	Low (no data exists)	Low (no data exists)

3.6.4 Expert panel rationale for scoring ecosystem impacts of the Chatham Rise hoki fishery

Matt Pinkerton provided a detailed outline of the current state of knowledge of the Chatham Rise ecosystem.

- An ecosystem model is available for Chatham Rise, and stomach contents data from Chatham Rise trawl surveys has been analysed.
- The stomach contents work confirmed that the main prey items of hoki are myctophids and euphausids. Using stomach contents analysis, hoki were assessed to be of 70% importance as a prey of school sharks sampled on the Chatham Rise. Hoki comprise a small proportion of the stomach contents of ling and hake.
- The ecological importance of a species can be determined by understanding its potential effects on different species of prey and predators within a food web. Biota that have high biomass have higher ecological importance (generally) and hoki therefore comes out as the most ecologically important fish on the Chatham Rise. Myctophids and euphausids (the main prey items of hoki) are also really important in the ecosystem.
- In terms of keystone species, hoki comes out 1st among the fish species present. So, it's definitely of particular importance within the fish community on the Chatham Rise. This increases the importance of the impacts on hoki in terms of trophic interactions.

The Expert Panel noted that it would be interesting to see the diet information and relative importance of the different size classes of hoki. The work that Matt Pinkerton has done could be used for this work in the future.

Matt Pinkerton provided the following additional information:

- Major changes in the Chatham Rise have occurred in terms of the biomass of ecologically important species, but there is no evidence of loss of species composition, community constituents or changes in ecosystem function.

- Research has shown that the mean trophic level (MTL) of both the trawl survey and commercial catch is declining, and the decline is faster in the trawl survey data. Fishing appears to be affecting the higher trophic levels.
- Some properties of the Chatham Rise ecosystem have definitely changed, and determining how this change is likely to continue is important. The decline in MTL is continuing, which could be a cause for concern.
- Although there is no evidence of species disappearing from the time series, because the decline in MTL is ongoing it is unclear if or when the ecosystem will reach a new, steady state or continue to a state which is unsuitable for some species.
- It is unclear at this point whether these observed changes are predominantly the result of the hoki fishery on the Chatham Rise. There is no way of separating out the effects of each of the main fisheries. However, hoki is the most ecologically important fish species on the Chatham Rise, and therefore any changes in hoki abundance are likely to be important.
- A study of hoki diet concluded that it appears that the importance of myctophids to hoki has increased and euphausids had declined, but the importance of hoki to the hake and ling diets haven't changed.

The Expert Panel then discussed whether there were any further external influences that could be important, or driving the observed changes and made the following observations.

There is no substantial trend in primary production due to the effects of global warming within the NZ EEZ as a whole. There is evidence of warming of the ocean over the Chatham Rise, but this seems to be less than has been observed in the Tasman Sea. It seems unlikely that observed changes in the fish community of the Chatham Rise are a result of warming on the Chatham Rise.

The El Nino Southern Oscillation was also considered unlikely to have caused the changes in the Chatham Rise fish community, but the effect of climate and oceanographic changes on New Zealand fish stocks is poorly understood at present.

The Expert Panel agreed that there is high confidence of major change in the Chatham Rise fish community having occurred since fishing for hoki began but the Expert Panel was not very confident about the ecological significance of the change or whether the change will have an impact on the ecosystem in the future. The Expert Panel could not reach a consensus on whether the consequence score should be 2 (moderate) or 3 (major).

Some recent work suggests that MTL based on commercial catch alone is not as useful an indicator as once thought (Branch et al. 2010). However, the MTL decline is observed in both the trawl survey and commercial catch data, which is strong evidence for an actual decline and is still considered useful (Branch et al. 2010).

In terms of consequences scoring, the Expert Panel discussed at least assigning a moderate impact (2). The aim of fishing is to remove hoki biomass from the ecosystem. The management target for hoki is 35-50%B_0, which requires a measurable decline in abundance. However, the Expert Panel

disagreed over whether the criteria to support a consequence score of 3 (major) to the ecosystem were being met.

Some changes to the ecosystem (a reduction in MTL and the fact that there is ongoing change in other ecosystem properties) have been identified, but it is not clear what this means in terms of risk to the ecosystem. It was agreed that there is a need to further investigate the effects of the removal of hoki in order to assess the changes in terms of ecosystem function and structure, and the ecosystem effects of the removal of significant volumes of a keystone species (hoki).

Matt Pinkerton expressed the view that if all of the abundance indices of species on the Chatham Rise were flat, with no observed significant change, or, if there were contradictory signals from the different indicators, then a score of 2 would be suitable, but as there is ongoing change, scoring 3 is more appropriate.

The Expert Panel heard that the information to support a semi-quantitative level 2 assessment using the method of Hobday et al. (2007) for this ecosystem was approximately a year or two away. The Chatham Rise trophic model is still in development.

It was clear to the Expert Panel that a better understanding of the impact and consequences of removing large proportions of an ecologically important species is necessary. It was noted that it was important to distinguish between change and risk. Change is a consequence of fishing and is not necessarily a bad thing. Change does not mean that ecosystem functioning or structure is at risk.

The Expert Panel agreed that, whether a score of 2 or 3 was assigned, further work is necessary to determine the importance of these changes.

In the end, while the trophic modeling expert strongly supported a consequence score of 3 (major) for the trophic impacts of the hoki fishery on Chatham ecosystem, other members of the Expert Panel supported a consequence score of 2 (moderate). The Expert Panel did not reach consensus.

3.6.5 Expert panel rationale for scoring ecosystem impacts of the Sub-Antarctic hoki fishery

There is no ecosystem model available for the Sub-Antarctic, but there is a model of the Southern Plateau. It is unlikely this model would be useful as it is not focused on the area where the hoki fishery occurs in the Sub-Antarctic area and does not separate fish by species.

The Sub-Antarctic trawl survey has been used to develop indicators for this ecosystem, and, as for the Chatham Rise ecosystem, there is evidence of ongoing change, including a decline in mean trophic level.

As for the Chatham Rise, there are concerns regarding scoring the indicators in sub-areas, given that the boundaries of ecosystems are uncertain.

The diet of hoki is pretty similar everywhere, the other fish species that occur in each region are largely similar. Productivity is slightly different, but is still in the same range.

The recent fishing effort (described in the trawl footprint) seems to occur within the same environmental class in the Chatham Rise and Sub-Antarctic fishery areas.

Therefore, all these commonalities point towards the need to keep the scores the same for both non-spawning fisheries.

3.6.6 Expert panel rationale for scoring ecosystem impacts of the WCSI and Cook Strait fisheries

The Expert Panel determined that the likely change to the ecosystem as a result of changes in the spawning fisheries is likely to be minor and assigned a consequence score of 1 for the WCSI and Cook Strait fisheries.

Fewer adult hoki spawning in these areas would mean fewer hoki available for predation. However, as hoki are only present in these areas for a small amount of time through the year, the ecosystem effects are likely to be minor. Adult hoki don't feed much during spawning, so again the effect of reduced consumption is probably small, probably in the order of 20-40 t over the period that hoki are present on the spawning grounds

The effect of fewer eggs and larvae on those grounds as a result of a lower (fishing induced) biomass may be more important – assuming each fish is producing the same number of eggs. Larvae will eat less food, but this is likely to be a very minor change in terms of the ecosystem. The most important consideration for risk assessment of the hoki spawning fisheries is the fact that the eggs the spawning hoki produce will be an important food source for other organisms. Because of fewer spawning hoki, there will be less larvae and eggs available for other species to eat. Spiny dogfish eat hoki eggs when hoki are spawning. It is difficult to tell whether this food source for spiny dogfish is significant. Spiny dogfish are found throughout all four of the hoki fishery areas in relatively high abundance, suggesting that the effect of the reduction in the production of hoki eggs due to the hoki fishery is minor. There may be a risk of spiny dogfish consumption of hoki eggs limiting hoki recruitment by reducing the number of hoki eggs maturing into larvae but there is no data to support this.

Finally, the Expert Panel discussed the significance of the amount of offal being put back into the ecosystem.

The tonnage of offal discarded can be calculated, but it is uncertain whether the volume of offal will have any effect on the ecosystem or the benthic environment. One potential effect could be an increase in the abundance of scavengers. Although patterns of discarding offal could be analysed the Expert Panel concluded that the release of offal would have a negligible effect on ecosystems and therefore would not influence the ecosystem consequence scores.

3.6.7 Evolutionary impacts of the hoki fishery

By targeting a component of the population (larger, faster growing fish), it is not clear whether the any observed changes are behavioural or genetic. If the changes make the hoki less fit for their environment then the changes will be important, if over time the stock as a whole becomes less suited to its environment.

It is unclear whether any work has been done to assess the occurrence of such changes. The Expert Panel determined that it could not assess the risk of evolutionary change, as it was considered there was a lack of expertise present for such an assessment.

4 Discussion

4.1 Overall results

The aim of the 2010 hoki ERA was to provide a broad assessment of all of the main ecological components potentially impacted by the four target hoki fisheries to update the 2002 hoki ERA. This was achieved. The results summarised in Table 11 below indicate that the consequences to ecological components impacted by the four target hoki fisheries are mainly negligible to moderate.

Table 11 Summary of risk assessment scores by hoki fishery area with associated numbers of High or Low confidence scores in brackets below.

Consequence	Chatham Rise	Sub-Antarctic	WCSI	Cook Strait	All areas
Negligible	6	4	8	15	33
Minor	8 (5 High, 3 Low)	10 (9 High, 1 Low)	10 (2 High,8 Low)	5 (2 High, 3 Low)	33 (18 High, 15 Low)
Moderate	9 (6 High, 3 Low)	10 (4 High, 6 Low)	7 (2 High, 5 Low)	5 (1 High, 4 Low)	31 (13 High, 18 Low)
Major or moderate[3]	1 (Low)	1 (Low)	0	0	2 (2 Low)
Major	1 (Low)	0	0	0	1 (Low)
Severe	0	0	0	0	0
Catastrophic	0	0	0	0	0

[3] Disagreement between experts

The Expert Panel's confidence in the risk assessments reflected the information available; with slightly less than half of the assessments being given a high confidence, usually because of sound data; with the remainder being given a low confidence, usually because of poor or conflicting data. Where a consequence score of 2 (moderate consequence) has been assessed and confidence in the assessment is low, it is a signal to managers that more or better data are required. Overall, Chatham Rise and Sub-Antarctic fishery assessments received more high confidence scores. This is a reflection of the better information available from the series of research trawl surveys undertaken in those areas. The Expert Panel did not score the level of confidence where it determined there were negligible consequences but it is reasonable treat the confidence in these scores as being high.

The Expert Panel's decision not to score likelihood separately from consequence is a significant modification of the Fletcher (2005) risk assessment approach. A result of this change is that the Fletcher (2005) approach which combined likelihood and consequence to determine risk categories is not possible. However, Fletcher's risk categories and hierarchy of likely management responses are still relevant, with moderate and higher consequence scores indicating a management response is indicated. This response will range from a need to actively monitor (moderate) to the development of specific management measures (major or higher consequence).

As recorded earlier, the Expert Panel noted that the boundary between what was generally considered an acceptable and an unacceptable consequence level risk lay between a score of 2 (moderate) and 3 (major). In practical terms, where there are moderate (or lower) consequences, ongoing monitoring may be required, whereas major (or higher) consequences will require specific management responses. As a precautionary approach has been adopted, it is possible that further work that will follow the 2010 hoki ERA may determine that some of the risks are lower that have been assessed. It may also confirm them.

No ecological components were identified as having risks of severe or catastrophic consequences. One ecological component was identified as having risks of major consequences (BOMEC Class 9 in the Chatham Rise area).

The Expert Panel could not reach consensus on ecosystem/tropic impacts in the Chatham Rise and Sub-Antarctic areas, with some Panel members scoring the consequences as major, and some as moderate. A precautionary approach is adopted in a Level 1 risk assessment and managers will need to take this uncertainty and lack of consensus on trophic consequences into account in assessing their response.

4.2 ERA coverage of target and bycatch species

The 2010 hoki ERA assessed the majority of the target and bycatch species associated with the hoki fishery but some species were not assessed. Most species that were not assessed are managed under the quota management system (QMS) and their bycatch in the hoki fishery forms a very small part of their total catch.

The top 49 species or species groups (plus the non-biological category of rocks and stones) by catch weight recorded in target hoki trawls from observer records are listed in Table 2 of the Hoki Fishery Plan (Ministry of Fisheries 2010)[4]. Table 12 indicates which of these top 49 species or species groups were assessed in the 2010 hoki ERA, whether they are QMS species and the proportion they formed of the total observed catch.

The assessed species comprise in excess of 98% of the average annual observed catch weights from the target hoki fisheries for the 3 fishing years ending 30 September 2009. All but 7 of the 27 species or groups not assessed in the 2010 hoki ERA are managed species under the QMS (excluding the category 'Others' which comprises all other species). These seven non-QMS species not assessed in the 2010 hoki ERA are silverside, warty squid, scabbard fish, deepsea flathead, rudderfish, banded bellowsfish and silver dory, these make up a combined of 0.21% of observed catch weights from the hoki fishery.

Some caveats apply to the observer catch weight data as observer coverage is not consistent over all areas, seasons and vessel types. Catches may also vary from year to year. However, observer coverage in the four hoki fisheries is good (at least 10% in Cook Strait and 20% in the other hoki fisheries) and observers report a much more detailed species breakdown than commercial catch-effort returns. The data in Table 2 of the Hoki Fisheries Plan (Ministry of Fisheries 2010) shows a similar pattern to observer catch weights for the period 2000 to 2007 presented in Ballara et al (2010).

Table 12: 2010 hoki ERA coverage of hoki target and bycatch species compared to average observed percentage catch weight for the top 50 species or species groups caught in hoki trawls from observer data. (Percentage data taken from Hoki Fisheries Plan (Ministry of Fisheries 2010) and averaged over the 3 year period 1 October 2006 to 30 September 2009.)

Species	Species assessed in 2010 hoki ERA	Managed under QMS	average annual % of observed catch by weight
Hoki	Yes	Yes	85.42%
Ling	Yes	Yes	3.21%
Javelinfish	Yes	Yes	2.43%
Rattails	Yes	No	1.31%
Silver warehou	Yes	Yes	1.13%
Hake	Yes	Yes	0.97%
Spiny dogfish	Yes	Yes	0.94%
Frostfish	Yes	Yes	0.68%
White warehou	Yes	Yes	0.50%
Pale ghost shark	Yes	Yes	0.43%
Black oreo	No	Yes	0.21%
Shovelnose dogfish	Yes	Yes	0.19%
Ribaldo	No	Yes	0.17%

[4] Marine mammals, seabirds and marine reptiles are reported separately by observers and are not included in the observer catch records in Table 12. Other protected species (fish, protected corals) are included.

Species	Species assessed in 2010 hoki ERA	Managed under QMS	average annual % observed catch by weight
Southern blue whiting	No	Yes	0.14%
Lookdown dory	Yes	Yes	0.14%
Baxter's lantern dogfish	Yes	No	0.13%
Alfonsino	No	Yes	0.13%
Sea perch	No	Yes	0.13%
Blue warehou	No	Yes	0.12%
Squid	No	Yes	0.10%
Other sharks and dogs	Some	Some	0.09%
Redbait	No	Yes	0.09%
Stargazer	No	Yes	0.09%
Jack mackerel	No	Yes	0.07%
Rays bream	No	Yes	0.07%
Silverside	No	No	0.07%
Smooth skate	No	Yes	0.07%
Barracouta	No	Yes	0.06%
Orange roughy	No	Yes	0.06%
Spiky oreo	No	Yes	0.05%
Warty squid	No	No	0.05%
Long nosed chimaera	Yes	No	0.05%
Ghost shark	No	Yes	0.05%
Seal shark	Yes	No	0.04%
Smooth oreo	No	Yes	0.03%
Red cod	No	Yes	0.03%
Bluenose	No	Yes	0.02%
Porbeagle shark	No	Yes	0.02%
Gemfish	No	Yes	0.02%
Longnose velvet dogfish	Yes	No	0.02%
Rocks/stones	n/a	n/a	0.02%
Scabbardfish	No	No	0.02%
Leafscale gulper shark	Yes	No	0.02%
Deepsea flathead	No	No	0.02%
Oliver's rattail	Yes	No	0.02%
Rudderfish	No	No	0.02%
Banded bellowsfish	No	No	0.02%
Silver dory	No	No	0.01%
Deepwater dogfish unspecified	Yes	No	0.01%
Lucifer dogfish	Yes	No	0.01%
Others	Some	Some	0.29%

4.3 Target and major bycatch species

The risks to hoki as a result of the target hoki fisheries were assessed as moderate with a high degree of confidence in the assessment. Hoki is New Zealand's largest fishery and its management is supported by good data, a high level of observer coverage on the hoki fleet, and a comprehensive research programme, including a series of annual trawl surveys in the Chatham Rise area spanning twenty years.

A number of major bycatch species were assessed as having risks of moderate consequences in all or some of the four hoki fishery areas. Better data for the Chatham Rise and Sub-Antarctic fisheries means that the confidence scores for the assessments of the major bycatch species in these two fisheries were generally higher than for the WCSI and Cook Strait fisheries. However, data is poor or limited for some bycatch species in some areas where the risks were assessed as moderate. This list includes ling and hake in the Sub-Antarctic. Data for some species is available for the Sub-Antarctic area, but has not yet been analysed. This data would be useful to inform a future risk assessment.

The risks to the other major bycatch species (lookdown dory, spiny dogfish, frostfish and javelinfish) were assessed as minor or negligible consequence in all of the hoki fisheries.

4.4 Minor bycatch species

The Expert Panel assigned the risks to deepwater dogfish species (at least 12 species) in the Chatham Rise and Sub-Antarctic fisheries as being moderate, but with low confidence. These species are generally not caught in the WCSI and Cook Strait fisheries. There is little information on the productivity of the deepwater shark species but it is believed to be low. Deepwater dogfish made up 0.5% of the total observed catch in all hoki fisheries between 2000 and 2007 (Ballara et al. 2010).

The risk to pale ghost shark in the Chatham and Sub-Antarctic fisheries was assessed as moderate with high confidence. Deepwater skates and rays were assessed as having risks of negligible or minor consequence.

4.5 Protected species

4.5.1 New Zealand fur seal

The risk to New Zealand fur seals in all of the hoki fisheries was assessed as minor, except in Cook Strait where it was assessed as moderate, with low confidence. The catch rate of New Zealand fur seals in the Cook Strait hoki fishery is high and there is limited data on the populations of fur seals in the Cook Strait area.

The assessment for the WCSI fishery was provisional as there is conflicting information. Unpublished Department of Conservation data that has not been peer reviewed suggests a decline in fur seal pup numbers. A report using the PBR approach that has not been peer reviewed indicates that the PBR is not being exceeded. A population estimate for fur seals on WCSI is not available. There is a need for all of the information to be compiled and reviewed to add more certainty to the risk assessment but the Expert Panel provisionally assessed the risks to fur seals in the WCSI hoki fishery as of minor consequence.

4.5.2 Seabirds

The Expert Panel did not assess risks to seabirds as there is both a recent completed Level 1 and a draft Level 2 seabird risk assessment in preparation. The Expert Panel did not consider it necessary or worthwhile to repeat an assessment for seabirds in light of this recent research and requested that the Ministry of Fisheries finalise and release the draft Level 2 risk assessment as soon as possible.

4.5.3 Other protected species

The risk to the other marine mammals (New Zealand sea lion, whales and dolphins was assessed as negligible or minor with high confidence. Basking sharks were assessed as having moderate risk to three of the hoki fisheries with low confidence. Basking sharks sightings and bycatch have both declined in New Zealand waters over recent years (Francis & Smith 2010). Risks to all other protected marine fishes and reptiles were assessed as negligible.

4.6 Sharks

Sharks were assessed in three different ecological categories, as a major bycatch (spiny dogfish), as a minor bycatch (deepwater dogfish, deepwater skates and rays and pale ghost shark) and as a protected species (basking shark). Spiny dogfish is a significant bycatch of the hoki fisheries (about 1% of the observed catch and in the top 10 bycatch species); the consequence of the hoki fisheries to spiny dogfish was assessed as minor, with high confidence.

All of the deepwater dogfish species were assessed together as they share similar characteristics of low productivity, slow growth and low fecundity. Deepwater dogfish comprise in the order of 0.5% of the recent observed catch weight of the target hoki fisheries (Table 2, Hoki Fishery Plan) Ministry of Fisheries (2010) and Ballara et al. (2010); more are caught on the Chatham Rise and in the Sub-Antarctic areas than in the WCSI and Cook Strait areas and the consequence score of moderate for these areas reflects their life history characteristics and poor knowledge. In a recent review of their distribution and abundance, Blackwell (2010) found that abundance indices for a number of the deepwater shark species on the northeast Chatham Rise showed little change from 1986 to 2002 although the indices for Baxter's dogfish were more variable. Blackwell (2010) suggested continued monitoring of deepwater shark stocks.

Pale ghost shark share similar characteristics to deepwater dogfish, with low productivity, slow growth and low fecundity. However there is good data from research trawl surveys to support the consequence score of moderate for pale ghost shark in the Chatham Rise and Sub-Antarctic hoki fisheries.

4.7 Benthic impacts

Except for benthic impacts on parts of the Chatham Rise and possible trophic impacts on the Chatham Rise and Sub-Antarctic ecosystems, the 2010 hoki ERA has found that the impacts of the four target hoki fisheries pose negligible to no more than moderate risks to all BOMEC classes. The Expert Panel had some reservations about the use of BOMEC, primarily related to two issues. One was that some Panel members understood that that the BOMEC appeared to be based mainly on physical variables and may not reflect the distribution of at risk benthic organisms particularly well. The second was that BOMEC is a broad classification and there may be a range of different communities within each BOMEC class, perhaps by region or latitude.

Some of the reservations of the Expert Panel about BOMEC as the basis for the benthic risk assessment may not be justified. BOMEC is described in Leathwick et al. (2009) as a classification specifically designed to assess and manage the effects of bottom trawling on the benthic environment. It is a modification of the marine environment classification (Snelder et al. 2005) that incorporates a range of biological data that includes eight biological groups including demersal fish and seven benthic invertebrate groups. Although it is based on data for a limited number of biological groups, the BOMEC represents the best information available and was developed for assessing benthic impacts of fishing. It has also been developed at a scale that provides a consistent classification framework for assessment of benthic impacts from bottom trawling in all four of the hoki fisheries.

The Expert Panel requested that the analysis of the hoki trawl footprint by BOMEC Class be broken down into each of the four hoki fisheries so that it could confirm some of its assessments, in particular the assessments for BOMEC 7 in Cook Strait and for BOMEC 9 in the Sub-Antarctic.

4.8 Trophic Impacts

The trophic risk assessment was based on two main sources of information. The first is an unpublished model of the Chatham Rise ecosystem that is still in development (Pinkerton, 2010). This indicates hoki is an ecologically important species and the most important fish species within the Chatham Rise food-web. It was also based on a Ministry of Fisheries' research project on ecosystem indicators (Tuck et al. 2010). The indicator results indicate that there is ongoing change in the Chatham Rise ecosystem with a reduction in mean trophic level, some species declining in abundance and others increasing.

The hoki fishery has reduced the biomass of hoki on the Chatham Rise by more than 50% since the fishery began with major changes to the fish communities there. Tuck et al. (2010) found significant trends in a number of ecosystem indicators on the Chatham Rise. However, there is apparently no sign of a loss of ecosystem structure or function. The Expert Panel did not reach a consensus as to whether the consequence to the Chatham Rise ecosystem from the hoki fishery was moderate or major. Although there is no ecosystem model for the area in which the hoki fishery operated in the Sub-Antarctic, the Expert Panel members assessed the risks to ecosystems there as having the same consequence (either moderate or major) as for the Chatham Rise ecosystem, again failing to reach consensus.

It is not clear whether the observed changes in the Chatham Rise and Sub-Antarctic ecosystems meet the description of major ecosystem consequences in Table A5 of Appendix 2 which includes a loss of structure and function. This appears to be the main reason why consensus was not reached by the Expert Panel. The Expert Panel indicated that it is important that the Chatham Rise ecosystem model and results are completed, peer reviewed and published in order to allow a more definitive assessment of the ecological importance of hoki to inform future risk assessment.

In its discussions of trophic impacts, the Expert Panel specifically considered the trophic impacts from the removal of hoki on availability of food for fur seals and on availability of hoki and hoki eggs for predation by spiny dogfish and concluded that any such effects were small.

4.9 Further work and information needs

The Expert Panel identified the following information needs and areas requiring further work - in some cases to confirm their assessments:

Fur seals:

- WCSI, consolidate and analyse all information on fur seals, including unpublished Department of Conservation data on fur seal counts from WCSI rookeries.

Protected corals

- No distributional data exists on which to base an informed risk assessment.

Benthic impacts:

- Further work on hoki trawl footprint coverage in BOMEC Class 9 for Chatham Rise and Sub-Antarctic fisheries is needed to confirm the assessments;
- Additional information on where trawling occurs/does not occur in Cook Strait is needed to confirm the Cook Strait assessment in BOMEC 7;
- Additional information on the composition of benthic communities (especially in BOMEC Class 9 on Chatham Rise) is needed in the longer term in order to confirm that the BOMEC classes are representative of benthic community types potentially at risk and to more

confidently assess the impacts of the hoki trawl fishery on benthic communities. Data already collected as part of the Oceans 2020 research project may fulfill this need, at least in part and should be followed up.

Ecosystem/trophic effects

- Finalise and publish trophic model of Chatham Rise, including consolidation of knowledge on ecological importance.

5 Summary

Except for benthic impacts on parts of the Chatham Rise and possible trophic impacts on the Chatham Rise and Sub-Antarctic ecosystems, the 2010 hoki ERA has found that the impacts of the four target hoki fisheries pose negligible to no more than moderate risks to all ecosystem components.

- Risks to hoki populations are moderate – an expected level of risk as the populations are fully exploited;
- Risk to bycatch species are negligible to moderate – most of these species are fully managed under the QMS
- Risks to all groups of protected species, including fur seals and marine mammals, range from negligible to moderate – these results are supported by an extensive observer data base;
- Risks to the benthic environment are negligible to moderate except to BOMEC Class 9 on the Chatham Rise – but data is limited and there is a need to 'ground truth' the BOMEC classes with better knowledge of benthic communities
- Risks to the ecosystem (as measured by trophic impacts) from the WCSI and Cook Strait hoki fisheries are low – data is limited but there is consensus that spawning hoki make a small contribution to the ecosystems in these areas
- The Expert Panel could not reach consensus on risks posed by the target hoki fisheries on the Chatham Rise and Sub-Antarctic ecosystems and scored them either moderate, or major. A trophic model for the Chatham Rise indicates hoki have high ecological importance in the fish community. Ministry of Fisheries projects show that there is ongoing change to fish communities of the Chatham Rise and Sub-Antarctic; there is no evidence of loss of ecosystem structure or function in either region.

6 References

Baird, S.J.; Gilbert, D.J. (2010). Initial assessment of risk posed by trawl and longline fisheries to selected seabird taxa breeding in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 50. 98p.

Baker, B.; Hamilton, S. (2010). Assessment of the impact of selected fisheries mortality on New Zealand fur seal populations using the Potential Biological Removal (PBR) approach. 37p. (Draft report prepared by Latitude42 Environmental Consultancy Pty Ltd for Deepwater Group Ltd, Nelson, November 2010.)

Ballara, S.L.; O'Driscoll, R.L.; Anderson, O.F. (2010). Fish discards and non-target fish catch in the trawl fisheries for hoki, hake, and ling in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 48. 100p.

Black, J.; Wood, R. 2010. Analysis of New Zealand's Trawl Grounds for the Tier 1 Species, GNS Science Consultancy Report 2010/167. 31p.

Blackwell, R.G. (2010). Distribution and abundance of deepwater sharks in New Zealand waters, 2000–01 to 2005–06. New Zealand Aquatic Environment and Biodiversity Report No. 57. 51p.

Branch, T.A.; R. Watson; E.A. Fulton; S. Jennings; C.R. McGilliard; G.T. Pablico; D. Ricard; S.R. Tracey (2010). The trophic fingerprint of marine fisheries. Nature, 468: 431–435.

Fletcher, W. J. (2005). The application of qualitative risk assessment methodology to prioritize issues for fisheries management. ICES Journal of Marine Science 62:1576-1587.

Fletcher, W. J.; Chesson, J.; Fisher, M.; Sainsbury, K. J.; Hundloe, T.; Smith, A.D.M.;Whitworth, B. (2002). National ESD reporting framework for Australian Fisheries: The how to guide for wild capture fisheries. FRDC Report 2000/145, Canberra, Australia. 120p.

Francis, M.P.; Smith, M.H. (2010). Basking shark (Cetorhinus maximus) bycatch in New Zealand fisheries, 1994–95 to 2007–08. New Zealand Aquatic Environment and Biodiversity Report No. 49. 57p.

Hobday; A. J.; Smith, A.; Webb, H.; Daley, R.; Wayte, S.; Bulman, C.; Dowdney, J.; Williams, A.; Sporcic, M.; Dambacher, J.; Fuller, M.; Walker, T. (2007). Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra. 174p.

Leathwick, J.R.; Rowden, A.; Nodder, S.; Gorman, R.;Bardsley, S.; Pinkerton, M.; Baird, S.J.; Hadfield, M.; Currie, K.; Goh, A. (2009). Benthic-optimised marine environment classification for New Zealand waters. Final Research Report for Ministry of Fisheries project BEN2006-01, Objective 5. 52p.

Ministry of Fisheries (2005). Strategy for Managing the Environmental Effects of Fishing. 26p. (Unpublished document held by New Zealand Ministry of Fisheries, Wellington)

Ministry of Fisheries (2008). New Zealand national plan of action for the conservation and management of sharks. 92 p. (Unpublished document held by Ministry of Fisheries, Wellington.)

Ministry of Fisheries (2010). National Deepwater Plan PART 1B Hoki Fisheries Plan, September 2010. 51p. (Unpublished document held by Ministry of Fisheries, Wellington)

Ministry of Fisheries, Science Group (Comps.) (2010). Hoki. In: Report from the Fishery Assessment Plenary, May 2010: stock assessments and yield estimates. (Unpublished report held in NIWA Greta Point library, Wellington.)

Richard, Y.; Abraham, E.; Filippi, D. (in press). Assessment of the risk to seabird populations from New Zealand commercial fisheries. 154p. (Unpublished DRAFT Report to the Aquatic Environment Working Group November 5, 2010.)

Rowe, S. (2010). Level 1 Risk Assessment for Incidental Seabird Mortality Associated with New Zealand Fisheries in the NZ-EEZ, Marine Conservation Services, Department of Conservation. Wellington. 75p.

Sharp, B.R. 2009. A risk assessment framework for incidental seabird mortality associated with New Zealand fisheries in the NZ-EEZ. 41p. (Unpublished document held by Ministry of Fisheries, Wellington.)

Snelder , T.; Leathwick, J.; Dey, K,; Weatherhead, M.; Fenwick, G.; Francis, M.; Gorman, R.; Grieve, J.; Hadfield, M.; Hewitt, J.; Hume, T.; Richardson, K.; Rowden, A.; Uddstrom, M.; Wild, M.; Zeldis, J. (2005). The New Zealand Marine Environment Classification, Ministry for the Environment, Wellington. 70p.

Stocklosa, R. (2010). Advice of stakeholders to Deepwater Group and New Zealand Ministry of Fisheries: prospects for ecological risk assessment of hoki and EEZ fisheries – report of 14 December workshop and 15 December technical meetings, Revision B subject to stakeholder review. E-Systems Pty Ltd. February 2010. 45p. (unpublished document held by Deepwater Group Ltd, Nelson)

Tuck, I.; Cole, R.; Devine, J. (2009). Ecosystem indicators for New Zealand fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 42. 188 p.

URS (2002). Report on Hoki Impact Characterisation Workshop. 39p. (Unpublished report held by Deepwater Group Ltd, Nelson)

URS (2003). Draft Report on Hoki Risk Characterisation Workshop. 22p. (Unpublished report held by Deepwater Group Ltd, Nelson)

Wood, R. (2010) Analysis of hoki trawl footprint and BOMEC areas. Letter with attachments to Deepwater Group Limited, 15 September 2010

APPENDIX 1

Hoki ERA Process and Timeline (updated to 16 December 2010)

Dec 14 2009	Initial meeting to assess ERA Methodological Options
Jan-May 2010	Invite proposals for service providers to undertake hoki ERA on contract to DWG.
Jun - Jul 2010	Costs for initial proposal were all too high, ERA process revised and new process initiated
Jul 2010	DWG contracted Boyd Fisheries Consultants Ltd to undertake Level 1 ERA for hoki fisheries
Aug - Nov 2010	Preparatory work, finalising methodologies, assessing and compiling relevant documentation, and organising key participants
Nov 2010	Notification/confirmation of hoki ERA workshop dates, invitation to participants
Dec 13-14 2010	Level One ERA workshop to identify levels of impact of hoki fishing on target species, major fish by-catch, seabirds, marine mammals, benthic habitats and communities
Dec 24 2010	Circulate record of ERA workshop together with draft of assessments to Expert Panel members for corrections
Jan 24 2011	Corrections to ERA workshop record and assessments due from ERA Panel Members
Jan 31 2011	Draft Hoki ERA Report to Panel Members for comments, edits and corrections
Feb 11 2011	ERA Panel to respond with comments, edits and corrections to draft hoki ERA report
Feb 16 2011	Final hoki ERA Report provided to DWG Ltd
Feb 28 2011	DWG Board to consider and accept the revised hoki ERA
Mar 31 2011	In consultation with stakeholders, scope and implement a process to develop objectives and then develop draft objectives for each of the main ecological risks identified in the revised ERA
Mar 31 2011	In consultation with stakeholders, develop a proposed management plan to achieve each of the above objectives,
Apr 2011	Present a Proposed Management Plan (including proposed objectives and proposed management/mitigation measures) to DWG Board for their

	consideration and adoption
May-Oct 2011	Implement the agreed Management Plan, mitigation measures and procedures, along with research and monitoring plans to measure the effects of these management measures and to obtain further information where this has been identified as necessary to meet objectives
Oct 2011 - Sept 2012	Ongoing review of monitoring results, periodic and annual reports to DWG Board and stakeholders

APPENDIX 2

Hoki ERA – Description of method and procedures for ERA Panel

1. Introduction

This document describes the method that will be used by the hoki ERA expert panel (the ERA Panel) for the updated hoki ecological risk assessment (hoki ERA) for the hoki fisheries.

The assessment will be an expert–judgment based analysis (generally termed Level 1) and will be conducted by the ERA Panel at the hoki ERA workshop which will be open to stakeholders and interested parties. The risk analysis will commence on the initial assumption that all ecological components may be at high risk. The purpose of the risk assessment exercise is to identify and separate out issues or components that are at moderate to high risk from those that are not, and to determine the level of risk for each component. The ERA Panel will not consider future management responses to any identified risks nor will it consider possible future mitigation measures. These will be the subject of a separate and future exercise that will be undertaken through the development and implementation of the Ministry of Fisheries' National Fisheries Plan for Deepwater and Middle-depth Fisheries.

2. Scope

The hoki ERA will address the current ecosystem effects of the four target hoki fisheries; Chatham/East Coast, Cook Strait, Southland/SubAntarctic and West Coast. Direct and indirect impacts will be considered. It will provide a broad overview and current snapshot of the impact of the target hoki fisheries on all potentially affected ecological components. These components include target species, incidental capture species (fish and non–fish), protected, endangered and threatened species, benthic habitats (structure, function, integrity) and the ecosystem (structure, function, diversity, and trophic considerations).

In assessing present risks, the hoki ERA will take into consideration the current management of the hoki fisheries, including mitigation measures that are presently in place. The rationale and any qualifiers attached to each assessment will be documented and will form part of the risk assessment.

The assessments will be based on the expert judgment of the ERA Panel and will therefore be qualitative rather than quantitative. However, quantitative data, scientific reports and other information that is in the public domain will be used to support and inform the risk assessments. Because the hoki ERA will cover the full ecological spectrum, an overview of existing information that is directly relevant to the hoki fisheries will be available to assist in focusing the assessment on the most uncertain or controversial elements. The ERA Panel will determine which areas where there may be the most uncertainty or concern and which areas, if any, may be of less concern. The assessment will be assisted by input from stakeholders and observers at the ERA workshop.

3. Workshop Procedure

The Workshop Facilitator (who will also be the Chair) will assist the ERA Panel by introducing and opening up each topic or component for consideration and will provide structure to keep the discussions on topic and reach a conclusion within the available time. There will be a Secretary who will take a record of the proceedings, including all decisions and the reasons for them. Throughout the risk assessment and scoring process, the Secretary will take a record of any matter where the Panel is unable to reach a consensus, and in each such case will record the different views and the reasons for them.

The ERA Panel will use its Protocols to guide how it undertakes its discussions, deliberations and responsibilities.

At appropriate times, and with the agreement of the ERA Panel, the Workshop Facilitator will invite stakeholders and interested parties present to ask questions of the Panel, raise relevant topics or issues for the Panel's consideration, or to provide information or comments to the Panel. Every endeavour will be made to allow free and open contributions from stakeholders and interested parties and for discussion of any matters they raise in these circumstances provided that it is strictly on topic, assists the risk assessment and does not impede the work of the ERA Panel.

4. Method

The ERA method sequentially progresses through three main steps: (i) the examination of sources of risk; (ii) an assessment of the potential consequences of those risks and; (iii) the likelihood of a particular level of consequence occurring from the hoki target fisheries. Scores will be given to the potential consequence (6 levels from negligible to catastrophic) and to the likelihood of that consequence (remote to likely) using a set of standard tables that describe each level. This is commonly referred to as the exposure – consequence risk assessment method.

Characterisation of the hoki fisheries

Existing information will be used to characterise the four hoki fisheries. The most recent hoki Plenary (2010) provides a comprehensive overview of the four fisheries and includes an extensive list of references of the most relevant scientific literature. The hoki ERA Panel will use this information as the agreed formal description of the hoki fisheries, including details of history, extent, method, gear, management and trends. The knowledge, experience and expertise of the ERA Panel will also supplement and expand this formal description of the hoki fisheries.

Identifying sources of risk

Risk will be identified, but not scored. Risk to ecological components arises from any actual or potential interaction between the activity of fishing and the ecological component that may have a negative impact on its biological well being or sustainability.

Where data exists this is to be used to assess the scale and intensity or significance of the interaction or exposure. For example, where there is known or suspected distributional overlap between any of the hoki fisheries and the ecological component under consideration, this information is to be used to assess the potential scale of the exposure. Similarly, where there is specific observer data or quantitative analysis that shows that there is a known impact of an ecological component from the target hoki fisheries; this is to be used to assess the level of exposure.

Where data does not exist, a precautionary approach will be adopted. For example, where the distribution of a particular hoki fishery is known but the distribution of the ecological component is uncertain, there will be an assumption that the potential risk is high because the ecological component under consideration may be exposed to the hoki fisheries.

The identified risks and the reasons for them will be recorded by the hoki ERA workshop Secretary.

Scoring consequence

Based on the identified risks and influence s such as the scale, intensity and significance of the exposure of the ecological component to those risks from the hoki fisheries, the ERA Panel will discuss, evaluate and score the consequences of that exposure on a scale of 0 to 5, using a set of 6 prepared consequence descriptions ranging from negligible to catastrophic. Tables A1 to A5 provide the descriptions of the consequence levels and scores for the five ecological categories. These descriptions will have been reviewed by the ERA Panel prior to the workshop.

As the nature of the potential consequences of exposure to the fishery depends on the particular ecological component being considered, there are different set of descriptions of consequence levels for each of the ecological categories.

The consequence scores and the reasons for them will be recorded by the hoki ERA workshop Secretary.

Scoring likelihood

Following the scoring of the consequence, the ERA Panel will discuss, assess and then score the likelihood of that consequence occurring. Likelihood scores will be from 1 to 6, ranging from remote to likely. The likelihood descriptions are provided (Table A6) and will have been reviewed by the ERA Panel prior to the workshop.

The likelihood scores and the reasons for them will be recorded by the hoki ERA workshop Secretary.

Recording confidence

When it has completed the evaluation of each ecological component, based on the evidence and its judgment, the ERA Panel will rate its confidence in its assessment (high or low). Table A7 provides the confidence ratings together with a set of prepared rationales. These will have been reviewed by the ERA Panel prior to the workshop.

5. Post Workshop

The draft ERA workshop scoring report (essentially a clean and tidy copy of the scores together with the recorded reasons and rationales, including documentation of any areas where there were divergent views amongst the ERA Panel and any topics where the Panel considered they had a lack of expertise to reach an opinion), will be provided to the ERA Panel members as soon as possible after the ERA workshop for their corrections (but not new considerations).

A draft of the full ERA report will subsequently be provided to the ERA Panel members for their comments and corrections before it is made available to DWG.

Table A1 Consequence descriptions for the impact of the hoki fisheries on target species and the main fish bycatch species

Level	Descriptor	Ecological consequences
0	Negligible	Insignificant impacts to populations. Unlikely to be measurable against background variability for this population.
1	Minor	Possibly detectable, but minimal impact on population size and none on dynamics.
2	Moderate	Full exploitation rate, but long–term recruitment/dynamics not adversely impacted.
3	Major	Affecting recruitment levels of stocks/or their capacity to increase.
4	Severe	Likely to cause local extinctions if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list; e.g. IUCN category).
5	Catastrophic	Local extinctions are imminent/immediate

Table A2 Consequence descriptions for the impact of the hoki fisheries on minor fish bycatch species

Level	Descriptor	Ecological consequences
0	Negligible	The area where fishing occurs is negligible compared to where the relevant stock of the species resides (< 1%).
1	Minor	Take in this fishery is small (< 10%), compared to total take by all fisheries and/or these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
2	Moderate	Relative area of, or susceptibility to capture is suspected to be less than 50% of the distribution of the species and the species does not have vulnerable life history traits.
3	Major	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species. Relative levels of capture/susceptibility suspected/known to be greater than 50% of the distribution of the species and the species should be examined explicitly.
4	Severe	Likely to cause local extinctions, if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list e.g. IUCN category).
5	Catastrophic	Local extinctions are imminent/immediate

Table A3 Consequence descriptions for the impact of the hoki fisheries on protected species, endangered species and threatened species

Level	Descriptor	Ecological consequences
0	Negligible	Almost none are impacted
1	Minor	Some are impacted but there is no impact on the sustainability of the population(s)
2	Moderate	Levels of impact are at the maximum that will allow the population to at maintain itself at its current size with a high degree of confidence
3	Major	Affecting recruitment levels of populations/or their capacity to rebuild if depleted
4	Severe	Likely to cause local extinctions, if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list e.g. IUCN category)
5	Catastrophic	Local extinctions are imminent/immediate

Table A4 Consequence levels and scores for the impacts of the target hoki fisheries on benthic habitat structure and function

Level/score	Descriptor	Ecological consequences (habitat))
0	Negligible	No detectable change to the internal dynamics of habitat or populations of species making up the habitat. Activity affects < 1% of the area of the BOMEC class or habitat type. Time taken to recover to pre-disturbed state on the scale of hours to days.
1	Minor	Detectable impact on habitat structure and function. Measurable impacts on BOMEC class but the impact affects < 5% of the area of the BOMEC class or habitat type. Recovery time from impact on the time scale of days to months, regardless of spatial scale.
2	Moderate	Impact reduced habitat structure and function but the impacts are expected to be within the capacity of the habitat type to maintain itself given the % of the BOMEC class or habitat type impacted, the types of impact occurring and the recovery capacity of the habitat. For less fragile habitats this may be up to 50% of habitat impacted and for more fragile habitats, to stay in this category the percentage area affected will probably be <20%. Recovery time to recover from impacts on the scale of months to <1 year.
3	Major	The level of impact of reduction of internal dynamics of habitat may threaten ability to recover or it will cause strong downstream effects from loss of function. For non–fragile habitats the area impacted is <50% of the BOMEC class or habitat type, for fragile habitats the affected area is <25% . Time to recover from impact is on the scale of >1 year to decadal.
4	Severe	A high proportion of the BOMEC class or habitat type is being affected which may endanger its long–term survival and result in severe changes to ecosystem function (i.e., up to 70 – 90% of the habitat is being impacted or removed by the activity). Time to recover is likely to be >decadal.
5	Catastrophic	The dynamics of the entire habitat is in danger of being changed in a catastrophic way that may not be reversible. Most or all of the BOMEC class or habitat type is impacted. (i.e. > 90% of the habitat area is impacted). Habitat losses occur, although some elements may remain. Recovery in the scale of decades to centuries.

Table A5 Consequence levels for the impact of the hoki fisheries on the ecosystem (structure, function, diversity, trophic levels).

Level/score	Descriptor	Ecosystem consequences
0	Negligible	Impacts to structure, function, diversity or trophic levels are not measurable against background variability.
1	Minor	Impacted species and / or affected habitats do not play a keystone role in the composition or distribution of species or functional groups. Change in species composition, community constituents, functional group composition and mean trophic level are <5%.
2	Moderate	There are measurable changes in species composition, community constituents, functional group composition and mean trophic level of <10%.
3	Major	There are major changes to the ecosystem involving keystone species that include major changes in species composition (e.g. loss of components or new species appearing), loss of community constituents, changes in ecosystem function and changes in trophic level in the order of 25%. Recovery measured in years.
4	Severe	Significant changes to ecosystem structure and function. Different species occurring in fishery. Some functional groups missing, new functional groups present. Ecosystem function severely altered with changes to structure, function, diversity and trophic level in the order of 50%. Recovery period measured in decades.
5	Catastrophic	Total collapse of ecosystem and processes. Long-term recovery period measured in decades to centuries.

Table A6 Confidence scores

Confidence rating	Score	Rationale for confidence score
Low	1a	Data exists, but is considered poor or conflicting.
	1b	No data exists.
	1c	Agreement between experts, but with low confidence
	1d	Disagreement between experts
High	2a	Data exists and is considered sound.
	2b	Consensus between experts
	2c	High confidence - exposure to impact cannot occur (e.g. no spatial overlap of fishing activity and species distribution)

APPENDIX 3

HOKI ERA - LIST OF REFERENCE DOCUMENTS MADE AVAILABLE TO EXPERT PANEL AND STAKEHOLDERS ON DWG WEBSITE (2010 hoki ERA CD attachment)

Abraham, E.R.; Thompson, F.N. (2009). Capture of protected species in New Zealand trawl and longline fisheries, 1998–99 to 2006–07. New Zealand Aquatic Environment and Biodiversity Report No. 32. 197 p.

Abraham, E.R.; Thompson, F.N.; Oliver, M.D. (2010). Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2007–08 New Zealand Aquatic Environment and Biodiversity Report No. 45. 148 p.

Anderson, O.F.; Bagley, N.W.; Hurst, R.J; Francis, M.P.; Clark, M.R.; MacMillan, P.J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. NIWA Technical Report 42. 303p.

Arnold, A. (Ed.) (2004). Shining a spotlight on the biodiversity of New Zealand's marine ecoregion. Experts Workshop on Marine Biodiversity 27-28 May 2003, Wellington. WWF New Zealand. 85p.

Bagley, N.W.; Anderson, O.F.; Hurst, R.J; Francis, M.P.; Taylor, P.R.; Clark, M.R.; Paul, L.J. (2000). Atlas of New Zealand fish and squid distributions from midwater trawls, tuna longline sets and aerial sightings. NIWA Technical Report 72. 171p

Baird, S.J. (2005). Net captures of seabirds during trawl fishing operations in New Zealand waters. Report prepared for Clement and Associates Limited, Nelson. NIWA Client Report WLG2008-22. 51p.

Baird, S.J.; Gilbert, D.J. (2010). Initial assessment of risk posed by trawl and longline fisheries to selected seabird taxa breeding in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 50. 98p.

Baker, B.; Hamilton, S. (2010). Assessment of the impact of selected fisheries mortality on New Zealand fur seal populations using the Potential Biological Removal (PBR) approach. 37p. (Draft report prepared by Latitude42 Environmental Consultancy Pty Ltd for Deepwater Group Ltd, Nelson, November 2010.)

Ballara, S.L.; O'Driscoll, R.L.; Anderson, O.F. (2010). Fish discards and non-target fish catch in the trawl fisheries for hoki, hake, and ling in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 48. 100p.

Black, J.; Wood, R. 2010. Analysis of New Zealand's Trawl Grounds for the Tier 1 Species, GNS Science Consultancy Report 2010/167. 31p.

Blackwell, R.G. (2010). Distribution and abundance of deepwater sharks in New Zealand waters, 2000–01 to 2005–06. New Zealand Aquatic Environment and Biodiversity Report No. 57. 51p.

Boren, L. (2010). Diet of New Zealand fur seals (Arctocephalus forsteri): a summary. Department of Conservation Research and Development Series 319. Department of Conservation, Wellington. 19p.

Bradford-Grieve, J.M.; Probert, K.P.; Nodder, S.D.; Thompson, D.; Hall, J.; Hanchet, S.; Boyd, P.; Zeldis, J.; Baker, A.N.; Best, H.A.; Broekhuizen, N.; Childerhouse, S.; Clark, M.; Hadfield, M.; Safic, K.; Wilkinsong, I. (2003). Pilot trophic model for subantarctic water over the Southern Plateau, New Zealand: a low biomass, high transfer efficiency system. Journal of Experimental Marine Biology and Ecology 289: 223– 262.

Bull, B.; Livingston, M.E.; Hurst, R.; Bagley, N. (2001). Upper-slope fish communities on the Chatham Rise, New Zealand, 1992-99. NZ Journal of Marine and Freshwater Research 35:795-815

Clark, M.R. (1985). Feeding relationships of seven fish species from the Campbell Plateau, New Zealand. NZ Journal of Marine and Freshwater Research 19: 365-374.

Clark, M.R.; Bowden, D.A.; Baird, S.J.; Stewart, R. (2010). Effects of fishing on the benthic biodiversity of seamounts of the "Graveyard" complex, northern Chatham Rise New Zealand Aquatic Environment and Biodiversity Report No. 46. 40 p.

Consalvey, M.; Mackay, K.; Tracey, D. (2006). Information review for protected deep-sea coral species in the New Zealand Region. Report prepared for Department of Conservation, Wellington. NIWA Client Report: WLG2006-85. 53p.

Dunn, M.R.; Szabo, A.; McVeagh, M.S.; Smith, P.J. (2010). The diet of deepwater sharks and the benefits of using DNA identification of prey. Deep-Sea Research I 57: 923–930.

Abraham, E.R. (2009). Batching of waste to reduce seabird numbers behind trawl vessels. Report prepared by Dragonfly for the Department of Conservation, Wellington, New Zealand. 23p.

Fairfax, D. (2005). Marine Protected Species Interactions with Commercial Fisheries 2003. Marine Conservation Unit, Department of Conservation, Wellington. 17p.

Fletcher, W. J. (2005). The application of qualitative risk assessment methodology to prioritize issues for fisheries management. ICES Journal of Marine Science 62:1576-1587.

Fletcher, W. J., Chesson, J.; Fisher, M.; Sainsbury, K. J.; Hundloe, T.; Smith, A.D.M.; Whitworth, B. (2003). National application of sustainability indicators for Australian fisheries. Final Report to Fisheries Research and Development Corporation on Project 2000/145. 48p.

Fletcher, W. J.; Chesson, J.; Fisher, M.; Sainsbury, K. J.; Hundloe, T.; Smith, A.D.M.;Whitworth, B. (2002). National ESD reporting framework for Australian Fisheries: The how to guide for wild capture fisheries. FRDC Report 2000/145, Canberra, Australia. 120p.

Fletcher, W.J.; Chesson, J.; Fisher M.; Sainsbury, K.J.; Hundloe, T.J. (2004). National ESD Reporting Framework: The 'How To' Guide for Aquaculture. Version 1.1 FRDC, Canberra, Australia. 88p.

Francis, M.P.; Smith, M.H. (2010). Basking shark (Cetorhinus maximus) bycatch in New Zealand fisheries, 1994–95 to 2007–08. New Zealand Aquatic Environment and Biodiversity Report No. 49. 57p.

Francis, R.I.C.C.; Bell, E.A. (2010). Fisheries risks to the population viability of black petrel (Procellaria parkinsoni). New Zealand Aquatic Environment and Biodiversity Report No. 51. 57p.

Gordon, D.P.; Beaumont, J.; MacDiarmid, A.; Robertson, D.; Ayyon, S.T. (2010). Marine Biodiversity of Aotearoa New Zealand. PLoS ONE 5(8) www.plosone.org. e10905. 17p.

Hitchmough, R.; Bull, L.; Cromarty, P. (Comps) (2007). New Zealand Threat Classifications List 2005 Department of Conservation, Wellington. (Report split into two electronic pdf documents, Part 1 (p. 1-134) & Part 2 (p. 135-194) plus schedule in an accompanying MSExcel file)

Hobday; A. J.; Smith, A.; Webb, H.;Daley, R.; Wayte, S.; Bulman, C.; Dowdney, J.; Williams, A.; Sporcic, M.; Dambacher, J.; Fuller, M.; Walker, T. (2007). Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra. 174p.

Horn, P.L.; Dunn, M.R. (2010). Inter-annual variability in the diets of hoki, hake, and ling on the Chatham Rise from 1990 to 2009. New Zealand Aquatic Environment and Biodiversity Report No. 54. 57p.

http://www.lntreasures.com/nzmf.html Checklist of Endemic Marine Fish Species

Hurst, R.J,; Bagley, N.W.; Anderson, O.F.; Francis, M.P.; Griggs, L.H.; Clark, M.R.; Paul, L.J.; Taylor, P.R. (2000). Atlas of juvenile and adult fish and squid distributions from bottom and midwater trawls and tuna longlines in New Zealand waters. NIWA Technical Report 84. 162p.

Key, J.M. (2002). A review of current knowledge describing New Zealand's deepwater benthic biodiversity. Marine Biodiversity Biosecurity Report No. 1. 25p

Leathwick, J.; Dey, K.; Julian, K. (2006). Development of a marine environmental classification optimised for demersal fish. Report prepared for Department of Conservation, Wellington. NIWA Client Report HAM-063. 18p.

Leathwick, J.; Francis, M.; Julian, K. (2006). Development of a demersal fish community map for New Zealand's Exclusive Economic Zone. Report prepared for Department of Conservation, Wellington. NIWA Client Report HAM-062. 35p.

Leathwick, J.R.; Rowden, A.; Nodder, S.; Gorman, R.;Bardsley, S.; Pinkerton, M.; Baird, S.J.; Hadfield, M.; Currie, K.; Goh, A. (2009). Benthic-optimised marine environment classification for New Zealand waters. Final Research Report for Ministry of Fisheries project BEN2006-01, Objective 5. 52p.

Francis, M.P.; Dunn.; M.; Mackay, K.A.; Anderson, O.F. (2003). NABIS marine finfish species distributions. Final Research Report for Ministry of Fisheries Research Project ZBD2002/20 Objectives 1 and 2 National Institute of Water and Atmospheric Research, Wellington. 28p.

Ministry of Fisheries (2005). Strategy for Managing the Environmental Effects of Fishing. (Unpublished document held by New Zealand Ministry of Fisheries, Wellington) 26p.

Ministry of Fisheries (2008). New Zealand national plan of action for the conservation and management of sharks. (Unpublished document held by Ministry of Fisheries, Wellington.) 92p.

Ministry of Fisheries (2010). Draft National Deepwater Plan PART 1B Hoki Chapter, May 2010 (Unpublished document held by Ministry of Fisheries, Wellington) 40p.

Ministry of Fisheries, Science Group (Comps.) (2010). Hoki p. 367-400 In: Report from the Fishery Assessment Plenary, May 2010: stock assessments and yield estimates. (Unpublished report held in NIWA Greta Point library, Wellington.)

O'Driscoll, R.L.; Bagley, N.W. (2009). Trawl survey of middle depth species in the Southland and Sub-Antarctic areas, November–December 2008 (TAN0813). New Zealand Fisheries Assessment Report 2009/56. 67 p.

Pinkerton, M.H. (2008). Ecosystem modelling of the Chatham Rise, New Zealand. 49p. (Unpublished report on the Chatham Rise trophic model presented to the MFish BRAG group October 2008 held by NIWA, Wellington.)

Pinkerton, M.H. (2009). Headline indicators for the New Zealand ocean. 42p. (Unpublished document held by NIWA, Wellington.)

Pinkerton, M.H. (2011). Hoki ecological risk assessment: ecosystem and food-web effects. 8p. (Unpublished document for 2010 hoki ERA held by NIWA, Wellington)

Ramm, K. (2010). Draft Conservation Services Programme observer report 01 July 2008 to 30 June 2009. Marine Conservation Services, Department of Conservation, Wellington. 126p

Rowden, A.A.; O'Shea, S.; Clark, M.R. (2002). Benthic biodiversity of seamounts on the northwest Chatham Rise. Marine Biodiversity Biosecurity Report No. 2. 21 p.

Rowe, S.J. (2009). Conservation Services Programme observer report 01 July 2004 to 30 June 2007. Marine Conservation Services, Series 1. Department of Conservation, Wellington. 93p.

Rowe, S.J. (2009). Conservation Services Programme observer report 01 July 2007 to 30 June 2008. Marine Conservation Services, Series 4. Department of Conservation, Wellington. 97p.

Rowe, S. (2010). Level 1 Risk Assessment for Incidental Seabird Mortality Associated with New Zealand Fisheries in the NZ-EEZ, Marine Conservation Services, Department of Conservation. Wellington. 75p.

Thrush, S.F; Dayton, P.K (2002). Disturbance to Marine Benthic Habitats by Trawling and Dredging: Implications for Marine Biodiversity. Annual Review of Ecology and Systematics, Vol. 33, pp. 449-473

Smith, M.H.; Baird, S.J. (2009). Model-based estimation of New Zealand fur seal (Arctocephalus forsteri) incidental captures and strike rates for trawl fishing in New Zealand waters for the years 1994–95 to 2005–06. New Zealand Aquatic Environment and Biodiversity Report No. 40. 90 p.

Snelder , T.; Leathwick, J.; Dey, K,; Weatherhead, M.; Fenwick, G.; Francis, M.; Gorman, R.; Grieve, J.; Hadfield, M.; Hewitt, J.; Hume, T.; Richardson, K.; Rowden, A.; Uddstrom, M.; Wild, M.; Zeldis, J. (2005). The New Zealand Marine Environment Classification, Ministry for the Environment, Wellington. 70p.

Stevens, D.W.; O'Driscoll, R.L.; Horn, P.L. (2009). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2009 (TAN0901). New Zealand Fisheries Assessment Report 2009/55. 91p.

Thompson, F.N.; Abraham, E.R. (2009). Estimation of the capture of New Zealand sea lions (Phocarctos hookeri) in trawl fisheries from 1995–96 to 2006–07 New Zealand Aquatic Environment and Biodiversity Report No. 41. 31 p.

Thompson, F.N.; Abraham, E.R.; Oliver M.D. (2010). Estimation of fur seal bycatch in New Zealand trawl fisheries, 2002–03 to 2007–08. New Zealand Aquatic Environment and Biodiversity Report No. 56. 29p.

Thompson, F.N.; Oliver, M.D.; Abraham, E.R. (2010). Estimation of the capture of New Zealand sea lions (Phocarctos hookeri) in trawl fisheries from 1995–96 to 2007–08 New Zealand Aquatic Environment and Biodiversity Report No. 52. 25p.

Tracey, D. (2007). Identification of protected corals. (Unpublished report prepared for Department of Conservation, Wellington) 47p.

Tracey, D; Mackay, E.; Gordon, D.; Sanchez, J.; Opresko, D.; Rowe, S. (2008). Coral Identification Guide. Prepared for Marine Conservation Services Department of Conservation, Wellington. 16p.

Tuck, I.; Cole, R.; Devine, J. (2009). Ecosystem indicators for New Zealand fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 42. 188 p.

Waugh, S.M.; MacKenzie, D.I.;Fletcher, D. (2008). Seabird bycatch in New Zealand trawl and longline fisheries, 1998–2004. Papers and Proceeding of the Royal Society of Tasmania 142(1): 45–66.

Wood, R. (2010). Analysis of hoki trawl footprint and BOMEC areas. (Report to Deepwater Group Limited, 15 September 2010)

APPENDIX 4

LATIN NAMES OF SPECIES REFERRED TO IN THE REPORT

Common name	Latin name
Hoki	Macruronus novaezelandiae
Ling	Genypterus blacodes
Javelinfish	Lepidorhynchus denticulatus
Rattails	Macrouridae (Family)
Silver warehou	Seriolella punctata
Hake	Merluccius australis
Spiny dogfish	Squalus acanthias
Frostfish	Lepidopus caudatus
White warehou	Seriolella caerulea
Pale ghost shark	Hydrolagus bemisi
Black oreo	Allocyttus niger
Shovelnose dogfish	Deania calcea
Ribaldo	Mora moro
Southern blue whiting	Micromesistius australis
Lookdown dory	Cyttus traversi
Baxter's lantern dogfish	Etmopterus baxteri
Alfonsino	Beryx splendens
Sea perch	Helicolenus spp.
Common warehou	Seriolella brama
Arrow squid	Nototodarus sloanii, N. gouldi
Sharks & Dogfish (Not otherwise specified)	Selachii (Order)
Redbait	Emmelichthys nitidus
Giant stargazer	Kathetostoma spp.
Jack mackerel	Trachurus declivis, T. murphyi, T. novaezelandiae
Ray's bream	Brama brama
Silverside	Argentina elongata
Smooth skate	Dipturus innominatus
Barracouta	Thyrsites atun
Orange roughy	Hoplostethus atlanticus
Spiky oreo	Not evaluatedocyttus rhomboidalis
Warty squid	Moroteuthis spp.
Long-nosed chimaera	Harriotta raleighana
Ghost shark	Hydrolagus novaezealandiae
Seal shark	Dalatias licha
Smooth oreo	Pseudocyttus maculatus
Red cod	Pseudophycis bachus
Bluenose	Hyperoglyphe antarctica
Porbeagle shark	Lamna nasus
Gemfish, southern kingfish	Rexea spp.

Longnose velvet dogfish	Centroscymnus crepidater
Common name	Latin name
Scabbardfish	Benthodesmus spp.
Leafscale gulper shark	Centrophorus squamosus
Deepsea flathead	Hoplichthys haswelli
Olivers rattail	Caelorinchus oliverianus
Rudderfish	Centrolophus niger
Banded bellowsfish	Centriscops humerosus
Silver dory	Cyttus novaezealandiae
Deepwater dogfish (Unspecified)	N/A
Lucifer dogfish	Etmopterus lucifer

APPENDIX 5

FULL PROGRAMME – HOKI ERA WORKSHOP

Venue – Seafood Industry House, 74 Cambridge Terrace, Wellington

2 days, 0800-1700 13-14 December 2010,

MONDAY 13 DECEMBER 2010

0800-0815	Welcome & introduction from the Chair
0815-0900	Alignment and consistency discussion - ERA Panel discuss interpretations and understanding of ERA method and definitions
0900-1015	Target and major bycatch fish species
1015-1030	Morning break - refreshments
1030-1130	Minor bycatch fish species
1130-1215	Non-fish bycatch
1215-1230	Wrap up of Target and Bycatch session
1230-1310	Lunch (supplied)
1310-1315	Introduction to Protected Species session from the Chair
1315-1345	Protected species - bird
1345-1430	Protected species - marine mammals (fur seals, sea lions, other)
1430-1500	Protected species - corals
1500-1515	Afternoon break - refreshments
1515-1530	Protected species - fish (basking sharks)
1530-1630	Other at risk, endangered or threatened non-fish species
1630-1645	Wrap up of Protected Species session
1645-1700	Review of progress, comments, feedback

TUESDAY 14 DECEMBER 2010

0800-0815	Welcome & introduction to Benthic Session from the Chair
0815-0845	Discussion of trawl impact on seabed and hoki trawl footprint information
0845-0915	Discussion of BOMEC classes/gridcodes & benthic habitat types
0915-1000	Discussion of benthic habitat; fauna, structure & function
1000-1015	Morning break - refreshments
1015-1130	Impacts on benthic habitat, structure and function
1130-1200	Wrap up of Benthic Session
1200-1240	Lunch (supplied)
1240-1300	Introduction to Trophic Session
1300-1500	Trophic impacts
1500-1515	Afternoon break - refreshments
1515-1545	Wrap up of Trophic Session
1545-1700	Summary and Review of Workshop

APPENDIX 6

Protocols for the hoki ERA Panel

1. The hoki ERA expert panel (the ERA Panel) agrees to apply its collective expertise, knowledge and professional judgement in an objective manner in undertaking the formal risk assessment for the updated Level 1 hoki ecological risk assessment.
2. A precautionary approach will be adopted where there is an absence of information.
3. The ERA Panel agrees to use consensus decision making as a guiding principle. Where consensus cannot be reached, alternative views will be recorded and the reasons for these will be documented.
4. ERA Panel members agree to use their professional knowledge and expertise in an independent manner rather than representing any policies or viewpoints of the organisations to which they may belong.
5. The ERA Panel members agree to operate openly and constructively together in the course of undertaking their assessment and all information will be shared.
6. The ERA Panel agrees to endeavour to make its assessment technically robust to the extent that is possible given the available information or lack of information and its collective expertise.
7. ERA Panel members individually or collectively may seek advice, information or comments from stakeholders or observers present at the hoki ERA workshop that have specific technical knowledge, expertise or information but having received any advice, information or comments, the ERA Panel will itself make the assessments of risk.
8. At the ERA workshop, the ERA Panel will be responsible for matters of interpretation but will be guided by the Facilitator in doing so.
9. The ERA Panel may add to or amend these protocols by agreement between themselves but only after approval by the Facilitator.

APPENDIX 7

DEEPWATER DOGFISH SPECIES INCLUDED IN ASSESSMENT OF MINOR BYCATCH SPECIES

Species name	Common name
Apristurus spp.	Cat shark
Centrophorus squamosus	Leafscale gulper shark
Centroscymnus coelolepis	Potuguese dogfish
Centroscymnus crepidater	Longnose velvet dogfish
Centroscymnus owstoni	Smooth skin dogfish
Centroscymnus plunketi	Plunket's shark
Dalatias licha	Seal shark
Deania calcea	Shovelnose dogfish
Etmopterus baxteri	Baxter's lantern dogfish
Etmopterus lucifer	Lucifer dogfish
Etmopterus spp.	Etmopterus spp.
Oxynotus bruniensis	Prickly dogfish

DEEPWATER SKATES AND RAYS INCLUDED IN ASSESSMENT OF MINOR BYCATCH SPECIES

Amblyraja hyperborea	Deepwater spiny skate
Bathyraja richardsoni	Long-tailed skate
Bathyraja shuntovi	Longnosed deepsea skate
Dasyatis brevicaudatus	Richardson's skate
Dasyatis brevicaudatus	Short-tailed black ray
Notoraja spp.	Deepsea skates

APPENDIX 8

TABLE 21 FROM ROWE (2010)

Table 21: Seabird species potentially at risk from middle depth trawl finfish fisheries

Common name	Exposure	Consequence	Potential risk score	Risk category	Optimum exposure	Actual risk	Optimum risk category
White-chinned petrel	5	4	20	High	5	20	High
Salvin's albatross	5	4	20	High	3	12	Moderate
Sooty shearwater	5	3	15	High	5	15	High
White-capped albatross	5	3	15	High	3	9	Moderate
Black-browed albatross	4	3	12	Moderate	3	9	Moderate
Southern Buller's albatross	4	3	12	Moderate	3	9	Moderate
Chatham albatross	3	4	12	Moderate	2	8	Moderate
Grey petrel	3	3	9	Moderate	3	9	Moderate
Common name	Exposure	Consequence	Potential risk score	Risk category	Optimum exposure	Actual risk	Optimum risk category
Northern Buller's albatross	3	2	6	Low	2	4	Low
Campbell albatross	3	2	6	Low	2	4	Low
Northern giant petrel	3	1	3	Low	2	2	Low
Southern giant petrel	3	1	3	Low	2	2	Low
Antipodean albatross	2	2	4	Low	1	2	Low
Gibson's albatross	2	2	4	Low	1	2	Low
Southern royal albatross	2	2	4	Low	1	2	Low
Wandering albatross	2	2	4	Low	1	2	Low
Westland petrel	2	2	4	Low	2	4	Low
Cape petrel	2	1	2	Low	2	2	Low
Snares Cape petrel	2	1	2	Low	2	2	Low
Northern royal albatross	1	1	1	Negligible	1	1	Negligible
Grey-headed albatross	1	1	1	Negligible	1	1	Negligible
Light-mantled albatross	1	1	1	Negligible	1	1	Negligible

APPENDIX 9

MARINE PROTECTED SPECIES IN NEW ZEALAND

All marine mammals
All seabirds (except black backed gulls)
All marine reptiles
Black corals (all species in the order Antipatharia)
Gorgonian corals (all species in the order Gorgonacea)
Stony corals (all species in the order Scleractinia)
Hydrocorals (all species in the family Stylasteridae)
Basking shark (*Cetorhinus maximus*)
Deepwater nurse shark (*Odontaspis ferox*)
White pointer shark (*Carcharodon carcharias*)
Whale shark (*Rhincodon typus*)
Manta ray (*Manta birostris*)
Spinetail devil ray (*Mobula japanica*)
Giant grouper (*Epinephelus lanceolatus*)
Spotted black grouper (*Epinephelus daemelii*)