Ministry of
Fisheries
Te Tautiaki i nga tini a Tangaroa

10 Year Research Programme for Deepwater Fisheries

Management and Research Summaries

New Zealand Government

10-Year Research Programme for Deepwater Fisheries

Management and Research Summaries

As part of the 10-Year Research Programme for Deepwater Fisheries (10 Year Plan), research will be conducted to assess the abundance of fishstocks, and to monitor the effects that fishing has on the aquatic environment. This document provides more detailed information about what research is proposed for each of the 26 species managed as part of the National Deepwater Fisheries Plan. It also describes in more detail the accompanying research that will be conducted to monitor the environmental effects of that fishing activity.

The information in this document is divided into three sections. The first two sections summarise the following information for each of the nine Tier 1 species and the 16 Tier 2 species:

- The proposed management objectives and approach
- A brief summary of current knowledge and past research
- The proposed research that will be conducted on stock monitoring and assessment
- The proposed research to monitor environmental interactions

Outstanding research issues are identified for each of the species in the 10 Year Plan and additional research will be considered as part of the Additional Research component of the 10 Year Plan. This will be subject to a prioritisation process if demands are greater than available funding and in some cases improved baseline information from observer sampling will be required before these issues can be addressed adequately.

The third section describes the core research that will be conducted to monitor the effects of fishing on the aquatic environment.

- Benthic habitat interactions
- Endangered, threatened or protected species
- Fish bycatch and discards
- Ecosystem functioning and trophic linkages

Additional research will be indentified to address information gaps or respond to management needs, and as above, this will subject to a prioritisation process.

All of the research included in the 10 Year Plan is primarily cost recovered. Exceptions exist where an environmental impact is directly attributable to deepwater fishing activity such as some sea lion research or spatial management of deepwater benthic interactions in the EEZ. This research is included in the 10 Year Plan although it is jointly funded by both the Crown and the fishing industry through cost recovery.

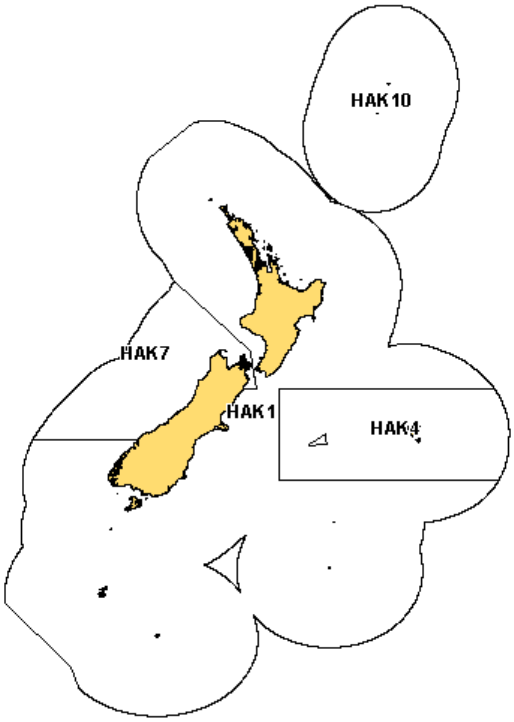
However, research to support standards development is generally excluded from the 10 Year Plan and will be progressed through the Ministry's other science planning processes. Possible exceptions include situations where the standard, or an identifiable component of the standard, exclusively applies to deepwater fisheries. This exception exists because it may be possible to deliver the necessary research through the 10 Year Plan with only a marginal increase in cost (e.g. collecting stomachs for analysis on trophic relationships).

10-Year Research Programme for Deepwater Fisheries

Management and Research Summaries

Part 1: Tier 1 Species

1. HAKE (HAK)



Introduction

Hake is assessed and managed as three separate stocks, HAK 1, 4 and 7.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
HAK1	Auckland, Central, Southeast, Southland, Sub-Antarctic	1,2,3,5,6,8 & 9	3,701	3,701	3,415
HAK4	South-East (Chatham Rise)	4	1,818*	1,800	856
HAK7	Challenger	7	7,777†	7,700	5,954
HAK10	Kermadec	10	10	10	0
Total			13,306	13,211	10,225

* Note that the HAK4 TAC includes an 18 tonne allowance for other sources of fishing related mortality

† Note that the HAK7 TAC includes a 77 tonne allowance for other sources of fishing related mortality

Management approach

These three main hake stocks (HAK 1, 4 and 7) are all Tier 1 stocks, for which formal stock assessments will be carried out at 2-3 year intervals. CPUE standardisation, stock characterisations and monitoring of stock biomass, as described below, will inform these stock assessments. These stock assessments are informed, in turn, by the annual monitoring of stock biomass in each of the three fisheries as described below.

The assessments will provide estimates of stock status, in line with the reference points described in the harvest strategy below, and will be used to inform TAC/TACC decisions.

Harvest strategy

The following table details the generic reference points and corresponding management responses that will be used for the three hake stocks, based on the Harvest Strategy Standard. Stock-specific reference points and associated management responses for each of the hake stocks will likely be developed as part of the National Deepwater Fisheries Plan.

Table 2: Harvest strategy for hake

Reference point	Management response
Management target of 40% B_0	Stocks are permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which the hake fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fish plan status

Hake is not yet included in the National Deepwater Fisheries Plan. Work on a specific chapter for hake is planned to commence during 2010-2011. The hake chapter of the Deepwater Fisheries Plan will detail the management and operational objectives for each of the hake stocks.

Summary of current knowledge

Stock assessment

Stock assessments are available for all hake stocks. However, there are no abundance indices for HAK7 available; the model relies on changes in the catch at age data to determine the fishing mortality rates for the stock. The lack of contrast in abundance indices (trawl survey relative biomass estimates) in the sub-Antarctic (HAK1) means that the level of current biomass is very uncertain, although the stock status is considered to be well above target levels.

Stock structure

There is good evidence to suggest that at least three separate stocks may exist in the EEZ. There are three main hake spawning areas; off the west coast of the South Island, on the Chatham Rise and on the Campbell Plateau. Juvenile hake are found in all three areas. There are differences in size frequencies of hake between the west coast and other areas, and differences in growth parameters between all three areas.

The Chatham Rise (HAK4) stock is considered to include the whole of the Chatham Rise (including the western end currently forming part of the HAK1 management area). The sub-Antarctic stock is considered to comprise the Southland and sub-Antarctic management areas (HAK1) and the third stock is the west coast South Island (HAK7).

Productivity

Hake growth rates are known for the three stocks from otolith readings. Routine catch at age data are collected from the trawl surveys and the main commercial fisheries. Year class strength is estimated within the assessment models.

Stock monitoring – the historical data series

Both HAK1 and HAK4 have been surveyed as part of the fisheries independent sub-Antarctic and Chatham Rise wide area trawl surveys. Surveys have been completed on a regular basis since 1991 for HAK1 and 1992 for HAK4. There is no fisheries independent data available for the HAK7 stock.

CPUE data from the commercial fisheries, and catch-at-age data from both the commercial trawl fisheries and the research trawl surveys has also been collected.

Table 3: The historical series of hake abundance indices and catch at age data.

Fishstock	Trawl surveys	CPUE	Catch at age
HAK 1	1991-93, 2000-09	Trawl fishery 1990-2006	Trawl fishery 1990, 1992-94, 1996, 1998-2008 Research survey: 1989, 1991-93, 1996, 1998, 2000-09
HAK 4	1992-2010	Trawl fishery 1991-2006	Trawl fishery: 1992, 1995-6, 1998-2002, 2004-05, 2007-09 Research survey: 1989, 1992-2010
HAK 7			Trawl fishery: 1990-2009

10 Year Research Plan – stock monitoring and assessment

Overview

The three Tier 1 hake stocks will undergo stock assessments at least every 2-3 years using the stock assessment models that have been revised (HAK1 and HAK4) and developed (HAK7). The models will be informed by the following research, depending on which of the hake stocks is being assessed:

- Wide-area trawl survey on the Chatham rise
- Biennial wide-area trawl survey on the Sub-Antarctic
- Combined trawl and acoustic survey on the West Coast South Island (new research under development)
- Regular CPUE analysis
- Regular length-frequency sampling and otolith collection by Observers and during trawl surveys
- Routine catch-at-age analysis

Trawl surveys

Chatham Rise Survey: Continuation of the trawl survey series is planned for the Chatham Rise (HAK4) in eight of the ten years of the 10 year plan. This survey is a priority for regular delivery due to the reliable catch and biological information that is collected for a number of stocks including HAK4.

Sub-Antarctic Survey: The sub-Antarctic (HAK1) survey will occur biennially under the 10 year plan, alternating with the proposed trawl survey on the west coast of the South Island (WCSI). The Sub-Antarctic survey provides reliable abundance, catch and biological information for a number of stocks including HAK1

WCSI trawl Survey: A new trawl survey is proposed for the WCSI to address the lack of fisheries independent data for the HAK7 stock. The ability of this survey to successfully contribute to the HAK7 stock assessment is unknown. It is proposed to undertake this survey, starting in winter 2011, for three consecutive years in order to assess methodologies and to determine the utility of results. At the end of this period the viability/validity of the survey will be reviewed. If this review indicates the survey is worthwhile (recognising that its validity may be based on successfully providing information for species other than hake) then the survey will occur biennially, in order to alternate with the sub-Antarctic survey. If the results of the review indicate that this survey is not viable then it will be discontinued. If this is the case, alternative approaches for surveying HAK7 will be explored.

CPUE analyses

CPUE from the trawl fisheries will be used as input to the stock assessments for Chatham Rise (HAK4) and the Sub-Antarctic (HAK1) stocks, and possibly the WCSI (HAK 7) stock.

Observer sampling

Under the 10 year research programme there will be full observer coverage across the deepwater fishing fleet, although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform stock assessments will consist of:

1. Otolith collection
2. Length-frequency sampling
3. Staging

Otoliths will be collected annually from the three main commercial trawl fisheries by Observers and on the trawl surveys by researchers as follows:

Table 4: Numbers of otoliths collected from each hake stock

Fishstock	Collection method	Otolith numbers
HAK 1	Trawl fishery Research survey	500 each sex 500 each sex
HAK 4	Trawl fishery Research survey	500 each sex 500 each sex
HAK 7	Trawl fishery Research survey	500 each sex 500 each sex

Observers will also complete regular length-frequency sampling and regularly stage fish across each of the main hake fisheries.

Routine ageing

Otoliths collected by observers from commercial fisheries will be aged each year as part of a routine ageing programme.

10 Year Research Plan – Monitoring environmental interactions

Environmental monitoring

Each deepwater vessel will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

Hake is taken by trawling which may have an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the hake fishery against any relevant environmental standards.

Endangered, threatened and protected species

The hake fishery is known to have limited interactions with seabirds and marine mammals, particularly fur seals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the hake fishery against any relevant environmental standards. If any part of the hake fishery does not meet the prescribed environmental standards, then further research into appropriate mitigation measures will be delivered though the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[1] For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A level 1 risk assessment is also planned for non-QMS bycatch.

[1] Observer data from target hake tows shows that 66.4% of the catch is hake and 94.4% comprises hake and other QMS species, this will vary among fisheries.

Outstanding issues

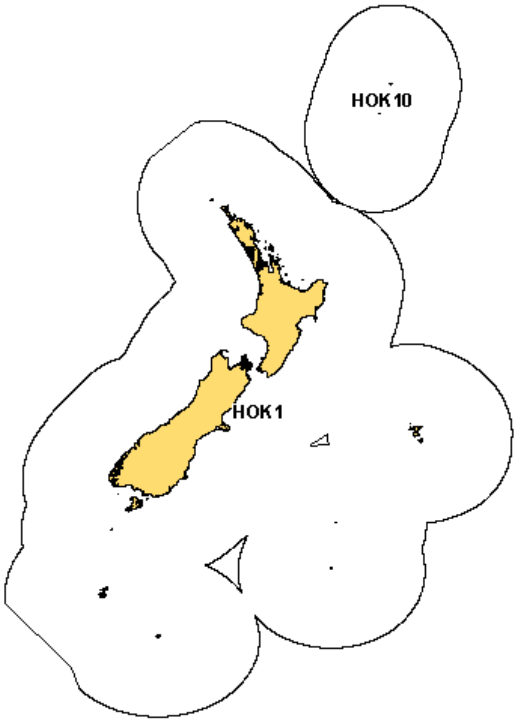
Stock assessment

- There are no abundance indices for the west coast South Island stock (HAK7). The model relies on changes in the catch at age data to determine the fishing mortality rates for the stock.
- The lack of contrast in abundance indices (trawl survey relative biomass estimates) in the sub-Antarctic (HAK1) means that the level of current biomass is very uncertain, although the stock status is considered to be well above target levels.

Stock structure

The appearance of spawning hake on the western Chatham Rise (near the Mernoo Bank) raises the possibility that there may be more than one stock on the Chatham Rise.

2. HOKI (HOK)



Introduction

Hoki is both assessed and managed as two separate stocks (eastern and western) included under a single TAC and QMS fish stock (HOK1). The current TACC is managed under separate catch limits for the western (50,000 t) and eastern stocks (60,000 t).

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fish stock	QMA	FMA	TAC	TACC	Landings (2008-09)
HOK1	All areas except FMA 10	1 to 9	111,040	110,000	88,805**
HOK10	Kermadec	10	10	10	0
Total			11,050	110,010	88,805*

*Note that the hoki TAC includes a 1000 tonne allowance for other sources of fishing related mortality and 20 tonne allocations to both customary and recreational fishers.

**2008-09 landings were against a TACC of 90,000 t.

Management approach

HOK1 is a Tier 1 stock.

The management approach for hoki is assessment-based and leads to regular TAC/TACC reviews based on the results of an annual stock assessment. The stock assessment is informed, in turn, by the annual monitoring of stock biomass of the eastern and western stocks as described below. The assessment provides estimates of stock status in line with the reference points described in the hoki harvest strategy described below.

Harvest strategy

The harvest strategy for hoki (both stocks) is described in the table below.

Table 2: Harvest strategy for hoki

Harvest strategy components	Management response
Management target range of 35-50% B_0	Catch levels set to maintain stock size within the target range
Soft limit of 20% B_0	A formal time-constrained rebuilding plan will be implemented if the stock size falls below this limit
Hard limit of 10% B_0	The limit below which the hoki fishery will be considered for closure
Rebuild strategy	Catch limit to be set so that the fishery will deliver half the rate of rebuild that would occur in the absence of fishing
Harvest control rule	There is currently no defined harvest control rule for hoki. Currently catch limits are determined by the results of five year projections of stock status against biological reference points using the results of the hoki stock assessment

Fisheries plan status

The hoki fishery is included within the current National Deepwater Fisheries Plan. Full details of the management and operational objectives that relate to the hoki fishery can be found in this plan.

Summary of current knowledge

Stock assessment

A robust stock assessment model is available for hoki and reliable estimates of the key parameters within this stock assessment model are also available (age structure, growth rates and stock productivity).

Stock structure

Morphometric and ageing studies have clearly demonstrated that there are at least two sub-populations of hoki. Hoki off the west coast of the North and South Islands and the area south of New Zealand (including Puysegur, Snares and the Southern Plateau) are assumed to be one stock unit (the "western stock"). Mature hoki in the area of the east coast South Island, Mernoo Bank, Chatham Rise, Cook Strait and the east coast North Island up to North Cape are assumed to be the other stock unit the other stock unit (the "eastern stock"). Immature fish of both stocks are found mixed on the main nursery ground, the Chatham rise. The genetic relationship between the two stocks is poorly determined.

Productivity

Hoki growth rates are known for both stocks from otolith readings. Routine catch at age data are collected from the four main commercial trawl fisheries and from two wide-area trawl surveys. Year class strength for each stock is estimated within the assessment models.

Stock monitoring – historical data series

Abundance biomass estimates have been obtained from fisheries-independent wide area trawl surveys while catch at age data is collected from both the commercial trawl fishery and research surveys.

Table 3: Historic trawl surveys and sources of catch-at-age data

Fish stock	Trawl surveys (wide-area)	Catch at age data source
HOK1 (western non-spawning stock)	1991-93 and 2000-09	Commercial trawl fishery: 2001-04, 2006-09 Research trawl surveys: 1991-93, 2000-09
HOK1 (eastern non-spawning stock)	1992-2010	Commercial trawl fishery: 1999-2009 Research trawl surveys: 1992-2010

In addition abundance estimates are available from acoustic surveys conducted in the spawning aggregations in Cook Strait and Pegasus areas (eastern stock) and off the west coast of the South Island (western stocks).

Table 4: Historic acoustic surveys and sources of catch-at-age data

Fish stock	Acoustic surveys (spawning area)	Catch at age data source
HOK1 - WCSI (western spawning area)	1988-93, 1997 and 2000	Commercial trawl fishery: 1988-2009
HOK 1 - Cook Strait (eastern spawning area)	1991, 1993-99, 2001-03 and 2005-09	Commercial trawl fishery: 1988-2009

CPUE indices from trawl fisheries are not currently used as an input to the stock assessment for hoki as the trends in the indices do not match the trawl survey data.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

Hoki will undergo an annual stock assessment using a multi-stock model for both stocks simultaneously, supported by the following research

- Wide-area trawl survey on the Chatham rise
- Biennial wide-area trawl survey on the Sub-Antarctic
- Biennial acoustic surveys of the eastern spawning stock in the Cook Strait
- Combined trawl and acoustic survey on the West Coast South Island (new research under development)
- Regular length-frequency sampling by Observers
- Routine catch-at-age analysis of otoliths collected by Observers and during trawl surveys

Trawl surveys

Chatham Rise Survey: A bottom trawl survey with a priority focus on surveying both the eastern and western hoki stock non-spawning juvenile population and the eastern stock adult population. The survey also collects catch information on all species caught and biological information on a range of species on the Chatham Rise including hake, ling and many of the Tier 2 and Tier 3 species. For these reasons the survey is a priority for regular delivery and will occur in eight years over the 10 year planning period.

Sub-Antarctic Survey: As with the Chatham Rise trawl survey the sub-Antarctic survey is a bottom trawl survey with a targeted focus on monitoring the non-spawning western hoki stock (the adult western stock population). This survey also collects abundance information on a wide range of species in the sub-Antarctic including hake, ling and many of the Tier 2 species. This survey will occur biennially from 2010, alternating with the other western stock survey on the WCSI.

WCSI trawl and acoustic survey: This is a new survey designed to monitor the stock size of a range of species on the WCSI including the western hoki spawning stock.

The ability of this survey to successfully contribute to the hoki stock assessment is currently unknown. The survey will take place, starting in winter 2011, for three consecutive years in order to assess methodologies and to determine utility of results. At the end of this period the viability/validity of the survey will be reviewed. If this review indicates the survey is worthwhile (recognising that its validity might be based on successfully providing information for species other than hoki) then the survey will occur biennially. At that point it will alternate with the sub-Antarctic survey. If the results of the review indicate that this survey is not viable then it will be discontinued and the sub-Antarctic survey may return to an annual survey to ensure more regular monitoring of the western hoki stock.

Acoustic surveys

Two acoustic surveys will take place under this research programme – one each in the eastern and western hoki spawn fisheries.

Cook Strait acoustic survey: The Cook Strait spawning stock has been regularly surveyed acoustically to provide relative estimates of spawning biomass for the eastern stock; the results of this survey are included in the hoki stock assessment. Although these survey estimates do not exert a strong influence on the results of the stock assessment they appear to provide a reliable indicator of trends in stock size. This survey will continue biennially.

WCSI acoustic survey: Included as part of the WCSI trawl survey described above. This will survey hoki on the WCSI from around the Hokitika Canyon south to the Cook Canyon. As this is a new survey it is difficult at this stage to determine how it will contribute to the hoki stock assessment. However, it should provide some indication of trends in spawning stock size.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the annual stock assessment will consist of:

1. Otolith collection
2. Length frequency sampling
3. Gonad stage sampling (females)

Otoliths will be collected annually from the four main commercial trawl fisheries by Observers and on the trawl surveys by researchers. The following numbers of otoliths will be read each year:

Table 5: Planned hoki otolith sampling

Fishstock	Fishing method	Otolith numbers (readings)
HOK1 (western stock)	Trawl fishery Research survey	600 each sex 400 each sex
HOK1 (eastern stock)	Trawl fishery Research survey	600 each sex 400 each sex
HOK1 – WCSI* (western spawning area)	Trawl fishery	400 each sex
HOK 1 - Cook Strait* (eastern spawning area)	Trawl fishery	400 each sex

* includes possibility of shed sampling

Catch at age analysis

Otoliths collected by observers from commercial fisheries will be aged each year as part of a routine ageing programme.

10 Year Research Plan – Monitoring environmental interactions

Environmental monitoring

Each deepwater vessel will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic Impacts

Hoki is taken by trawling which will have an impact on seabed communities particularly when fished using bottom trawl gear. This occurs primarily on the Chatham Rise while on the WCSI fish are primarily taken using mid-water gear. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the hoki fishery against any relevant environmental standards.

Endangered, threatened or protected species

The hoki fishery is known to have incidental interactions with seabirds and marine mammals. Monitoring information collected by observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the hoki fishery against any relevant environmental standards. If the hoki fishery is not meeting environmental standards then further research on mitigation measures etc. will be delivered through the annual Additional Research fund.

Fish bycatch

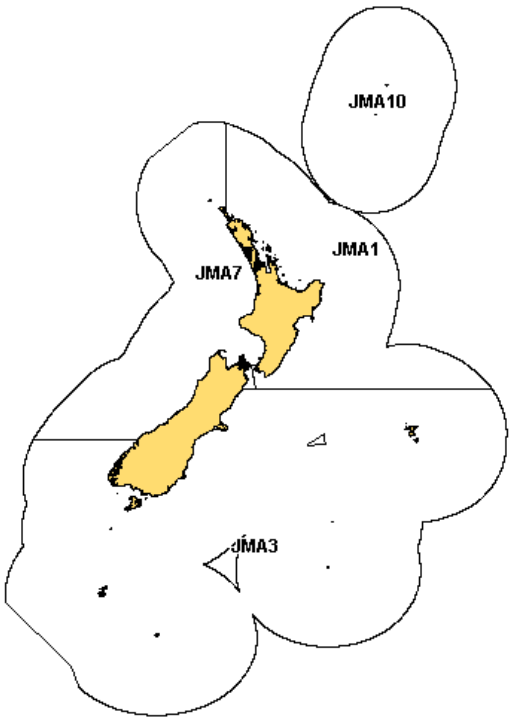
Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[2] For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment for non-QMS bycatch will occur during 2011 - 2012.

Outstanding issues

None currently identified

[2] Observer data from target hoki tows shows that on average 84.7% of the catch is hoki and 95.1% comprises hoki and other QMS species.

3. JACK MACKERELS (JMA)



Introduction

Three species of jack mackerel are managed together as JMA: *Trachurus declivis*, *T. novaezelandiae*, and *T. murphyi* (Peruvian jack mackerel). Jack mackerel are almost exclusively a target species on the west coast of the North and South Islands in JMA 7. Much of the catch in JMA 3 is also targeted although the balance in this area comes from trawl bycatch of squid and barracouta on the Chatham Rise and in the Southland/Sub-Antarctic region. A summary of TACCs (t), and reported landings (t) for the most recent fishing year.

Note: Increased availability of jack mackerels caused by the influx of *T. murphyi* resulted in an increased TACC in JMA3 to 9,000 t for the 1993–94 fishing year, and a further increase to 18,000 t for the 1994–95 year. The latter increase was made on the proviso that the additional catch was *T. murphyi* only; combined landings of *T. declivis* and *T. novaezelandiae* would not exceed the original quota of 2,700 t.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-09
JMA1	Auckland (East), Central (East)	1 and 2	10,000	10,000	9,791
JMA3	South-East, Southland, Sub-Antarctic	3, 4, 5 and 6	18,000	18,000	1,964
JMA7	Challenger, Central (West), Auckland (West)	7, 8 and 9	32,536	32,536	28,828
JMA10	Kermadec	10	10	10	0
Total			60,547	60,547	40,582

* There is no customary or recreational allowance for squid and nor is there an allocation for other sources of fishing related mortality. As a result the TAC and TACC are the same

Management approach

JMA 7 and JMA 3 (*T. declivis* and *T. novaezelandiae*) are Tier 1 stocks. JMA 7 will undergo formal stock assessments at 2 year intervals (a full stock characterisation will form the first component of this stock assessment). JMA3 will undergo a full characterisation only. JMA 3 may move to more formal stock assessments if the necessary information becomes available from onboard catch and effort monitoring. Note that JMA1 is outside the 10 year plan as it is primarily a purse seine fishery that is not part of the deepwater fisheries complex.

Harvest strategy

The following are generic reference points and corresponding management responses that will be applied to JMA 3 and 7. Stock-specific reference points and associated management responses may be developed as part of the Deepwater Fisheries Plan:

Table 2: Harvest strategy for jack mackerel

Reference point	Management response
Management target of 40% B_0	Stocks are permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which the fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fisheries plan status

Jack mackerel is not yet included in the National Deepwater Fisheries Plan; a specific chapter will be included in the future.

Summary of current knowledge

Stock assessment

Stock assessments for jack mackerel are complicated by the reporting and management of three species under a single code. Preliminary stock assessments for *T. declivis* and *T. novaezealandiae* in JMA 7 were undertaken in 2007 based on data from a new Bayesian analysis for splitting the recorded commercial catch into *T. declivis*, *T. novaezealandiae*, and *T. murphyi* components. This analysis was used to derive catch history and CPUE indices for the *T. declivis* fishery in JMA 7, which were incorporated, along with a proportions-at-age series, into the assessments.

The 2007 preliminary assessment for *T. declivis* did not indicate sustainability concerns with this component of JMA 7 at that time; however, there are uncertainties in the assessment relating to the catch history and abundance indices.

Stock structure

For the two New Zealand jack mackerel species, the geographic separation of the fisheries has been used to define stocks for assessment and management.

There are two possible hypotheses on the stock structure of *T. murphyi* in New Zealand waters: it is either a separate stock established by fish migrating from South America, or part of a single, extensive trans-Pacific stock. While successful recruitment in New Zealand waters would indicate the establishment of a separate stock, current evidence favours the latter hypothesis with an extensive stock between latitudes 35–50°S, linking the coasts of Chile and New Zealand across what has been described as "the jack mackerel belt".

Productivity

T. novaezelandiae and *T. declivis* have moderate initial growth rates that slow after about 6 years. Both species reach a maximum age of 25+ years. Routine catch at age data has been collected sporadically from the main commercial fisheries. This should allow selectivity and year class strength to be estimated within the assessment models.

Initial ageing of *T. murphyi* taken in New Zealand waters has been recently completed, but the estimates are yet to be validated. Initial growth is rapid, slowing at 6–7 years, and *T. murphyi* is a moderately long-lived species with a maximum observed age of 32 years.

Stock monitoring – the historical data series

Trawl surveys have not previously been conducted to monitor biomass of jack mackerel stocks. The following table details the historical series of abundance indices and catch at age data.

Table 3: Historical series of abundance indeces and catch at age data for the jack mackerel stocks

Species	Fishstock	Trawl surveys	CPUE	Catch at age
T. declivis	JMA7		1990-96 1997-2005	1990-91, 1996, 2005, 2007-08
	JMA3			2007-08
T. novaezelandiae	JMA7		1990-96 1997-2005	1996, 2005, 2007 -08
	JMA3			2007-08
T. murphyi	All EEZ			2007-08

10 Year Research Plan – stock monitoring and assessment

Overview

JMA 7 will undergo formal stock assessment every two years. This will be based on a dedicated monitoring by trawl or acoustic survey, CPUE data and catch at age data. Whether trawl or acoustic monitoring will be used long-term has yet to be confirmed. Both methods will be investigated under the 10 year plan and the most appropriate will be selected as an ongoing monitoring tool. This document will be updated to reflect this decision.

JMA 3 will undergo a characterisation as part of the JMA 7 assessment.

Trawl surveys

A new trawl survey series is proposed for the west coast North Island to monitor JMA7. This would be designed to measure jack mackerel abundance. The trawl surveys of Chatham Rise and the Sub-Antarctic (JMA3) have not monitored mackerel abundance in the past as the vessel towed at the slower speeds required to catch hoki.

Acoustic surveys

MFish is working with industry to test the feasibility of using acoustic surveys for JMA7; particularly the ability to distinguish among species. Mark identification tows would be required as part of an acoustic survey, the high number of such tows required may reduce any benefit of doing an acoustic survey.

CPUE analyses

CPUE from the trawl fisheries will be used as input to the stock assessments for JMA7. A stock assessment model has been developed for *T. declivis* in JMA7 (up to 2005) and work on a similar model for *T. novaezelandiae* in JMA7 will be carried out in 2010. CPUE will also be used to monitor JMA 3 but without a formal assessment.

Observer sampling

Otoliths and length frequency data will be collected annually from the main trawl commercial fisheries by Observers or researchers as follows:

Table 4: Planned jack mackerel otolith sampling

Fishstock	Fishing method	Otolith numbers
JMA7 (all 3 species)	Trawl fishery Research survey	400 each sex 400 each sex
JMA3 (all 3 species)	Trawl fishery	400 each sex

Catch at age analysis

Otoliths collected by observers from commercial fisheries will be aged each year as part of a routine ageing programme.

10 Year Research Plan – Monitoring environmental interactions

Environmental monitoring

Each deepwater vessel will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

Jack mackerel is taken by trawling which may have an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the jack mackerel fishery against any relevant environmental standards.

Endangered, threatened and protected species

The jack mackerel fishery is known to have limited interactions with seabirds and marine mammals, particularly fur seals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the jack mackerel fishery against any relevant environmental standards. If any part of the jack mackerel fishery does not meet the prescribed environmental standards, then further research into appropriate mitigation measures will be delivered though the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[3] For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A level 1 risk assessment is also planned for non-QMS bycatch.

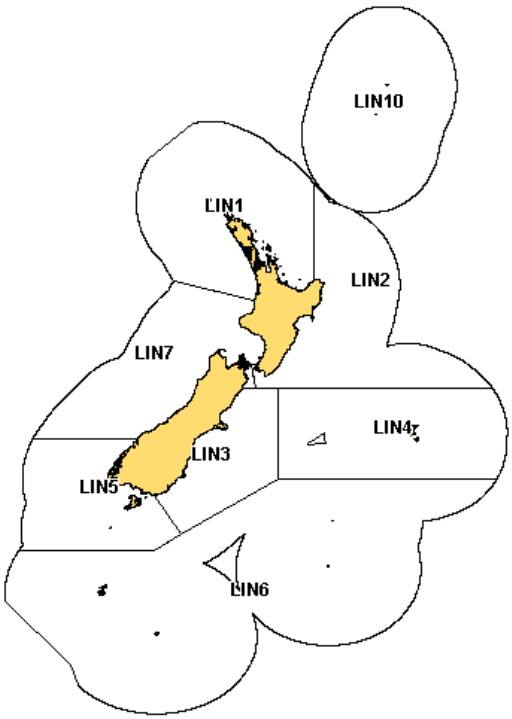
Outstanding issues

Stock assessment

- Declines in landings in JMA 3 are attributed to declining abundance of *T. murphyi*, which historically comprised the bulk of JMA 3 landings.
- Initial stock assessment models were developed for JMA 7 (*T. declivis* and *T. novaezelandiae*) up to 2005. The *T. novaezelandiae* model encountered convergence problems and there was also considerable uncertainty about the CPUE indices which are derived from species proportion estimates. Updated assessments are being carried out in 2010.

[3] Observer data from target jack mackerel tows shows that 73.0% of the catch is jack mackerel and 99.3% comprises jack mackerel and other QMS species; this will vary among fisheries.

4. LING (LIN)



Introduction

Ling is taken by both trawl and longline methods throughout New Zealand waters and is managed as several distinct stocks. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
LIN1	Auckland	1 & 9	463*	400	319
LIN2	Central (East)	2	982	982	634
LIN3	South-East (Coast)	3	2,060	2,060	1,751
LIN4	South-East (Chatham Rise)	4	4,200	4,200	2,000
LIN5	Southland	5	3,633†	3,595	3,009
LIN6	Sub-Antarctic	6	8,590‡	8,505	3,119
LIN7	Challenger, Central (West)	7 & 8	2,501∂	2,474	2,198
LIN10	Kermadec	10	10	10	0
Total			22,439	22,226	13,111

* Note the LIN1 TAC includes a 3 tonne allowance for other sources of fishing related mortality, a 20 tonne customary allowance and a 40 tonne recreational allowance.

† Note the LIN5 TAC includes a 36 tonne allowance for other sources of fishing related mortality and a 1 tonne allowance for both customary and recreational fishers.

‡ Note the LIN6 TAC includes a 85 tonne allowance for other sources of fishing related mortality.

∂ Note the LIN7 TAC includes a 25 tonne allowance for other sources of fishing related mortality and a 1 tonne allowance for both customary and recreational fishers.

Management objectives and approach

Ling consists of both Tier 1 and Tier 2 stocks. All stocks will undergo assessments at 2-3 year intervals. The Tier 1 stocks will undergo more formal assessments that will usually be based on targeted research (described below). Tier 2 stocks will undergo CPUE standardisation and stock characterisations. CPUE analysis and stock characterisations will also form the first component of the formal assessments undertaken for the appropriate Tier 1 stock.

Tier 1 ling stocks include:

- LIN 3 and 4 combined
- LIN 5 and 6 combined
- LIN 7 (West Coast South Island)
- Cook Strait (part of both LIN 2 and 7)
- Bounty Plateau (eastern part of LIN 6)

The remainder of LIN 2 is categorised as a Tier 2 stock and will be monitored using CPUE in the line fisheries.[4]

Harvest strategy

The generic harvest strategy for all ling stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard. Stock-specific reference points, and associated management responses, will be developed as part of the National Deepwater Fisheries Plan.

Table 2: Harvest strategy for ling

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

For Tier 1 stocks, the targeted research described below will provide the information necessary to manage against the harvest strategy. For LIN2, the research programme will also seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

[4] LIN1 is primarily an inshore fishery and will not be managed as part of the 10 year plan.

Fish plan status

Ling is not yet included in the National Deepwater Fisheries Plan. Work on a specific chapter for ling is planned to commence during 2010-2011.

Summary of current knowledge

Stock assessment

Stock assessments are available for all the Tier 1 stocks. These will be updated every 2-3 years using research survey results, CPUE indices and catch-at-age data.

Stock structure

There are at least five distinct ling stocks in New Zealand: west coast South Island (part of LIN7), Chatham Rise (LIN3 and 4 combined), Cook Strait (part of both LIN2 and 7), Bounty Plateau (part of LIN6), and the Southern Plateau (including the Stewart-Snares shelf and Puysegur Bank – LIN5 and part of LIN6 combined). Stock affinities of ling north of Cook Strait are unknown.

Productivity

Ling growth rates are known for the main stocks from otolith readings. Routine catch at age data are collected from the trawl surveys and the main commercial fisheries. Year class strength is estimated within the assessment models.

Stock monitoring – historical data series

Abundance estimates have been obtained from fisheries-independent wide-area trawl surveys and CPUE analyses, while catch at age data are collected from both the commercial trawl fishery and research surveys. The following table details the historical series of abundance indices and catch at age data.

Table 3: Historic catch monitoring for ling stocks

Fish stock	Trawl surveys	CPUE	Catch at age
LIN1		Line: 1990-2007	
LIN2			
LIN3&4	1992-2010	Line: 1990-2007	Research survey: 1989, 1992-2010
LIN5&6	1991-93 and 2000-09	Line: 1991-2007	Line: 2000-08 Trawl: 1992-2008 Research survey: 1989, 1991-93, 1996, 1998, 2000-09
Bounty (LIN6)		Line: 1992-2006	Line: 1993, 2000-01, 2004, 2008
LIN7 WCSI		Line: 1990-2007 Trawl: 1999-2007	Trawl: 1991-2009 Line: 2006, 2007
Cook Strait (LIN2&7)		Line: 1990-2007 Trawl: 1990-2007	Trawl: 1999-2009

10 Year Research Plan – Stock Monitoring & Assessment

Overview

Ling stocks will be assessed at 2-3 year intervals using the following information:

- Trawl surveys – primarily for LIN 3 and 4, LIN 5 and 6 and LIN7
- CPUE from the line fisheries (LIN 3 and 4, LIN 5 and 6 and LIN7, Cook Strait and Bounty)
- CPUE from the trawl bycatch (LIN7 and Cook Strait)
- Regular length-frequency sampling by Observers
- Routine catch-at-age analysis of otoliths collected by Observers and during trawl surveys

Trawl surveys

In order to provide the necessary biomass estimates for LIN 3 and 4, the current trawl survey will continue on the Chatham Rise in eight of the 10 years of the ten year plan. Biomass estimates for LIN 5 and 6 will be obtained from the trawl survey that currently occurs annually in the Sub-Antarctic; however, this will occur biennially. To monitor biomass in LIN 7, a new trawl series is proposed for the west coast South Island.

CPUE analyses

CPUE from the line and trawl fisheries will be used as appropriate as inputs to the stock assessments for all the Tier 1 stocks. The LIN2 stock will have regular characterisations and an assessment will be attempted if CPUE indices are found to be informative.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the annual stock assessment will consist of:

1. Otolith collection
2. Length frequency sampling

Otoliths will be collected annually from the main trawl and line fisheries by Observers or researchers. The following numbers of otoliths will be read each year.

Table 4: Planned ling otolith reading

Fishstock	Fishing method	Otolith numbers (readings)
LIN 3 and 4	Line fishery Research survey	400 each sex 400 each sex
LIN 5 and 6	Line fishery Research survey	400 each sex 400 each sex
Bounty (LIN 6)	Line fishery	400 each sex
LIN 7	Trawl fishery or Research survey	400 each sex
Cook Strait (LIN 2&7)*	Trawl fishery	400 each sex

*shed sampling is a possibility

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

Each deepwater vessel will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

Ling is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the ling fishery against any relevant environmental standards.

Endangered, threatened or protected species

The ling trawl fishery is known to have limited interactions with seabirds and marine mammals particularly fur seals. Ling is also taken using bottom long lines. This method is also known to interact with seabirds; however, captures of marine mammals are very rare. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the trawl and line fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[5] For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

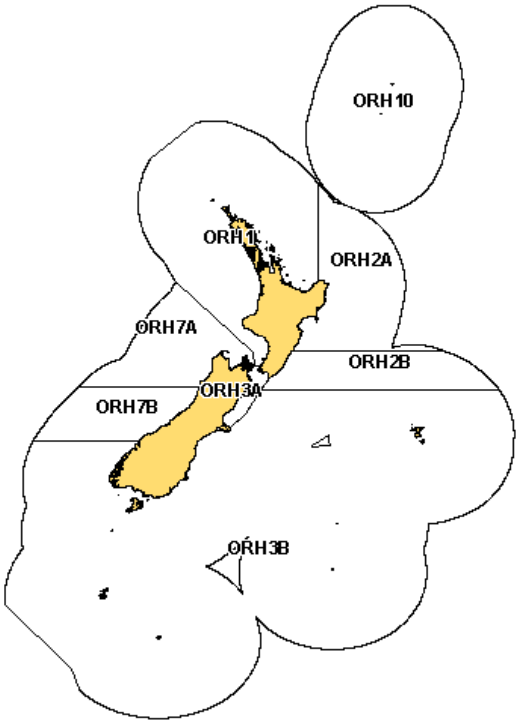
Outstanding issues

Stock assessment

- The lack of contrast in abundance indices (trawl survey relative biomass estimates) in the sub-Antarctic (LIN5 and) means that the level of current biomass is very uncertain, although the stock status is considered to be well above target levels.
- Stock assessment models need to be more robust to small changes in parameters; further development of the assessment methods is required.
- Catch at age data are required from the line fisheries in Cook Strait and west coast South Island to determine selectivity in these fisheries. A catch sampling or logbook programme could provide these data.
- Fishery-independent biomass indices do not exist for the west coast South Island stock; a new trawl survey series is proposed to address this.

[5] Observer data from target ling trawl and long-line fishing shows that 57.7% of the catch is ling and 93.6% comprises ling and other QMS species, this will vary among fisheries.

5. ORANGE ROUGHY (ORH)



Introduction

Orange roughy is managed as several different stocks, and in some cases sub-stocks. In most years the TACC of 11,062 tonnes is close to fully caught. Orange roughy has a complicated history of scientific research and is currently subject to different management approaches.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fish stock	QMA	FMA	TAC	TACC	Landings 2008-09
ORH1	Auckland	1, 8 & 9	1,470*	1,400	905
ORH2A	Central (East)	2 (part)	1,158†	1,100	1,114
ORH2B	Central (East)	2 (part)	194‡	185	173
ORH3A	South-East (Coast)	3 (part)	436∂	415	414
ORH3B	South-East (Chatham Rise), Southland, Sub-Antarctic	3, 4 & 5	8,350µ	7,950	8,758
ORH7A	Challenger	7 (part)	1	1	<1
ORH7B	WCSI	7 (part)	1	1	1
ORH10	Kermadec	10	10	10	0
Total			11,620	11,062	11,366

* Note that the ORH1 TAC includes a 70 tonne allowance for other sources of fishing related mortality
† Note that the ORH2A TAC includes a 58 tonne allowance for other sources of fishing related mortality
‡ Note that the ORH2B TAC includes a 9 tonne allowance for other sources of fishing related mortality
∂ Note that the ORH3A TAC includes a 21 tonne allowance for other sources of fishing related mortality
µ Note that the ORH3B TAC includes a 400 tonne allowance for other sources of fishing related mortality

Management objectives and approach

Orange roughy consists of both Tier 1 and Tier 2 stocks. The management approach consists of regular monitoring and frequent assessments at 2-3 year intervals. The Tier 1 stocks will undergo more formal assessments that will usually be based on targeted research (described below). Tier 2 stocks will undergo CPUE standardisation and stock characterisations. CPUE analysis and stock characterisations will also form the first component of the formal assessments undertaken for the appropriate Tier 1 stock.

Tier 1 orange roughy stocks include:

- ORH3B—East and south Chatham Rise
- ORH3B—Puysegur
- ORH3B—Priceless and northeast Pukaki Rise
- ORH3B—North-west Chatham Rise
- ORH7A—Challenger Plateau
- ORH MEC—Mid-East Coast (ORH2A South, 2B & 3A)
- ORH1—excluding Mercury-Colville (note that ORH1 has previously been managed under the Adaptive Management Programme)

The remaining stocks are Tier 2 stocks that will be monitored using CPUE and will be subject to regular fishery characterisations:

- ORH 1—Mercury-Colville
- ORH2A North—East Cape
- ORH3B—Other Sub-Antarctic areas (fishing has occurred historically in Southland, Fiordland, Snares Islands, Macquarie, Auckland Islands, Bounty and Antipodes)
- ORH7B—WCSI

The management approach differs among stocks, the table below summarises these management approaches and provides an indication of the method that is planned to monitor each orange roughy stock. More detail on the F_{MSY} management approach, and how this aligns with the Harvest Strategy Standard, is included in the following section.

Table 2: Overview of the management and monitoring approaches for orange roughy stocks and sub-stocks

Stock	Management Approach	Monitoring
ORH3B (E & S Chatham Rise)	F_{MSY} approach	Acoustic survey of Plume
ORH3B (Puysegur)	F_{MSY} approach	Acoustic survey
ORH3B (Priceless and NE Pukaki Rise)	Assessment model if CPUE provides abundance indices	CPUE monitoring and other information derived from characterisation
ORH3B (NW Chatham Rise)	F_{MSY} approach	Acoustic survey
ORH7A	F_{MSY} approach	Likely acoustic survey – will confirm after June 2010 survey
ORHMEC	Assessment model	Trawl survey

ORH1	Subject to ORH management strategy evaluation proposed for Year 1	
ORH1 (Mercury-Colville)	Subject to ORH management strategy evaluation proposed for Year 1	
ORH2A North	Assessment model if CPUE provides abundance indices	CPUE monitoring and other information derived from characterisation
ORH3B (Sub-Antarctic – other areas)	F_{MSY} approach	Acoustic survey[6]
ORH7B	Apply ORH7A approach in time	None -currently closed

Over time, the intention is to raise Tier 2 stocks to Tier 1 status if the fishery re-opens, new areas of the fishery are developed within the stock boundaries, or if the information base improves so as to allow the F_{MSY} management strategy to be applied.

Harvest strategy

The following reference points and corresponding management responses were derived from the Harvest Strategy Standard and apply to all orange roughy stocks. The F_{MSY} approach, that partially specifies how catch limits are set, is based on these reference points and is described below.

Table 3: Harvest strategy for orange roughy

Reference point	Management response
Management target of 30% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time-constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	Partially specified in F_{MSY} approach, to be determined for other stocks (see below).
Harvest control rule	Partially specified in F_{MSY} approach, to be determined for other stocks (see below).

F_{MSY} management approach

For most Tier 1 stocks, an F_{MSY} management approach has been adopted to give effect to the above reference points. To date this approach has only been applied to the ORH3B East & South Chatham Rise fishery.

Management is based on a fishing mortality approach where:

- If $B_{CURRENT}$ is above the soft limit then F is set at F_{MSY} (assumed to be M or 4.5% $B_{CURRENT}$)
- If $B_{CURRENT}$ is below the soft limit but above the hard limit then F set at ½ F_{MSY} to allow rebuild
- If $B_{CURRENT}$ is below the hard limit then F is set at zero (the fishery is closed)

[6] Tentative and subject to review of ORH management approach for these stocks.

This management option is dependent on reliable estimates of $B_{CURRENT}$ and B_0 being available for each ORH stock. Further work is currently underway to refine this approach and, potentially, apply it to other ORH stocks.

Fish plan status

The current National Deepwater Fisheries Plan includes all orange roughy fisheries. It details the management objectives that will apply across all New Zealand's deepwater fisheries and those objectives that are specific to orange roughy stocks.

Summary of current knowledge

Stock Assessment

Stock assessments based on model outputs have been used previously to determine the status of orange roughy stocks. However, some of the assumptions the models used (e.g. deterministic recruitment) were found to pre-determine the future trajectories of the stock, while ignoring the signals in the abundance indicators. After catches were reduced, the models automatically rebuilt the stocks, despite the data from the fisheries not showing the expected increases. To overcome this problem will require alternative models of recruitment (or productivity) for these stocks.

Stock structure

Stock structure is uncertain for orange roughy with many localised sub-stocks believed to exist; particularly in ORH 1 and the sub-Antarctic part of ORH3B. The location of major spawning grounds has helped to identify the other major stocks. It is assumed that the fisheries on spawning aggregations on the East Cape hills (ORH2A North), Ritchie Bank (ORH2A South), Chatham Rise (ORH3B), Puysegur (ORH3B), Challenger Plateau (ORH7A) and west coast South Island (ORH7B) are separate stocks because spawning occurs almost simultaneously in all six areas, and this is supported by genetic and other biological differences.

Genetically, two main stocks are recognised within ORH3B (Chatham Rise and Puysegur) and these are considered to be distinct from stocks in adjacent areas (Cook Canyon and Ritchie Bank). However, because of their geographical separation and discontinuities in the distribution of orange roughy, it is likely that concentrations of spawning fish on the Arrow Plateau, near the Auckland Islands, and west of the Antipodes Islands also form separate stocks.

Based on analyses of all available data, the Chatham Rise has been divided into two areas: the Northwest, and the East and South Rise combined. The centre of the Northwest stock is the Graveyard hills. The centre of the East and South Rise stock is the Spawning Box during spawning, and the southeast corner of the Rise during non-spawning.

Productivity

Ring counts on orange roughy otoliths have been used to determine the growth rate for the main stocks. However, the presence of a transition zone thought to be associated with the age of first maturity makes accurate ageing difficult and in the past routine catch at age data were not collected from the commercial fisheries. Consequently year class strength is not usually estimated within the assessment models.

Stock monitoring

The following table describes the historical series of abundance indices for all orange roughy stocks.

Table 4: Summary of historic monitoring for orange roughy

Fish stock	Trawl surveys	Acoustic surveys	CPUE	Other
ORH 1				
Mid-east coast (ORH 2A south, 2B and 3A)	1992-94	2001, 2003	1984-97 1997-2005	Egg survey 1993
Northwest Chatham Rise (part of ORH 3B)		1999, 2002, 2005 (& trawl)	1981-2005	Egg survey 1996
South and east Chatham Rise (main part of ORH 3B)	1984-87, 1988-90, 1992, 1996	1996, 98, 2000 2002-09	1981-2007	
Challenger (ORH 7A)	1987-90	2005, 2006 (& trawl)	1983-99	
Colville-Mercury (part of ORH 1)	1995, 2000		1994-99	
East Cape (ORH 2A north)	1992-94		1994-2002	Egg survey 1995
Puysegur (part of 3B)		2005, 2006 (& trawl)		
Priceless and northeast Pukaki (part of 3B)				
Rest of the Sub-Antarctic area (part of 3B)				
WCSI (ORH 7B)			1986-97 1991-2006	

Although trawl surveys have been used previously, they were discontinued as a general method of monitoring and assessing orange roughy in most cases because they were considered inappropriate for monitoring relative abundance (e.g. the spawning box on the East Chatham Rise) or because of the imprecision of the surveys or difficulties in interpreting the results. The aggregated spawning schools and the affinity of orange roughy with hill features made the area-swept method less reliable for estimating relative abundance.
The use of acoustic surveys has also presented challenges, and although these surveys have been used to monitor several stocks, a number of outstanding problems remain:

- Difficult to make accurate species identification from observed marks
- Low target strength for orange roughy relative to other deepwater species
- The shadow zone in hill strata means that it is likely that not all the mark can be measured acoustically

10 Year research Plan – Stock Monitoring and Assessment

Overview

Orange roughy stocks will be assessed at 2-3 year intervals using the following information:

- Trawl surveys – primarily for ORH MEC
- Acoustic surveys – primarily for ORH3B E & S Chatham Rise, ORH3B NW Chatham Rise, ORH3B Puysegur and ORH7A
- Regular length-frequency sampling by Observers and during any trawl surveys

Trawl surveys

Despite some of the challenges presented by using trawl surveys, a survey was used in 2010 to estimate relative biomass in the MEC stock for comparison with earlier surveys in 1993 and 1994. If this is successful it will be used to monitor ORH MEC in the future.

Extending the Chatham Rise trawl survey into deeper water has recently been trialled as part of the 10 year plan. If successful, this will provide some information about the Chatham Rise orange roughy stock at relatively low marginal cost.

The recent ORH7A survey had a trawl component and will continue if it proves successful following the second trial survey scheduled for June 2010.

Acoustic surveys

Because orange roughy lack a swim bladder and have a low target strength relative to other deepwater species, acoustic surveys are restricted to aggregations of fish where the species identification of the mark is known to be almost 100% orange roughy. This situation is found in the spawning plume on the Chatham Rise (ORH3B E&S Chatham Rise), which has been surveyed annually since 2002 using a commercial fishing vessel.

Despite the challenges described above, trial acoustic surveys will also be undertaken for ORH3B NW Chatham Rise, ORH3B Puysegur and ORH7A. Combined trawl and acoustic surveys have been carried out to overcome the problem with trawling in hill areas, but it is difficult to obtain a consistent series of relative abundance indices from these surveys. Without knowing target strength and species mix the acoustic estimates are not comparable to trawl based estimates. The combined trawl and acoustic approach has been tried recently for ORH 7A and will continue if it proves successful.

CPUE analyses

CPUE from commercial fishing will be used as an input to the stock assessments for the Tier 1 stocks where relevant. CPUE will also be used to monitor the Tier 2 stocks but without a formal assessment. However, the highly aggregated nature of the orange roughy fishery makes interpretation of the CPUE data very difficult, and consequently CPUE indices are unlikely to be directly proportional to abundance.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the annual stock assessment will consist of:

1. Otolith collection
2. Length frequency sampling

Observers will collect length data to allow the selectivity pattern to be determined for each fishery. Although otoliths will be collected routinely from the main commercial trawl fisheries, targeted ageing studies will only be conducted when required to address specific research questions (e.g. growth rates, age of maturity, age structure of the population from survey data).

Harvest strategy review

The F_{MSY} approach detailed above makes various assumptions about, for example, M and B_{MSY}. These assumptions will be tested as part of a wider review of the orange roughy harvest strategy that is planned for the second year of the 10 year plan.

Management Strategy Evaluation

Little targeted research has been conducted in ORH1. In the first year of the 10 year plan, a management strategy evaluation is proposed to consider management approaches and associated research.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

Orange roughy is taken by trawling which will have an impact on the seabed; particularly when fished using bottom trawl gear. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the orange roughy fishery against any relevant environmental standards.

Endangered, threatened or protected species

The orange roughy fishery is known to have limited interactions with seabirds. Information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the orange roughy fishery against any relevant environmental standards. If the orange roughy fishery is not meeting environmental standards then further research on mitigation measures etc. will be delivered through the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[7] For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

[7] Observer data from target orange roughy tows shows that 82.4% of the catch is orange roughy and 94.2% comprises orange roughy and other QMS species, this will vary among fisheries.

10 Year Research plan – Additional research

The 10 year plan includes an Additional Research category that will be used to fund targeted research as required. Currently, the following is planned for orange roughy stocks and further work may be included as it is identified.

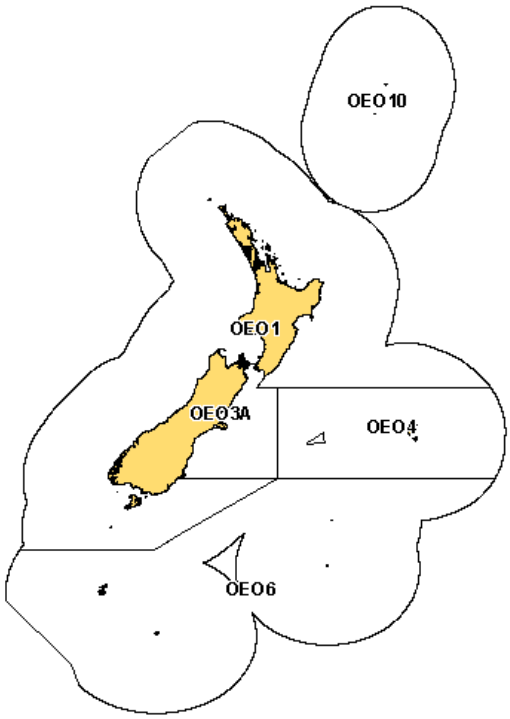
Table 5: Research currently planned for the orange roughy stocks

Year	Research Project 1	Research Project 2
2010-2011	Targeted ORH ageing project (MEC/7A and part ORH1)	ORH MSE – ORH1
2011-2012	Further ageing validation work for selected stocks	Review F_{MSY} approach
2012-2013	ORH model development	
2014-2015		

Outstanding issues

- Stock structure, particularly multiple stocks in ORH1 and Sub-Antarctic area. Management of these sub-stocks needs to take account of the significant difficulty of assessing stock size and the possibility of localised depletion of one or more of the sub-stocks.
- Research costs to assess closed fisheries. With a 1 t TACC there is no revenue to pay for cost recovered research.
- Lack of reliable abundance indices. As CPUE is not likely to be directly proportional to stock size, it is difficult to monitor the Tier 2 stocks in a cost-effective manner. The low target strength of orange roughy means that acoustic surveys are not useful on mixed species aggregations. The longevity of this species means that mortality estimation from catch curve analysis is not feasible.

6. OREOS (OEO)



Introduction

Four species of oreo are managed together as OEO Fishstocks; however, black and smooth oreo make up the vast majority of oreo catch:

- Black oreo (BEO) – *Allocyttus niger*
- Smooth oreo (SSO) – *Neocyttus rhomboidalis*
- Spiky oreo (SOR) – *Pseudocyttus maculatus*
- Warty oreo (WOE) – *Allocyttus verrucosus*

The total oreo TACC is 18,600 tonnes with the majority taken in the three main oreo fisheries: OEO3A, OEO4 and OEO6. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below; landings are presented by species in Table 2.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fish stock	QMA	FMA	TAC	TACC	Landings (2008-09)
OEO1	Auckland (E&W), Central (E&W), Challenger, Southland	1, 2, 3 (part) 5, 7, 8, 9	2,500	2,500	582
OEO3A	South-East (Coast)	3 (part)	3,518*	3,100	2,848
OEO4	South-East (Chatham Rise)	4	7,000	7,000	6,907
OEO6	Sub-Antarctic	6	6,000	6,000	5,540
OEO10	Kermadec	10	10	10	0
Total				18,600	15,878

* Note the OEO3A TAC includes a 168 tonne allowance for other sources of fishing related mortality

Table 2: Reported landings for 2007-08 split by species (tonnes)

Fishstock	TACC	Landings (2007-08)		
		Oreo (total)	Black oreo	Smooth oreo
OEO1	2,500	947	429	407
OEO3A	3,100	3,092	1,566	1,526
OEO4	7,000	7,038	592	6,150
OEO6	6,000	5,902	3,022	2,182
OEO10	10	0	0	0
Total	18,600	16,979		

Management objectives and approach

Oreo consists of both Tier 1 and Tier 2 stocks. The management approach consists of regular monitoring and frequent assessments at 3 year intervals. The Tier 1 stocks will undergo more formal assessments that will usually be based on targeted research (described below). The first component of these stock assessments will be CPUE standardisation and stock characterisations.

The Tier 1 oreo stocks are:

- Black oreo: Pukaki Rise (BOE6), BOE3A
- Smooth oreo: SSO3A, SSO4, Pukaki Rise (SSO6), Bounty (SSO6), Southland (SSO1&6)

Tier 2 stocks will undergo CPUE standardisation and stock characterisations on a three year cycle.

Tier 2 oreo stocks are:

- Black oreo: BOE4, Puysegur/Snares (BOE1)
- Smooth oreo: Puysegur/Snares (SSO1)

Tier 2 stocks may be reclassified if there are substantial increases in catch. As oreo fisheries are closely associated with orange roughy at Puysegur, any monitoring would be subject to targeted orange roughy fishing recommencing in that area.

Harvest strategy

The generic harvest strategy for all oreo stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard. Stock-specific reference points and associated management responses will be developed as part of the Deepwater Fisheries Plan.

Table 3: Harvest strategy for oreo

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.

Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The above harvest strategy will be applied to all oreo stocks. For Tier 1 stocks, the targeted research described below will provide the information necessary to manage against the harvest strategy. For Tier 2 stocks the research programme will also seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Oreo is not yet included in the National Deepwater Fisheries Plan. A specific chapter may be included in the future.

Summary of current knowledge

Stock assessment

Assessments have been carried out for the major oreo stocks. In OEO3A the assessment for smooth oreo was revised in 2009, while the black oreo assessment is unchanged from 2004.

The assessment of SSO4 was updated in 2007 using a new acoustic absolute abundance estimate and length data from a survey carried out in 2005. A further survey was completed in November 2009. In black oreo, investigations were carried out in 2009 using age-based single sex single step preliminary models. The data used in these models were four standardised CPUE indices and observer length frequencies. Growth and maturity were also estimated in some of the runs.

In other oreo stocks, a new assessment was conducted for Pukaki Rise black oreo, and other assessments for Southland (OEO1/OEO3A) and Pukaki smooth oreo have been conducted.

Stock structure

The stock structure of black and smooth oreos has not been well determined despite genetic and other studies. The geographic separation of the fisheries has been used to define stocks for assessment and management.

Productivity

The growth rates of both black and smooth oreo are known from otolith readings from the Chatham Rise (OEO 3A and 4) and from Puysegur (OEO 1). A bomb chronometer study supported estimates of maximum age for black oreo (153 years) and less clearly for smooth oreo (86 years) made by otolith readings. Routine catch at age data are not generally collected but some age frequency data are available from acoustic and trawl surveys. Year class strength is not usually estimated within the assessment models except in sensitivity runs.

Stock monitoring – historical data series

Estimates of relative abundance of oreos have been obtained from trawl surveys in OEO1, 3A, and 4. However, the relative abundance indices from these surveys have been used only in the early stock assessment for smooth oreo in OEO4.

The following tables detail the historical series of abundance indices and catch at age data for black and smooth oreo respectively.

Table 3: Black oreo historic stock monitoring

Fishstock	Trawl surveys	Acoustic surveys	CPUE
BOE3A	1986-87, 1990-93, 1995	1997, 2002, 2006	1980-89, 1993-2002
BOE4	1986-87, 1990-93, 1995	1998	1980-89, 1993-2008
BOE6-Pukaki Rise			1996-2008
BOE1-Puysegur/Snares	1992, 1994		

Table 4: Smooth oreo historic stock monitoring

Fishstock	Trawl surveys	Acoustic surveys	CPUE
SSO3A	1986-87, 1990-93, 1995	1997	1981-98, 2003-08
SSO4	1986-87, 1990-93, 1995	1998, 2001, 2005, 2009	1982-89, 1993-2006
SSO6-Pukaki Rise			1996-2005
SSO6-Bounty			1996-2000, 2001-07
SSO(1&6)-Southland			1984-88, 1993-2001
SSO1-Puysegur/Snares	1992, 1994		

Trawl surveys have been attempted in the past as a monitoring tool for oreo stocks in hilly areas. For the reasons outlined below, such surveys are no longer considered to be a viable monitoring tool:

- Previous survey series with the same vessel covered a short time period (3 consecutive years) so they had little influence in the stock assessment as relative estimates
- Earlier surveys have used different vessels and so were not comparable with the more recent *Tangaroa* surveys; consequently these were not suitable for use in stock assessment
- Interpreting the results for hill surveys is problematic
- Fish schools containing recruited fish became very sparse in the survey area, and so random trawls have a low probability of hitting a school; this leads to a large number of tows being needed to achieve target CVs

Despite these issues, trawl surveys appear to be suitable for monitoring the relative abundance of dispersed oreo on flat bottoms.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

Oreo stocks will be assessed at 3 year intervals using the following information:

- Trawl surveys – possibly for oreo on the Chatham Rise
- Acoustic surveys – primarily for SSO4 and BOE3A
- Regular length-frequency sampling by Observers

Trawl surveys

Extending the Chatham Rise trawl survey into deeper water has been trialled as part of the 10 year plan. If successful, this may provide useful information about the Chatham Rise oreo stocks at relatively low marginal cost.

Acoustic surveys

Acoustic surveys have been used in the past to obtain abundance estimates of smooth oreo (SSO4) and black oreo (BOE3A). Similar surveys are planned to obtain abundance estimates for OEO6, BOE4 and SSO1. It is anticipated that these surveys will use a mixture of dedicated research trips for wide-area surveys and industry vessels during commercial fishing trips for surveys of smaller areas.

CPUE analyses

CPUE from the trawl fisheries will be used as input to the stock assessments for all the Tier 1 stocks. CPUE will also be used to monitor the Tier 2 stocks if appropriate.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the annual stock assessment will consist of:

1. Otolith collection
2. Length frequency sampling

Observers will collect length data to allow the selectivity pattern to be determined for each fishery. Although otoliths will be collected routinely from the main trawl commercial fisheries, targeted ageing studies will only be conducted when required to address specific research questions (e.g. growth rates, age of maturity, age structure of the population from survey data).

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

Each deepwater vessel will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

Oreo is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the oreo fishery against any relevant environmental standards.

Endangered, threatened or protected species

The oreo fishery is known to have limited interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the oreo fishery against any relevant environmental standards. If any oreo fisheries are not meeting environmental standards then further research on mitigation measures etc. will be delivered through the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS.[8] For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

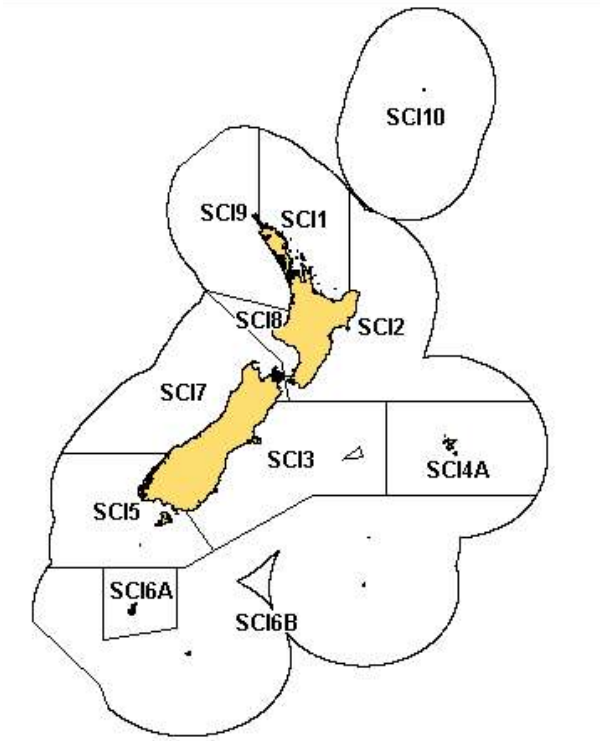
Outstanding issues

Stock assessment

- Assumption of absolute estimate of biomass from acoustic surveys; a longer time series of surveys may allow these to be treated as relative estimates.
- Assumption of deterministic recruitment in models; targeted ageing studies may allow year class strength to be estimated in some stocks.
- The 2009 BOE4 stock assessment is considered unreliable; although CPUE was considered to be reliable, length frequency data and spatial heterogeneity issues need to be addressed.

[8] Observer data from target oreo tows shows that 95.8% of the catch is oreo and 97.9% comprises oreo and other QMS species, this will vary among fisheries.

7. SCAMPI (SCI)



Introduction

The scampi fishery is managed as ten separate fish stocks (excluding SCI10) but only five of these stocks are commercially fished; SCI1, SCI2, SCI3, SCI4A and SCI6A.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-09
SCI 1	Auckland (East)	1	126	120	86
SCI 2	Central (East)	2	210	200	52
SCI 3	South-East (Coast)	3 & 4 (part)	357	340	190
SCI 4A	South-East (Chatham Rise)	4 (part)	126	120	1
SCI 5	Southland	5	42	40	0
SCI 6A	Auckland Islands	6 (part)	321	306	264
SCI 6B	Sub-Antarctic	6 (part)	53	50	0
SCI 7	Challenger,	7	79	75	1
SCI 8	Central (West)	8	5	5	0
SCI 9	Auckland (West)	9	37	35	0
SCI 10	Kermadec	10	0	0	0
Total				1,291	594

* Note that the scampi TACs include an allowance for other sources of fishing related mortality. There is no allocation for customary and recreational fishers

Management approach

SCI1, SCI2, SCI3 and SCI6A are Tier 1 stocks and the management approach is to assess stock status against biological reference points based on the results of formal stock assessments at 3 year intervals. CPUE standardisation and stock characterisations will form the first component of these stock assessments. The biological reference points are specified in the generic scampi harvest strategy which is described below.

Due to the low TACC and annual catches in recent years, the remaining scampi stocks including SCI4A are Tier 2 stocks. If catch rates increase in these stocks they will be monitored using CPUE and will be subject to regular fishery characterisations.

Harvest strategy

The following are generic reference points and corresponding management responses that will be applied to all SCI stocks. Stock-specific reference points and associated management responses may be developed as part of the Deepwater Fisheries Plan:

Table 2: Generic harvest strategy for scampi

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fish plan status

The National Deepwater Fisheries Plan describes the management objectives that apply across all deepwater fisheries and fisheries specific objectives for those fisheries that have been included in the plan. Scampi is not yet included in the Deepwater Fisheries Plan; a specific chapter may be included in the future.

Summary of current knowledge

Stock Assessment

There are no agreed stock assessments for any scampi stocks, although a Bayesian length based approach is being developed which may provide useful estimates in the future

Stock structure

Stock structure of scampi in New Zealand waters is not well known. Preliminary electrophoretic analyses suggest that scampi in SCI6A are genetically distinct from those in other areas, and there is substantial heterogeneity in samples from SCI1, 2, and 4A. The abbreviated larval phase of this species may lead to low rates of gene mixing.

Productivity

Scampi growth rates are currently being investigated using scampi tagging studies but comprehensive information on stock productivity is not currently available.

Stock monitoring – historical data series

Attempts have been made to index scampi abundance using CPUE and trawl survey indices and, more recently, photographic surveys of scampi burrows. However it has still not been possible to provide reliable indices of scampi abundance.

The following table details the historical series of abundance indices and catch at age data.

Table 3: Historic stock monitoring of scampi

Fishstock	Trawl surveys	Camera surveys
SCI 1	1993-95	1998, 2000, 2001, 2002, 2003, 2008
SCI 2	1993-95	2003-06
SCI 3		2001, 2009
SCI 4A		
SCI 6A		2007, 2008, 2009

Attempts at using trawl surveys to provide estimates of biomass were tried in the early 1990's but due to the behaviour of scampi, they are no longer considered to be a suitable monitoring method.

Since the late 1990's photographic surveys have been used (this method has been used to successfully estimate abundance of European scampi). Although it is still uncertain whether they can provide reliable indices of scampi abundance in New Zealand this survey method is showing promise as a means to provide the following information:

- The density of visible scampi – as a minimum estimate of absolute abundance
- Density of major burrow openings

10 Year Research plan – stock assessment

Overview

Tier 1 scampi stocks will undergo a three year cycle of stock assessments supported by the following research

- Annual camera surveys including a trawl catch component (size data)
- Observer tagging programme and mark-recapture analyses

Camera surveys

Burrow counts from photographic surveys are intended as an index of abundance and will be an input into an assessment model. There is also potential for the use of survey counts of visible scampi as a minimum abundance estimate, subject to considerations over the mean size of individuals, burrow emergence and survey coverage. The following surveys will take place at regular intervals, typically on a three year cycle:

- SCI1 – February
- SCI2 – March
- SCI6A – March
- SCI3 – October

A workshop to address some of the outstanding issues associated with camera surveys will take place during 2010-11 to explore a range of issues including the interpretation of photographic data.

CPUE analyses

Annual unstandardised CPUE indices (total catch divided by total effort (hours of trawling)) will continue to calculated for both Tier 1 and Tier 2 scampi stocks using commercial fishing data. Concerns over potential variability in catchability between years mean that these are not considered reliable indices of abundance.

The potential to use MSE to assess the implications of relative changes in CPUE will be explored through the annual discretionary research component of the 10 Year Research Plan.

Length frequency data

Length frequency data will be collected annually from the main trawl commercial fisheries by Observers. Commercial grading data may also be able to provide historical trends in length data and options to collect this data will be explored.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the scampi stock assessments will consist of:

1. Tagging for growth estimation
2. Length frequency sampling

Mark and recapture analysis

The results of the Observer tagging programme and the subsequent recaptures will be analysed annually as part of the relevant stock assessment and scampi characterisation study.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing are required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic Impacts

Scampi is taken by trawling which will have an impact on the seabed; particularly when fished using bottom trawl gear or midwater gear fished hard on the seabed. Previous research has shown that scampi trawl activity has an impact on benthic community structure. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the scampi fishery against any relevant environmental standards.

Endangered, threatened or protected species

The scampi fishery is known to have interactions with seabirds and marine mammals including sea lions in the SCI6A fishery around the Auckland Islands. Previous estimates on the extent of these interactions have been difficult because of the low level of observer coverage in the scampi fishery.

Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the scampi fishery against any relevant environmental standards. If the scampi fishery is not meeting environmental standards then further research on mitigation measures etc. will be delivered through the annual Additional Research fund.

Fish bycatch

Scampi fisheries are traditionally associated with significant quantities of fish and invertebrate bycatch.[9] Monitoring of QMS bycatch from these scampi fishery occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A level 1 risk assessment is also planned for non-QMS bycatch.

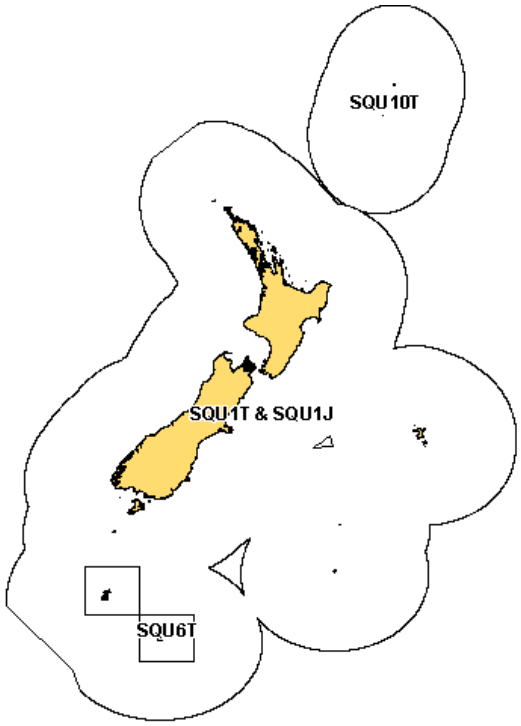
Outstanding issues

Stock assessment

- The absence of a robust stock assessment model means it is not currently possible to provide reliable status of stocks. This is currently being addressed and any additional research necessary will be included in the annual discretionary fund of the 10 Year Research Plan.
- Issues around the interpretation of photographic survey data. The planned scampi camera workshop will address this issue
- Changes in the behavior of scampi that may influence catchability. There is no specific research proposed to address this at this time apart from ongoing monitoring through camera surveys and observer sampling.

[9] In a typical scampi trawl between 70-80% of the catch is bycatch.

8. ARROW SQUID (SQU)



Introduction

The New Zealand arrow squid fishery is based on two related species. *Nototodarus gouldi* is found around mainland New Zealand north of the Subtropical Convergence, whereas *N. sloanii* is found in and to the south of the Convergence. Except for the Southern Islands fishery (SQU6T), for which a separate TACC is set, the two species are managed as a single fishery within an overall TACC.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC*	TACC	Landings (2008-09)
SQU1J	All areas except SQU6T and SQU10T	1-9	50,212	50,212	1,032
SQU1T	All areas except SQU6T and SQU10T	1-9	44,741	44,741	16,407
SQU6T	Auckland and Campbell Islands	6 (part)	32,369	32,369	28,872
SQU10T	Kermadec	10	10	10	0
Total			127,332	127,332	46,311

* There is no customary or recreational allowance for squid and nor is there an allocation for other sources of fishing related mortality. As a result the TAC and TACC are the same.

Management approach

SQU1T and 6T are Tier 1 stocks. Due to the limited fishing activity that occurs in the jig fishery SQU1J is categorised as a Tier 2 stock.

There is currently no harvest strategy in place for any squid fishery and nor is there a set of agreed biological reference points against which the status of the squid fishery can be assessed.

The biology of squid means it is not possible to estimate stock biomass prior to the fishing season. The biomass of squid available in any year varies significantly and TACCs do not usually constrain catches. TACCs have been increased in-season to allow larger catches in years of high abundance. In addition the SQU6T fishery is limited by a set numbers of tows that can be conducted in order to manage the impact of fishing on the New Zealand sea lion.

The key management objective for arrow squid is to maintain current TACCs, but to allow for in-season TACC reviews in selected fisheries based on appropriate early season indicators. This requires the development of a robust approach to determine the timing and amount of any increases and to ensure an adequate proportion remain after fishing to spawn.

A squid management and information workshop will be conducted in year 1 of the 10 year plan to determine management measures and harvest strategies that could be used in these squid fisheries.

Fish plan status

Squid is not yet included in the National Deepwater Fisheries Plan. A specific chapter for squid fisheries will be included in the future.

Summary of current knowledge

Stock Assessment

There is no proven method at this time to estimate yields from the squid fishery before a fishing season begins. The ability to estimate abundance is complicated by the life cycle of squid, which is described in more detail in the section below on productivity.

Stock structure

It is assumed that the stock of *N. gouldi* (the northern species) is a single stock, and that *N. sloanii* around the mainland comprises a unit stock for management purposes, though the detailed structure of these stocks is not fully understood. The distribution of the two species is largely geographically separate but those occurring around the mainland are combined for management purposes. The Auckland Islands Shelf stock of *N. sloanii* appears to be different from the mainland stock and is managed separately.

Productivity

Arrow squid live for one year, spawn once then die. Every squid fishing seasons is therefore based on what amounts to a new stock. It is not possible to calculate reliable yield estimates from historical catch and effort data for a resource which has not yet been hatched. Furthermore, a combination of short life span and rapid growth means it is not possible to estimate stock biomass before the start of the season. The issue is further complicated because the biomass increases rapidly during the season and then decreases to low levels as the squid spawn and die.

Stock monitoring – historical data series

To date there has been no formal stock monitoring programme for squid.

Size frequencies from commercial catches throughout the season have been measured to identify separate cohorts moving through the fishery and to measure the growth of squid.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

The focus of squid management is to maintain current TACCs, but to allow for in-season TACC reviews in selected fisheries based on appropriate early season indicators

Research in 2009 indicated that there is potential to predict good seasons of high squid abundance based on early season catch rates, but that modelling work is required to develop this approach further. Post-assessment modelling of the amount of squid left at the end of a fishing season is also possible and may help inform management. A workshop will be held in 2010 to discuss potential management approaches that can be used for squid and to identify what further research is necessary to support a "predictive" management approach.

CPUE analyses

CPUE from the trawl and jig fisheries will continue to be collected and will contribute to analyses to determine whether in-season management of the fishery may be possible.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet although this coverage will be scaled up during the first three years of the programme.

Length frequency data will be collected annually from the main trawl commercial fisheries (observers will collect approx. 300 samples annually from SQU6T and SQU1T (Snares)). Collection of length, weight and maturity data for several years will allow for better determination of stock relationships between the Snares and Auckland Island fisheries.

10 Year Research Plan – Monitoring environmental Interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing is required, leveraging opportunities from research and industry vessels to collect additional data will be assessed on a regular basis.

Benthic Impacts

Squid is taken by trawling which may have an impact on the seabed; particularly when fished using bottom trawl gear or midwater gear fished hard on the seabed. Data from vessels'

catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the squid fishery against any relevant environmental standards.

Endangered, threatened or protected species

The squid fishery is known to have interactions with seabirds and marine mammals; particularly sea lions around the Auckland Islands. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the squid fishery against any relevant environmental standards. If the squid fishery is not meeting environmental standards then further research on mitigation measures etc. will be delivered through the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

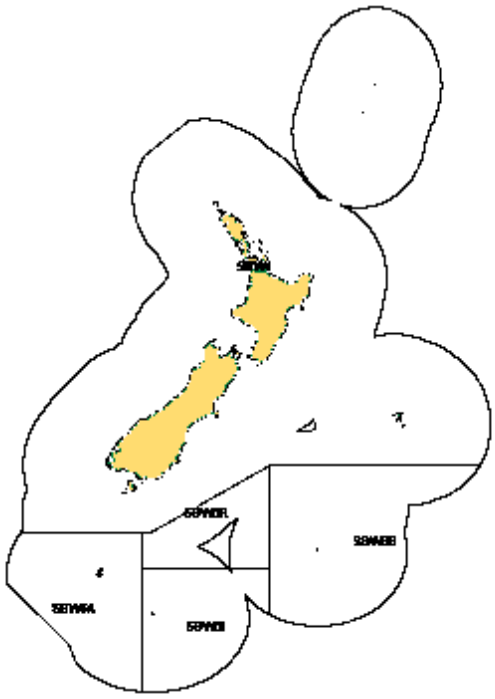
Stock assessment

In-season management appears to be feasible using early season catch rate (and possible length frequency data) but the timing and amount of any catch increase are best determined through development of a depletion modeling approach and management strategy evaluation (MSE).

Post-season assessment using a depletion modeling approach has the potential to provide estimates of the impact of the fishery on squid stocks (exploitation rates and status of the stocks annually).

Research and analysis to support this approach will be delivered through the discretionary research fund following the results of the squid workshop scheduled in 2010.

9. SOUTHERN BLUE WHITING (SBW)



Introduction

Southern blue whiting (SBW) is managed as five fish stocks (SBW1, SBW6B, SBW6I, SBW6R and SBW6A). Four of the stocks support target fisheries of varying volume, and the other fish stock (SBW1) is for administrative purposes (catch of SBW in other areas).

Table 1: Summary of TACs and TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fish stock	QMA	FMA	TAC	TACC	Landings (2008-09)
SBW1	All areas excluding FMA 6	1, 2, 3, 4, 5, 7, 8, 9, 10	8	8	21
SBW6A	Auckland Islands Shelf	6 (part)	1,640	1,640	143
SBW6B	Bounty Platform	6 (part)	15,000*	14,700	9,864**
SBW6I	Campbell Island	6 (part)	23,460†	23,000	20,483‡
SBW6R	Pukaki Rise	6 (part)		5,500	1,377
Total				36,948	31,888

*Note that the SBW6B TAC includes a 300 tonne allowance for other sources of fishing related mortality.

**2008-09 landings were against a TACC of 9,800 tonnes

†Note that the SBW6I TAC includes a 460 tonne allowance for other sources of fishing related mortality.

‡2008-09 landings were against a TACC of 20,000 tonnes

Management approach

Tier 1 stocks (SBW6I, SBW6B and SBW6R)

The management approach for the three Tier 1 SBW stocks is assessment based and leads to regular TAC/TACC reviews. The reviews are based on the results of stock assessments, carried out at 2–3 year intervals. The Tier 1 stocks will be subject to focussed stock monitoring research that will inform these stock assessments. This is discussed in more detail below.

Tier 2 stocks

SBW6A and SBW1 are Tier 2 stocks. SBW6A will be managed using information from monitoring CPUE, and Observer sampling and catch at age data if available. This stock will also be subject to regular fishery characterisation. If fishing effort in SBW 6A increases it will move to a Tier 1 status and the management and monitoring approach will be revised.

Harvest strategy

The following table details the generic reference points and corresponding management responses that will be used for the SBW stocks, based on the Harvest Strategy Standard. Stock-specific reference points and associated management responses will be developed for SBW as.0 part of the National Deepwater Fisheries Plan.

Table 2: Harvest strategy for southern blue whiting stocks

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move SBW stocks toward or above this target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which SBW fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fish plan status

Southern blue whiting is not yet included in the National Deepwater Fisheries Plan. Work on a specific chapter for SBW is planned to commence during 2010. The SBW chapter of the National Deepwater Fisheries plan will detail the management and operational objectives for all SBW stocks.

Summary of current knowledge

Stock assessment

The stock assessment model that is available for the Tier 1 SBW stocks is currently being updated to enable it to take account of the strong year classes that are observed in SBW stocks as a result of episodic recruitment. The work is due to be completed in 2010 and will be used for all three Tier 1 SBW stocks.

Stock structure

There appear to be four main spawning grounds of SBW: the Bounty Platform, Pukaki Rise, Auckland Islands Shelf, and Campbell Island Rise. There are also consistent differences in the size and age distributions of fish, in the recruitment strength, and in the timing of spawning between these four areas. For the purposes of stock assessment it is assumed that there are four stocks of southern blue whiting with fidelity within stocks.

SBW is not targeted in SBW1 (the remainder of the EEZ). SBW is not found in large volumes in SBW1, but catch is recorded for quota monitoring purposes.

Productivity

Southern blue whiting growth rates are known for the main stocks from otolith readings. Early growth rates are fast, with fish reaching 20cm by the end of year 1 and 30cm by the end of year 2. Catch at age data are collected annually from the main commercial trawl fisheries (SBW6I and 6B). Year class strength is estimated within the assessment models.

Stock monitoring – the historical data series

The Tier 1 SBW stocks have been surveyed on a regular basis since 1993, and biomass estimates have been obtained using wide-area and aggregation-based acoustic surveys of the spawning aggregations in each stock. Traditionally, wide-area acoustic surveys have been used to survey the entire spawning area, although aggregation-based acoustic surveys have been carried out using Industry vessels in recent years. The minimum biomass estimates from these industry acoustic surveys have been used to set catch limits in recent years, in the absence of an agreed stock assessment.

Table 3: Historical series of SBW abundance indices and catch at age data. Dates in italics are industry surveys.

Fishstock	Acoustic surveys	CPUE	Catch at age
SBW6I	1993-95, 1998, 2000, 2002, *2003*, 2004, 2006, 2009	1986-2005	1979-2009
SBW6B	1993-95, 1997, 1999, 2001, *2004, 2006-09*	1990-2002	1990-2009
SBW6R	1993-95, 1997, 2000, *2009*		1989-2009
SBW6A	1995		

The management strategy used in SBW 6I and 6B in the absence of stock assessments is based on biomass estimates derived directly from the most recent acoustic surveys. A fishing mortality of 0.2 is applied to the conservative biomass estimates from these surveys to generate conservative yield estimates. The TACC is then selected from within this range of estimates.

10 Year Research Plan – Stock monitoring & assessment

Overview

The Tier 1 SBW stocks will undergo stock assessments at least every 2-3 years using the updated catch-at-age model that is under development. The model will be supported by the following research, depending on which of the SBW stocks is being assessed:

- Wide-area acoustic surveys of the spawning stocks
- Aggregation-based acoustic surveys of the spawning stocks

- Regular length-frequency sampling by Observers (Tier 1 and Tier 2)
- Routine catch-at-age analysis of otoliths collected by Observers (Tier 1 and Tier 2)

Stock characterisations of the Tier 2 stocks will include CPUE analysis and catch at age analysis will also be carried out. There are some issues associated with CPUE from the SBW fisheries because of the highly aggregated nature of the fishery and the targeting of fish marks which means it may not be possible to determine a reliable index of abundance.

Acoustic surveys

It is proposed to continue the acoustic survey series during the spawning season in each of the Tier 1 stocks.

SBW 6I: To effectively survey both spawning aggregations that occur in this stock, a dedicated vessel will be required to perform a biennial wide-area acoustic survey with a towed-body transducer.

SBW 6B: Industry vessels fishing commercially with hull-mounted transducers will likely be used to perform aggregation-based acoustic surveys. The surveys will be scheduled annually when using hull-mounted transducers to allow for poor weather and incomplete spatial coverage.

It has been recommended that this stock would also benefit from a periodic wide area acoustic survey, to ensure that the whole stock is monitored rather than a sub-set. One option would be to replace the aggregation based survey with a wide-area acoustic survey every 5 years.

SBW 6R: Biennial aggregation-based surveys are also proposed for this stock

The issues with aggregation-based surveys discussed above also apply to SBW6R and some form of wide area acoustic survey may be required.

SBW 6A: No dedicated acoustic survey is currently planned for SBW6A. Minimal fishing occurs in this area and catch and effort data will be used to monitor this stock. If catches increase, further acoustic work will be considered.

Observer sampling

Under the 10 Year Research Programme there will be full observer coverage across the deepwater fishing fleet, although this coverage will be scaled up during the first three years of the programme.

Observer biological sampling to inform the stock assessments will consist of:

- Otolith collection
- Length frequency sampling
- Gonad staging (females)

Otoliths will be collected annually from the main trawl fisheries by Observers. The following numbers of otoliths will be read each year:

Table 4: Planned southern blue whiting otolith sampling

Fish stock	Fishing method	Otolith numbers (readings)
SBW6I	Trawl fishery	400 each sex
SBW6B	Trawl fishery	400 each sex
SBW6R	Trawl fishery	400 each sex
SBW6A*	Trawl fishery	400 each sex

* If information is available

Catch at age analysis

Otoliths collected by observers from commercial fisheries will be aged regularly as part of a routine ageing programme.

10 Year Research Plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Where more detailed information on monitoring the environmental effects of fishing are required, leveraging opportunities from research and industry vessel platforms to collect additional data will be assessed on a regular basis.

Benthic impacts

SBW is taken by trawling with mid-water gear that is fished on or close to the seabed. Mid-water gear is lighter than bottom trawl gear, but may be fished hard down on the seabed and may cause an impact to the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the SBW fisheries against any relevant environmental standards.

Endangered, threatened and protected species

The SBW fishery is known to have incidental interactions with protected seabirds and marine mammals. New Zealand fur seals are caught predominantly in SBW6B, due to the close proximity of the Bounty Islands rookery, whereas New Zealand sea lions are predominantly caught in SBW6I, due to proximity to the Campbell Island rookery.

Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the SBW fishery against any relevant environmental standards. If any of the SBW fisheries do not meet the environmental standards, then further research into mitigation measures will be delivered through the annual Additional Research fund.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS; bycatch in SBW is very low.[10] For those species that are outside the QMS, increased observer coverage will allow for annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

Stock assessment

- The key inputs to the stock assessment models are catch-at-age and acoustic data. Biomass estimates from the industry acoustic surveys of the Bounty stock are highly variable between years because they often do not survey the entire aggregation.
- The stock assessment model for the Bounty Platform stock is currently unable to reconcile the very large and variable acoustic biomass estimates with the series of observed catch-at-age data. There were poor fits to the acoustic data and the strength of the 2002 year class responsible for the biomass increase is not well estimated. Work is progressing to refine this model to take into account the large variations in abundance observed in SBW6B and other SBW stocks. This work should be completed during 2010.

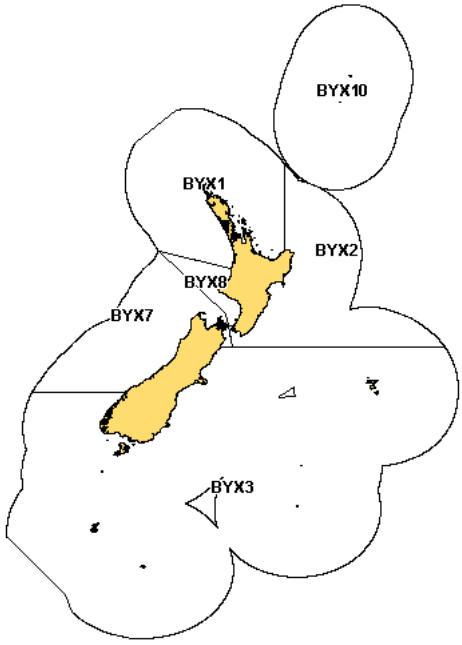
Stock monitoring

It is unclear whether the aggregation-based acoustic survey approach taken in SBW6B will be sufficient for long term management. Aggregation based surveys provide minimum estimates of spawning biomass, whereas wide-area surveys would provide relative estimates of total spawning biomass. To be confident in the status of the stock it may be necessary to carry out wide-area acoustic surveys, approximately every 5 years.

[10] Observer data from target southern blue whiting tows shows that, on average, 98.4% of the catch is southern blue whiting and 99.8% of the catch is comprised of southern blue whiting and other QMS species. These values will vary slightly between stocks.

Part 2: Tier 2 species

1. ALFONSINO (BYX)



Introduction

Alfonsino is primarily taken in a target trawl fishery off the east coast of the North Island (BYX 2) and to a lesser extent in BYX 3. Alfonsino is also a minor bycatch of other trawl fisheries around New Zealand. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
BYX1	Auckland (East),(West	1 & 9	304*	300	172
BYX2	Central (East)	2	1,575	1,575	1,589
BYX3	South east (coast), (Chatham), Southland, Sub-Antarctic	3 to 6	1,010	1,010	895
BXY7	Challenger	7	81	81	18
BYX8	Central (West)	8	20	20	<1
BYX10	Kermadec	10	10	10	0
Total			3,000	2,996	2,674

* Note the BYX1 TAC includes a 2 tonne allowance for both customary and recreational fishers.

Management objectives and approach

All alfonsino stocks are managed as Tier 2 stocks. The abundance of alfonsino will be monitored at 3 year intervals by regular characterisation of the fisheries. If it proves feasible catch-at-age data may be used to measure fishing mortality in the main fisheries.

Harvest strategy

The harvest strategy for all alfonsino stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for alfonsino

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fisheries plan status

All alfonsino stocks will be included in the oreo chapter of the National Deepwater Fisheries as a key bycatch species. Work on an oreo chapter will occur in the future.

Summary of current knowledge

Stock assessment

No current assessments are available for any alfonsino stocks.

Stock structure

No information is available to establish whether alfonsino is a single stock in New Zealand waters. Overseas data on alfonsino stock distributions suggest that New Zealand fish could form part of a widely distributed South Pacific stock.

Productivity

Alfonsino have a maximum recorded age of 17 years and females grow faster than males. Using a maximum age of 20 years, the rate of natural mortality (*M*) is about 0.23.

Stock monitoring

An abundance series was developed in 2010 for the bycatch (BYX1) in the longline fishery for bluenose in east Northland and Bay of Plenty; however, this is based on only 5% of the total catch in these areas. A CPUE series for the BYX 2 target trawl fishery was previously rejected

by the Working Group. Previous studies of catch-per-unit-effort in BYX3 concluded that the high variation in catch rates, the relatively small number of catch and effort records, and the complex nature of the fishery precluded the development of a reliable abundance (CPUE) index.

Stock monitoring – historical data series

The commercial catch in BYX2 is dominated by 5–11 year old fish. Without linking age structure to specific fishing grounds the age structure of the catch is unlikely to monitor changes in the population. Catch at age data have been collected from the main commercial trawl fishery in BYX 2.

Fishstock	CPUE	Catch at age data source
BYX2		Commercial trawl fishery: 1998-99 to 2004-05

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All alfonsino stocks will be monitored by regular characterisation of the fisheries. If feasible catch-at-age data may be used to measure fishing mortality in the main fisheries.

Trawl surveys

Trawl surveys do not appear to be appropriate to monitor any alfonsino stocks.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Fishstock	Fishing method	Otolith numbers
BYX2	Trawl fishery	600 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Alfonsino is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the alfonsino fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take alfonsino as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

Currently there are no indices of abundance available for Alfonsino.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information.

2. BARRACOUTA (BAR)

Introduction

Barracouta is primarily taken by the deepwater trawl fleet as both a target and bycatch fishery. The major target fisheries occur on spring spawning aggregations and on summer feeding aggregations; primarily in BAR 1 and 4. Barracouta also comprise a significant proportion of the bycatch in the west coast North Island jack mackerel and the Snares squid fisheries. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) from 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TACC	Landings 2008-09
BAR 1	Auckland (East), Central (East), South–East (Coast)	1, 2 & 3	11,000	8,861
BAR 4	South–East (Chatham),	4	3,019	968
BAR 5	Southland and Sub–Antarctic	5&6	7,470	7,659
BAR 7	Challenger, Central (West), Auckland (West)	7, 8 & 9	11,173	8,957
BAR 10	Kermadec	10	10	0
Total			32,672	26,445

Management objectives and approach

All barracouta stocks are managed as Tier 2 stocks. The abundance of barracouta will be monitored using CPUE in the trawl fisheries and supported by regular sampling by observers. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all barracouta stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for barracouta

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Barracouta is not yet included in the National Deepwater Fisheries Plan. Barracouta will be included as a key bycatch in the squid fishery and work on a squid chapter will occur in the future.

Summary of current knowledge

Stock assessment

No stock assessment is available for any BAR stock

Stock structure

Based on the information available at the time, four barracouta management areas were established in 1983. Stock boundaries are still not well understood, but the Chatham Islands stock is probably separate. There may be some overlap between mainland management areas as they are currently defined. In particular, it appears that there is considerable overlap of Southland fish with the west coast of the South Island and possibly the east coast as well. However, there is not enough data at this stage to alter the existing stock boundaries.

Productivity

No age data is available for the period prior to the onset of commercial fishing, which developed rapidly from 1968. Ageing studies carried out in the mid-1970s showed that the maximum age rarely exceeded 10 years. Data have been validated for fish up to 3 years old

by following modal progressions over time. Using 10 years for the maximum age suggests a natural mortality (*M*) of up to 0.46. The effect of fishing on age structure prior to the mid-1970s is unknown, but *M* is unlikely to be less than 0.3, which has been assumed in previous stock assessments.

Stock monitoring – historical data series

The following table details the historical series of abundance indices.

Table 3: The historical series of barracouta abundance indices and catch at age data.

Fishstock	Trawl surveys	CPUE	Catch at age
BAR 1	ECNI—Kaharoa 1993-96 ECSI—Kaharoa 1991-96		
BAR 5	Southland—Tangaroa 1993-96		
BAR 7	WCSI—Kaharoa 1992-2005		

10 Year Research Plan – Stock Monitoring & Assessment

Overview

No dedicated trawl or acoustic surveys are planned for barracouta. All barracouta stocks will undergo characterisations at 3 year intervals using the following information:

- Trawl surveys – Conducted primarily to index Tier 1 stocks on the Chatham Rise, Sub Antarctic and West Coast South Island
- Regular length-frequency sampling undertaken by Observers and during trawl surveys
- Characterisations and CPUE analyses every three years

Trawl surveys

Some data on barracouta will be obtained from the trawl surveys planned for the Chatham Rise, Sub Antarctic and West Coast South Island. This information may allow abundance in some sub-areas to be monitored. The Chatham Rise survey is planned to occur in eight of the 10 years of the ten year plan, while the Sub Antarctic and West Coast South Island surveys are planned to occur biennially. Additional information may also be available from the inshore survey conducted by the Kaharoa which occurs outside the 10 year plan.

CPUE analyses

CPUE has not previously been used to monitor barracouta; this will be attempted for the target fisheries.

Observer sampling

Although otoliths will be collected routinely from the main commercial trawl fisheries in BAR 1 and 4, targeted ageing studies will only be conducted when required to address specific research questions such as the structure of the catch and whether mortality rates can be estimated.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Barracouta is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the barracouta fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take barracouta as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

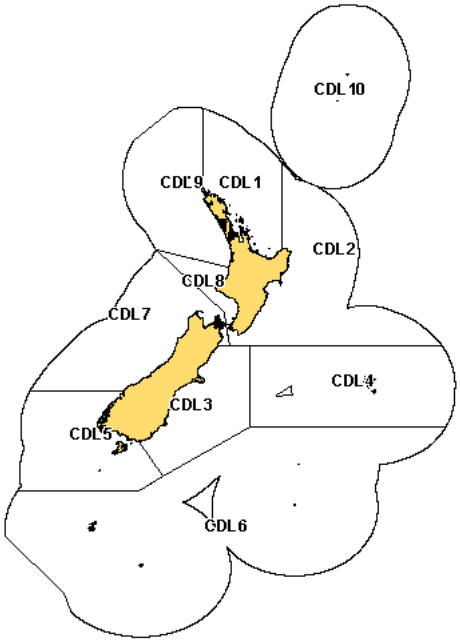
Outstanding issues

Stock assessment

- No indices of abundance exist for BAR stocks
- No stock assessment model
- Uncertainty about stock structure
- Uncertainty about productivity

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

3. BLACK CARDINALFISH (CDL)



Introduction

Cardinalfish is taken by the deepwater trawl fleet as a bycatch of the orange roughy fishery and, to a lesser extent, as a target species. The major target fishery occurs on the east coast of the North Island in CDL 2. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) from 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings 2008-09
CDL 1	Auckland (East)	1	1,320*	1,200	197
CDL 2	Central (East)	2	1,780†	1,620	1,135
CDL 3	South–East (Coast)	3	196	196	52
CDL 4	South–East (Chatham)	4	66	66	58
CDL 5	Southland	5	22	22	11
CDL 6	Sub–Antarctic	6	1	1	<1
CDL 7	Challenger	7	39	39	1
CDL 8	Central (West)	8	0	0	<1
CDL 9	Auckland (West)	9	4	4	2
CDL 10	Kermadec	10	0	0	0
Total				3,751	1,456

* Note that the CDL1 TAC contains a 120 tonne allowance for other sources of fishing related mortality

† Note that the CDL2 TAC contains a 160 tonne allowance for other sources of fishing related mortality

Management objectives and approach

All cardinalfish stocks are Tier 2 stocks under the 10 year plan. The abundance of cardinalfish will be monitored using CPUE in the trawl fisheries. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all spiny barracouta stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for black cardinalfish

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Cardinalfish is included in the orange roughy chapter of the Deepwater Fisheries Plan as a key bycatch species. Management of cardinalfish under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status cardinalfish against agreed management targets.

Summary of current knowledge

Stock assessment

A stock assessment for CDL 2, 3 and 4 was completed in 2009. No assessments have been made for stocks in other areas. For the purposes of stock assessment, it was been assumed that black cardinalfish on the east coast North Island (CDL 2) are from the same stock as fish on the north Chatham Rise (CDL 3 and CDL 4).

The assessment inputs were catches, two CPUE indices and length frequency and maturity at length samples. The CPUE indices were derived from catch and effort data for fisheries focused on and around specific hill features in CDL 2.

Stock structure

The stock boundaries and number of cardinalfish stocks in New Zealand are unknown. There are no data on genetics, or known movements of cardinalfish which indicate possible stock boundaries.

There is evidence that spawning occurs in CDL 1, CDL 2, CDL 7 and CDL 9 and outside the EEZ on North Challenger, Lord Howe and West Norfolk Ridge. No spawning grounds have been identified on the Chatham Rise, where adult fish are relatively rare.

Productivity

Otolith readings from 722 fish from QMA 2 have been validated using radiometric and bomb radiocarbon methods, this analysis indicated that cardinalfish are slow-growing and long lived. Maximum ages of over 100 years were reported, with the bulk of the commercial catch being between 35 and 55 years of age. The validation indicated fish aged over 60 years tended to be under-aged, by up to 30%. This bias would be likely to have little impact on the estimated growth parameters, but would influence the estimate of natural mortality (*M*). The following table details the historical series of abundance indices.

Table 3: Historic catch monitoring for black cardinalfish stocks

Fishstock	Trawl surveys	CPUE	Catch at age
CDL 2		2 series: 1990-1998 and 1998-2008	

10 Year Research Plan – Stock Monitoring & Assessment

Overview

No dedicated trawl surveys are planned for cardinalfish. All cardinalfish stocks will undergo characterisations at 3 year intervals using the following information:

- Trawl surveys – Conducted primarily to index Tier 1 stocks on the Chatham Rise, Sub Antarctic and West Coast South Island
- A dedicated acoustic survey for CDL 2
- Regular length-frequency sampling undertaken by Observers and during trawl surveys

Acoustic surveys

In 2010 a dedicated acoustic survey was conducted for the first time in CDL 2. If this research provides robust information that can be used to manage the CDL 2 fishery, this survey will be conducted a further four times over the next ten years.

CPUE analyses

CPUE has previously been used to monitor cardinalfish in CDL 2; this will continue.

Observer sampling

Otoliths will be collected annually from the main trawl commercial fisheries by Observers or researchers as follows:

Table 4: Planned black cardinalfish otolith sampling

Fishstock	Fishing method	Otolith numbers
CDL 2	Trawl	400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Cardinalfish is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the cardinalfish fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take cardinalfish as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

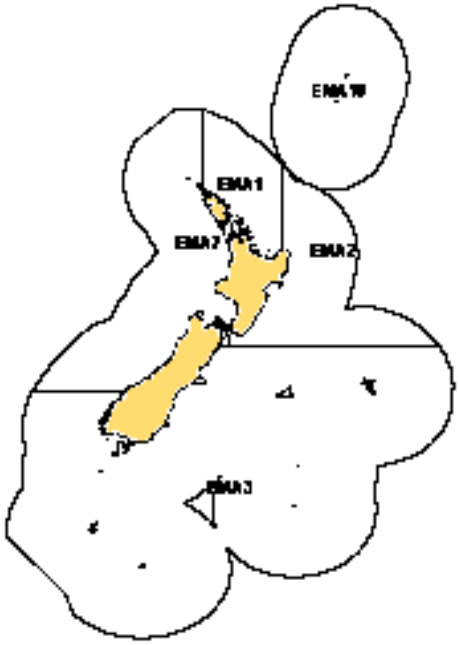
Outstanding issues

Stock assessment

- A pilot acoustic study was carried out in March 2010 to estimate abundance in CDL 2. The results have not yet been analysed or presented.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

4. BLUE MACKEREL (EMA)



Introduction

Blue mackerel are taken primarily in the deepwater as a bycatch in the target jack mackerel fishery in EMA 7. Of the EMA 7 catch, about 85% is taken by trawl with the remainder almost exclusively taken by purse seine. Much of the remaining blue mackerel catch comes from purse seine fisheries in the Bay of Plenty and East Northland (EMA 1 and 2); this is taken by the inshore fleet so is not included in the deepwater research plan. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
EMA1	Auckland (East)	1	7,690*	7,630	3,147
EMA2	Central (East)	2	187†	180	2
EMA3	South-East, Southland, Sub-Antarctic	3-6	392‡	390	88
EMA7	Challenger, Central (West), Auckland (West)	7-9	3,352∂	3,350	3,503
EMA10	Kermadec	10	10	10	0
Total			11,631	11,550	6,740

* Note the EMA1 TAC includes a 20 tonne allowance for customary fishers and a 40 tonne allowance for recreational fishers

† Note the EMA2 TAC includes a 2 tonne allowance for customary fishers and a 5 tonne allowance for recreational fishers

‡ Note the EMA3 TAC includes a 1 tonne allowance for both customary and recreational fishers

∂ Note the EMA7 TAC includes a 1 tonne allowance for both customary and recreational fishers

Management objectives and approach

All blue mackerel stocks are managed as Tier 2 stocks. The abundance of blue mackerel will be assessed using abundance indices from fishery-independent research and monitoring of the commercial trawl fishery. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all blue mackerel stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard. Stock-specific reference points and management responses will likely be developed as part of the Deepwater Fisheries Plan.

Table 2: Harvest strategy for blue mackerel stocks

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.

Fisheries plan status

Blue mackerel is not yet included in the National Deepwater Fisheries Plan. Blue mackerel will be included as a key bycatch in the jack mackerel fishery and work on a jack mackerel chapter will occur in the future.

Summary of current knowledge

Stock assessment

Little is known about the status of blue mackerel stocks and no estimates of current and reference biomass, or yield, are available for any blue mackerel fishery.

Stock structure

Sampling of eggs, larvae, and spawning blue mackerel indicate at least three spawning centres for this species: Northland-Hauraki Gulf; Western Bay of Plenty; and South Taranaki Bight. Meristic characters show significant regional differentiation within New Zealand fisheries waters and, combined with parasite marker information, blue mackerel are sub divided into at least three stocks in New Zealand fisheries waters: EMA 1, EMA 2, and EMA 7.

Productivity

Blue mackerel growth rates are known from otolith readings. Some routine catch at age data are available from the main commercial trawl fisheries in EMA7.

Stock monitoring – historical data series

Relative biomass estimates are obtained from fisheries-independent wide area trawl surveys while catch at age data are collected from the commercial trawl fishery.

Table 3: Historical series of blue mackerel catch at age data

Fishstock	Trawl surveys (wide-area)	Catch at age data source
EMA7		Commercial trawl fishery: 2002-03 to 2007-08

10 Year Research Plan – Stock Monitoring & Assessment

Trawl surveys

A new trawl survey is proposed on the west coast North Island (FMAs 7 and 8). This new survey will have a priority focus on surveying jack mackerel species; however, it will also collect information on blue mackerel and a range of other Tier 2 and Tier 3 species.

As described in the jack mackerel Management and Research Summary, MFish are currently planning research into both trawl and acoustic survey methods and will adopt the most appropriate as an index of jack mackerel abundance. That same approach will likely be adopted for blue mackerel.

CPUE analyses

CPUE has not previously been used to monitor blue mackerel; this will be attempted for the target fisheries.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 4: Planned blue mackerel otolith sampling

Fishstock	Fishing method	Otolith numbers
EMA7	Trawl fishery Research survey	600 each sex 400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Blue mackerel is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the blue mackerel fishery against any relevant environmental standards.

Endangered, threatened or protected species

Trawl fisheries are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

5. FROSTFISH (FRO)

Introduction

Frostfish are predominantly taken as bycatch from target trawl fisheries on jack mackerel and hoki and to a lesser extent, arrow squid, barracouta and gemfish. Target fishing for frostfish occurs primarily on the west coast of both the South Island and North Island and at Puysegur Bank, with the best catches taken from the west coast of the South Island. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10 , and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
FRO1	Auckland (East)	1	151*	149	36
FRO2	Central (East)	2	112†	110	24
FRO3	South-east (Coast)	3	176	176	6
FRO4	South-east (Chatham)	4	28	28	10
FRO5	Southland	5	135	135	2
FRO6	Sub-Antarctic	6	11	11	<1
FRO7	Challenger	7	2,625‡	2,623	576
FRO8	Central (West)	8	649	649	605
FRO9	Auckland (West)	9	140∂	138	110
FRO10	Kermadec	10	0	0	0
Total				4,019	1,369

* Note that the FRO1 TAC includes a 1 tonne allowance for both customary and recreational fishers
† Note that the FRO2 TAC includes a 1 tonne allowance for both customary and recreational fishers
‡ Note that the FRO7 TAC includes a 1 tonne allowance for both customary and recreational fishers
∂ Note that the FRO9 TAC includes a 1 tonne allowance for both customary and recreational fishers

Management objectives and approach

All frostfish stocks are managed as Tier 2 stocks. The abundance of frostfish will be monitored using CPUE in the trawl fisheries and supported by regular sampling by observers. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all frostfish stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for frostfish

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Frostfish is included in the hoki chapter of the National Deepwater Fisheries Plan as a key bycatch species. Management of frostfish under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status of frostfish against agreed management targets.

Summary of current knowledge

Stock assessment

Little is known about the status of frostfish stocks and no estimates of current and reference biomass, or yield, are available for any frostfish fishery.

Stock structure

The occurrence of spawning in three areas at similar times of year, and the distribution of frostfish from catches, suggest that there may be at least three separate stocks. A fourth stock is also possible based on known distribution of juveniles and adults and analogies with other species which often have a separate Chatham Rise stock. On the basis of this

information the following stock areas have been proposed: FRO 1 (QMAs 1 and 2); FRO 3: (QMAs 3 and 4); FRO 5: (QMAs 5 and 6) and FRO 7: (QMAs 7, 8, and 9).

Productivity

An ageing study using otolith readings has been conducted. This was inconclusive and could have been the result of using a limited size range of fish.

Stock monitoring – historical data series

No biomass estimates are available and catch at age data has not been collected routinely from the commercial trawl fishery.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All frostfish stocks will be monitored by regular characterisation of the fisheries and possible CPUE analyses. If feasible, catch-at-age data may also be used to measure fishing mortality in the main fisheries.

Trawl surveys

No trawl surveys will be targeted specifically at frostfish but the relative abundance will be monitored in the target jack mackerel survey on the west coast North Island. The new trawl survey proposed for the west coast South Island will also provide some information to monitor the relative abundance of FRO7.

CPUE analyses

CPUE has not previously been used to monitor frostfish; this will be attempted for the target fisheries.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 3: Planned frostfish otolith sampling

Fishstock	Fishing method	Otolith numbers
FRO 7 and FRO 8	Trawl fishery Research survey (WCNI)	600 each sex 400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples

and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Frostfish is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the frostfish fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take frostfish as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

6. PALE GHOST SHARK (GSP)

Introduction

Pale ghost shark are taken almost exclusively as a bycatch of other target trawl fisheries. In recent years pale ghost shark have been bycatch in the hoki target fishery and to a lesser extent ling. A summary of TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
GSP1	Auckland (East), Central (East), South-east, Kermadec	1, 2, 3 and 4	1,208*	1,150	486
GSP5	Southland, Sub-Antarctic	5 and 6	477†	454	294
GSP7	Challenger, Central (West), Auckland (West)	7, 8 and 9	176	176	15
Total			1,861	1,780	795

* Note that the GSP1 TAC includes a 58 tonne allowance for other sources of fishing related mortality

† Note that the GSP5 TAC includes a 23 tonne allowance for other sources of fishing related mortality

Management approach

All pale ghost shark stocks are managed as Tier 2 stocks. The abundance of pale ghost shark will be assessed using abundance indices from fishery-independent trawl surveys and monitoring of the commercial trawl fishery. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all pale ghost shark stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for pale ghost shark

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fisheries plan status

All pale ghost shark fisheries will be managed through the National Deepwater Fisheries Plan.

Summary of current knowledge

Stock assessment

Little is known about the status of pale ghost shark stocks and no estimates of current and reference biomass, or yield, are available for any pale ghost shark fishery.

Stock structure

The stock structure of pale ghost shark in New Zealand is unknown. However, when the species was introduced to the QMS in 1999 it was determined that the pale ghost sharks be managed as three Fishstocks, i.e., east coast New Zealand (QMAs 1–4), Stewart-Snares shelf and Campbell Plateau (QMAs 5 and 6), and west coast New Zealand (QMAs 7, 8, and 9). Areas of narrow continental shelf separate these QMA groupings, so they may provide barriers to stock mixing.

Productivity

No ageing has been completed on pale ghost sharks; however, a recent study has shown that eye lens measurements and spine band counts are potentially useful ageing techniques for the closely related dark ghost sharks. These techniques have yet to be validated.

Stock monitoring

Relative biomass estimates are available from the trawl surveys of the Chatham Rise and Sub-Antarctic areas, but catch at age data has not been collected routinely from the commercial trawl fisheries.

10 Year Research Plan – Stock Monitoring & Assessment

Trawl surveys

The current trawl surveys on the Chatham Rise and Sub Antarctic, primarily for hoki, will be used to monitor the abundance of GSP 1 and GSP 5 respectively. GSP 7 will undergo regular characterisations of and possibly catch-per-unit-effort analyses.

Observer sampling

Observer biological sampling from the commercial trawl fishery will undertake length frequency sampling to inform regular characterisations. Age material (spines) will not be collected routinely until the ageing technique has been validated.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Pale ghost shark is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the pale ghost shark fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take pale ghost shark as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

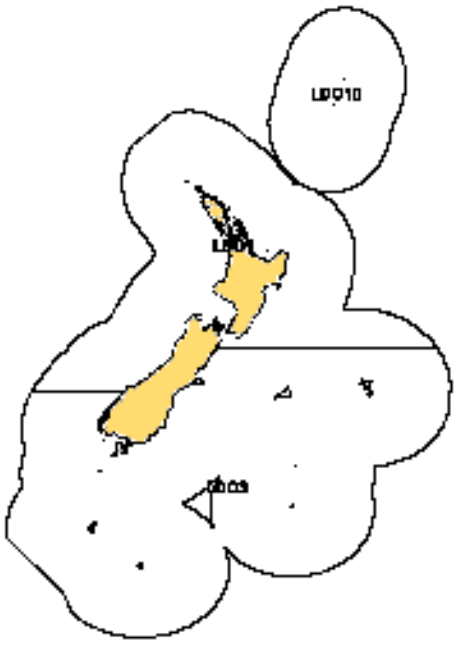
Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

The productivity (growth and natural mortality rates) are unknown for pale ghost shark.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

7. LOOKDOWN DORY (LDO)



Introduction

Lookdown dory is generally caught by trawling as a bycatch in a range of fisheries including hoki, barracouta, hake, ling, scampi and jack mackerel. Most of the catch has come from FMA 3 (east coast South Island), FMA 4 (Chatham Rise), and FMA 7 (west coast South Island). A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
LDO1	Auckland (East and West), Central (East and West), Challenger	1, 2, 7, 8 and 9	168	168	144
LDO3	Southeast, Southland, Sub-Antarctic	3, 4, 5 and 6	614	614	315
LDO10	Kermadec	10	1	1	0
Total				783	459

Management objectives and approach

All lookdown dory stocks are managed as Tier 2 stocks. The abundance of lookdown dory will be monitored at 3 year intervals by regular characterisation of the fisheries. If possible catch-at-age data may be used to measure fishing mortality in the main fisheries.

Harvest strategy

The harvest strategy for all lookdown dory stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for lookdown dory stocks

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fisheries plan status

Lookdown dory is included in the hoki chapter of the National Deepwater Fisheries Plan as a key bycatch species. Management of lookdown dory under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status of lookdown dory against agreed management targets.

Summary of current knowledge

Stock assessment

Little is known about the status of lookdown dory stocks and no estimates of current and reference biomass, or yield, are available for any lookdown dory fishery.

Stock structure

There is no information on stock structure, recruitment patterns, or other biological characteristics on which to base any fishstock boundaries.

Productivity

Although there are no published studies of age and growth of lookdown dory, preliminary work in Australia suggests this species may live to over 30 years.

Stock monitoring

No biomass estimates are available and catch at age data has not been collected routinely from the commercial trawl fishery.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All lookdown dory stocks will be monitored by regular characterisation of the fisheries. If possible catch-at-age data may be used to measure fishing mortality in the main fisheries.

Trawl surveys

The relative abundance of lookdown dory is measured by hoki trawl surveys of the Chatham Rise and the Sub-Antarctic. Lookdown dory biomass is usually in the top 10 species on the Chatham Rise and has low CVs. Lookdown dory are far less abundant in the Sub-Antarctic and biomass estimates have higher CVs. The proposed new trawl survey on the west coast South Island may also provide a relative abundance estimate.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 3: Planned lookdown dory otolith sampling

Fishstock	Fishing method	Otolith numbers
LDO3	Trawl fishery Research survey (C. Rise)	600 each sex 400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Lookdown dory is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the lookdown dory fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take lookdown dory as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

The productivity (growth and natural mortality rates) are unknown for look down dory.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

8. RIBALDO (RIB)

Introduction

In recent years most ribaldo has been taken, using both longline and trawl methods, as bycatch in target fisheries for ling, hake and hoki. In some instances, ribaldo is also targeted. Catch has primarily come from the Chatham Rise (RIB 4), the east coast South Island (RIB 3) and the west coast South Island (RIB 7). A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
RIB1	Auckland (East)	1	121	121	45
RIB2	Central (East)	2	176	176	74
RIB3	South-east (Coast)	3	394	394	216
RIB4	South-east (Chatham)	4	357	357	216
RIB5	Southland	5	52	52	31
RIB6	Sub-Antarctic	6	231	231	63
RIB7	Challenger	7	330	330	456
RIB8	Central (West)	8	1	1	<1
RIB9	Auckland (West)	9	2	2	10
RIB10	Kermadec	10	0	0	0
Total			1,664	1,664	1,111

Management objectives and approach

All ribaldo stocks are managed as Tier 2 stocks. The abundance of ribaldo will be monitored using CPUE in the trawl fisheries and supported by regular sampling by observers. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all ribaldo stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for ribaldo

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fisheries plan status

All ribaldo fisheries will be included within the National Deepwater Fisheries Plan as a key bycatch species in the ling fishery. Work on a specific chapter for ling is planned to commence during 2010-2011.

Summary of current knowledge

Stock assessment

Little is known about the status of ribaldo stocks and no estimates of current and reference biomass, or yield, are available for any ribaldo fishery.

Stock structure

It is not known whether different regional stocks of ribaldo occur in New Zealand waters but stocks may be separated stocks based on natural boundaries such as the New Zealand landmass, i.e., west and east coast stocks. There are considered to be four fishstocks based on the four main fishing areas, i.e., the east coast of the North Island (QMAs 1 and 2),

Chatham Rise and east coast South Island (QMAs 3 and 4), Southland and Sub-Antarctic (QMAs 5 and 6), the west coast of New Zealand (QMAs 7, 8 and 9).

Productivity

An ageing study using otolith readings was recently completed.

Stock monitoring

No biomass estimates are available and catch at age data has not been collected routinely from the commercial trawl fishery.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All ribaldo stocks will be monitored by regular characterisation of the fisheries and catch-per-unit-effort analyses. If possible catch-at-age data may also be used to measure fishing mortality in RIB7.

Trawl surveys

No trawl surveys will be targeted specifically at ribaldo but the relative abundance will be monitored in the new survey planned for the west coast South Island.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 3: Planned ribaldo otolith sampling

Fishstock	Fishing method	Otolith numbers
RIB7	Trawl fishery Research survey (WCSI)	600 each sex 400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Ribaldo is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the ribaldo fishery against any relevant environmental standards.

Endangered, threatened or protected species

Trawl fisheries are known to have interactions with seabirds and marine mammals. Ribaldo is also taken using bottom long lines. This method is also known to interact with seabirds; however, captures of marine mammals are very rare. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

9. RUBYFISH (RBY)

Introduction

Rubyfish is primarily targeted off the east coast of the North Island in QMA 2 and is a bycatch of the alfonsino fishery in the same area. Rubyfish is also taken as bycatch in a number of other fisheries including hoki, barracouta and jack mackerel. Summary of TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
RBY1	Auckland (East)	1	318*	300	192
RBY2	Central (East)	2	435†	433	467
RBY3	South-east (Coast)	3	3	3	<1
RBY4	South-east (Chatham)	4	6	6	19
RBY5	Southland	5	0	0	0
RBY6	Sub-Antarctic	6	0	0	<1
RBY7	Challenger	7	33	33	14
RBY8	Central (West)	8	6	6	<1
RBY9	Auckland (West)	9	19	19	2
RBY10	Kermadec	10	0	0	0
Total			820	800	694

* Note the RBY1 TAC includes a 15 tonne allowance for other sources of fishing related mortality, a 2 tonne allowance for recreational fishers and a 1 tonne allowance for customary fishers

† Note the RBY2 TAC includes a 1 tonne allowance for both customary and recreational fishers.

Management objectives and approach

All rubyfish stocks are managed as Tier 2 stocks. The abundance of rubyfish will be monitored at 3 year intervals by regular characterisation of the fisheries. If possible catch-at-age data may be used to measure fishing mortality in the main fisheries.

Harvest strategy

The harvest strategy for all rubyfish stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fisheries plan status

All rubyfish stocks will be included in the oreo chapter of the National Deepwater Fisheries as a key bycatch species. Work on an oreo chapter will occur in the future.

Summary of current knowledge

Stock assessment

Little is known about the status of rubyfish stocks and no estimates of current and reference biomass, or yield, are available for any rubyfish fishery.

Stock structure

It is not known whether different regional stocks of rubyfish occur in New Zealand waters.

Productivity

Ageing research based on counts of otolith structures indicates that rubyfish are a slow-growing and long-lived species. Using radiocarbon dating techniques the oldest fish sampled were born prior to the beginning of the period of atmospheric nuclear testing and therefore were at least 45 years old.

Stock monitoring

No biomass estimates are available and catch at age data has not been collected routinely from the commercial trawl fishery.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All rubyfish stocks will be monitored by regular characterisation of the fisheries and possible catch-per-unit-effort analyses. If possible catch-at-age data may also be used to measure fishing mortality in the main fisheries.

Trawl surveys

Trawl surveys do not appear to be appropriate to monitor any rubyfish stocks.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Fishstock	Fishing method	Otolith numbers
RBY1 and RBY2	Trawl fishery	600 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Rubyfish is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from

vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the rubyfish fishery against any relevant environmental standards.

Endangered, threatened or protected species

Trawl fisheries are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the fisheries against any relevant environmental standards.

Fish bycatch

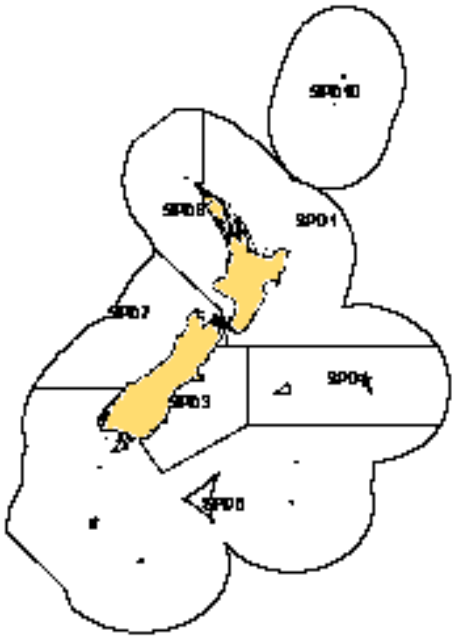
Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

Currently there are no indices of abundance available for rubyfish.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

10. SPINY DOGFISH



Introduction

Spiny dogfish is primarily taken by the deepwater fleet as a bycatch in the jack mackerel, barracouta, hoki, and arrow squid fisheries. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings (2008-09)
SPD 1	Auckland (East), Central (East)	1 & 2	413*	331	229
SPD 3	South–East (Coast)	3	5,075†	4,794	1,981
SPD 4	South–East (Chatham),	4	1,662‡	1,626	866
SPD 5	Southland and Sub–Antarctic	5&6	3,753∂	3,700	2,071
SPD 7	Challenger	7	1,983μ	1,902	923
SPD 8	Central (West), Auckland (West)	8 & 9	392β	307	150
Total			13,278	12,660	6,220

* Note that the SPD1 TAC includes a 4 tonne allowance for other sources of fishing related mortality, and a 39 tonne allowance for both customary and recreational fishers.

† Note that the SPD3 TAC includes a 51 tonne allowance for other sources of fishing related mortality, and a 115 tonne allowance for both customary and recreational fishers.

‡ Note that the SPD4 TAC includes a 16 tonne allowance for other sources of fishing related mortality, and a 10 tonne allowance for both customary and recreational fishers.

∂ Note that the SPD5 TAC includes a 37 tonne allowance for other sources of fishing related mortality, and an 8 tonne allowance for both customary and recreational fishers

μ Note that the SPD7 TAC includes a 19 tonne allowance for other sources of fishing related mortality, and a 31 tonne allowance for both customary and recreational fishers

β Note that the SPD8 TAC includes a 3 tonne allowance for other sources of fishing related mortality, and a 41 tonne allowance for both customary and recreational fishers.

Management objectives and approach

All spiny dogfish stocks are Tier 2 stocks under the 10 year plan. The abundance of spiny dogfish will be monitored using CPUE in the trawl fisheries. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all spiny dogfish stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Spiny dogfish are included in the hoki chapter of the Deepwater Fisheries Plan as a key bycatch species. Management of spiny dogfish under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status spiny dogfish against agreed management targets.

Summary of current knowledge

Stock structure

No specific research on the stock structure of spiny dogfish has been carried out. Trawl surveys have clearly shown that spiny dogfish migrate seasonally along the east coast of South Island. Spiny dogfish are most abundant in the southern part of the coast from October to April and more abundant to the north in May to September. It is also clear from summer trawl surveys that part of the population is resident on the Stewart/Snares Shelf over the summer months. Until more data become available fish from these two areas will be treated as separate stocks.

It is likely that some fish migrate north in winter, perhaps to the northern and southern Taranaki Bights, and Tasman Bay and Golden Bay. However, it is also clear from summer trawl surveys that part of the population is resident in the Taranaki Bights over the summer months. It may therefore be appropriate to treat fish from QMA 7 and 8 as a single stock.

Based on current knowledge, spiny dogfish will be managed as the following five fishstocks:

- SPD 1 and 2—Northeast
- SPD 3—Southeast
- SPD 4—Chatham Rise
- SPD 5 and 6—Southern
- SPD 7, 8 and 9—Western

Productivity

Spiny dogfish have been aged using fin spines, and early growth has been validated by following modes in length-frequency and eye lens weight frequency data. Males mature at 58 cm total length (TL) at age 6, and females mature at 73 cm TL at age 10. The maximum ages and lengths in a study of east coast South Island dogfish were 21 years and 90 cm TL for males, and 26 years and 111 cm TL for females.

The following table details the historical series of abundance indices and catch at age data.

Fishstock	Trawl surveys	CPUE	Catch at age
SPD 3	ECSI—Kaharoa 1991-2008		
SPD 4	Chatham Rise—Tangaroa 1991-2010		
SPD 5	Southland—Tangaroa 1993-96		
SPD 7	WCSI—Kaharoa 1992-2009		

The previous trawl surveys have not always provided reliable indices of abundance for spiny dogfish because of variable estimates and high CVs.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

No dedicated trawl or acoustic surveys are planned for spiny dogfish. All spiny dogfish stocks will undergo characterisations at 3 year intervals using the following information:

- Trawl surveys – Conducted primarily to index Tier 1 stocks on the Chatham Rise, Sub Antarctic and West Coast South Island
- Regular length-frequency sampling undertaken by Observers and during trawl surveys

Trawl surveys

Some data on spiny dogfish will be obtained from the trawl surveys planned for the Chatham Rise, Sub Antarctic and West Coast South Island. The Chatham Rise survey is planned to occur in eight of the 10 years of the ten year plan, while the Sub Antarctic and West Coast South Island surveys are planned to occur biennially.

CPUE analyses

CPUE has not previously been used to monitor spiny dogfish. Much of the catch has previously been discarded (current discarding is permitted under the 6th Schedule of the Fisheries Act 1996) so is not considered to be a deepwater target fishery.

Observer sampling

No routine age collection is planned for spiny dogfish. Fin spines may be collected and aged if considered necessary. Length frequency data will be collected regularly.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Spiny dogfish is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the spiny dogfish fishery against any relevant environmental standards. This analysis is likely to occur in conjunction with the major target fisheries of which spiny dogfish is a bycatch.

Endangered, threatened or protected species

Trawl fisheries that take spiny dogfish as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

Stock assessment

No indices of abundance exist for spiny dogfish stocks

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

11. SILVER WAREHOU (SWA)

Introduction

Silver warehou is primarily taken as a bycatch of the hoki, squid, barracouta and jack mackerel trawl fisheries. The majority of this catch is taken from the Chatham Rise, Canterbury Bight, southeast of Stewart Island and the west coast of the South Island. Some target fishing for silver warehou does occur, predominantly on the Mernoo Bank and along the Stewart-Snares shelf. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings 2008-09
SWA 1	Auckland (East) (West), Central (East) (West), & Challenger	1, 2, 7, 8 & 9	3,003*	3,000	1,366
SWA 3	South–East (Coast)	3	3,280	3,280	3,264
SWA 4	South–East (Chatham), Southland, and Sub–Antarctic	4, 5 & 6	4,090	4,090	4,213
SWA 10	Kermadec	10	10	10	0
Total			10,383	10,380	8,843

* Note the SWA1 TAC includes a 2 tonne allowance for recreational fishers and a 1 tonne allowance for customary fishers

Management objectives and approach

All silver warehou stocks are Tier 2 stocks under the 10 year plan. The abundance of silver warehou will be monitored using CPUE in the trawl fisheries. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.[11]

Harvest strategy

The harvest strategy for all silver warehou stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

Silver warehou is included in the hoki chapter of the National Deepwater Fisheries Plan as a key bycatch species. Management of silver warehou under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status silver warehou against agreed management targets.

Summary of current knowledge

Stock assessment

No stock assessments currently exist for any silver warehou stock, but an assessment of the WCSI (SWA1) fishery using CPUE and catch at age data has been attempted.

Stock structure

Spawning occurs on the Chatham Rise (Mernoo), east coast North Island and west coast South Island in late winter and at the Chatham Islands in late spring-early summer. There is some evidence for another spawning ground on the Stewart-Snares shelf, also in late winter.

[11] SWA 1 has been managed with a TACC of 3,000 t since October 2002 under the AMP.

It is uncertain whether the same stock migrates from one area to another, spawning whenever conditions are appropriate, or if there are several separate stocks. The current boundaries bear little relation to known spawning areas and silver warehou distribution.

Productivity

Silver warehou growth rates are known for the main stocks from otolith readings. Routine catch at age data are collected from the trawl surveys and the main commercial fisheries.

Stock monitoring – historical data series

Estimates of relative abundance of Silver warehou have been obtained from CPUE in SWA1. The following tables detail the historical series of abundance indices and catch at age data.

Fishstock	Trawl surveys	CPUE	Catch at age
SWA 1	Not used	Trawl 1986-2008 (Observer data)	1992-2005
SWA 3	Not used		
SWA 4	Not used		

Although trawl surveys have been conducted in the past on the Chatham Rise and in Sub Antarctic, these surveys have not provided reliable indices of abundance for silver warehou because of variable estimates and high CVs.

10 Year Research Plan – Stock Monitoring & Assessment

Trawl surveys

No dedicated surveys will be conducted for any silver warehou stock. Although information has been variable in the past, some information will continue to be obtained from trawl surveys conducted for Tier 1 stocks on the Chatham Rise and Sub Antarctic. This information will continue to be considered and used if appropriate.

CPUE analyses

CPUE recorded by Observers in the west coast South Island winter fishery (SWA1 – bottom and mid-water trawls) have recently been analysed and accepted as an index of abundance for this fishery. This will continue to be used for SWA1. Further work will continue to establish a similar index for SWA 3 and 4.

Observer sampling

Otoliths will be collected annually from the main trawl commercial fisheries by Observers or researchers as described in the following table.

Fishstock	Fishing method	Otolith numbers
SWA 1	Trawl	400 each sex
SWA 3	Trawl	400 each sex
SWA 4	Trawl	400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

Silver warehou is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the silver warehou fishery against any relevant environmental standards.

Endangered, threatened or protected species

Trawl fisheries that take silver warehou are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

Stock assessment

No indices of abundance exist for SWA 3 & 4.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

12. WHITE WAREHOU (WWA)

Introduction

White warehou are predominantly taken as bycatch from target trawl fisheries on hoki and silver warehou, and to a lesser extent, hake, ling and scampi. The main areas of fishing are the Southland area, with some extension into the Sub-Antarctic area since and the Chatham Rise. Limited target fishing of white warehou has been reported from around Mernoo Bank, the Stewart–Snares shelf, Puysegur Bank and on the west coast of the South Island, with the best catch rates recorded in the southern areas. A summary of TACCs (t), and reported landings (t) for the most recent fishing year is provided below.

Table 1: Summary of TACs and TACCs (tonnes) for 2009-10, and reported landings (tonnes)

Fishstock	QMA	FMA	TAC	TACC	Landings 2008-09
WWA 1	Auckland (East)	1	4	4	<1
WWA 2	Central (East)	2	75*	73	22
WWA 3	South–East (Coast)	3	585†	583	302
WWA 4	South–East (Chatham)	4	332‡	330	83
WWA 5B	Southland and Sub–Antarctic	5 & 6	2,621∂	2,617	1,644
WWA 7	Challenger	7	129µ	127	110
WWA 8	Central (West)	8	1	1	0
WWA 9	Auckland (West)	9	0	0	<1
WWA 10	Kermadec	10	0	0	0
Total			3,747	3 735	2,161

* Note the WWA2 TAC includes a 1 tonne allowance for both customary and recreational fishers

† Note the WWA3 TAC includes a 1 tonne allowance for both customary and recreational fishers

‡ Note the WWA4 TAC includes a 1 tonne allowance for both customary and recreational fishers

ð Note the WWA5B TAC includes a 2 tonne allowance for both customary and recreational fishers

µ Note the WWA7 TAC includes a 1 tonne allowance for both customary and recreational fishers

Management objectives and approach

All white warehou stocks are Tier 2 stocks under the 10 year plan. The abundance of white warehou will be monitored using CPUE in the trawl fisheries. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The harvest strategy for all white warehou stocks is based on the following reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

The research programme will seek, where possible, to provide an estimate of $B_{CURRENT}$ and B_{MSY} to manage to the reference points described above. However, higher CVs on estimates will be expected and accepted. This increased uncertainty may require a more cautious management response.

Fish plan status

White warehou is included in the hoki chapter of the National Deepwater Fisheries Plan as a key bycatch species. Management of white warehou under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status white warehou against agreed management targets.

Summary of current knowledge

Stock assessment

No stock assessment exists for any white warehou stock.

Stock structure

The existence of three likely spawning areas for white warehou at the same time of year (Mernoo Bank, Puysegur Bank and the west coast of the South Island) suggests the possibility of three separate stocks. The following stock affinities are assumed for white warehou: eastern stock (QMAs 1, 2, 3 and 4), southern stock (QMAs 5 and 6) and western stock (QMAs 7, 8 and 9).

Productivity

White warehou have been aged up to a maximum of 23 years from otolith readings, however, these ages have not yet been validated.

Stock monitoring – historical data series

The following tables detail the historical series of abundance indices and catch at age data.

Fishstock	Trawl surveys	CPUE	Catch at age
WWA 1, 2, 3 & 4	Not used		
WWA 5 & 6	Not used		
WWA 7, 8 & 9	Not used		

Although trawl surveys have been conducted in the past on the Chatham Rise and in Sub Antarctic, these surveys have not provided reliable indices of abundance for white warehou because of variable estimates and high CVs.

10 Year Research Plan – Stock Monitoring & Assessment

CPUE analyses

CPUE has not previously been used to monitor white warehou. Data will be collected from trawl surveys and by observers to attempt an analysis of CPUE in these fisheries.

Observer sampling

Otoliths will be collected annually from the main trawl commercial fisheries by Observers or researchers as described in the following table.

Fishstock	Fishing method	Otolith numbers
WWA 5 & 6	Trawl	400 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples

and other aquatic environment research such as establishing trophic relationships among species.

Benthic impacts

White warehou is taken by trawling which has an impact on the seabed; particularly when fished using bottom trawl gear or mid-water gear that is fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the white warehou fishery against any relevant environmental standards.

Endangered, threatened or protected species

Trawl fisheries that take white warehou are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

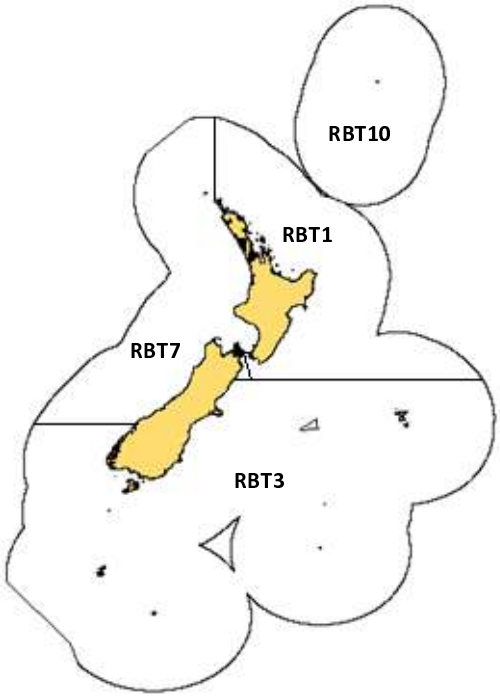
Outstanding issues

Stock assessment

No indices of abundance exist for WWA stocks.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. In some cases catch at age data will be collected to determine if fishing mortality rates can be estimated. However, in some cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information

13. REDBAIT (RBT)



Introduction

Although the amount of redbait being targeted is increasing, it is still most often taken as a bycatch to the jack mackerel trawl fishery (66% of total estimated catch from the past seven fishing years). The majority of the catch is taken from the west coast (FMAs 7, 8 and 9) with 61% of landed catch coming from that area during the past seven fishing years. The catch in RBT3 comes from a combination of bycatch from the jack mackerel, squid trawl and barracouta fisheries this varies considerably depending on abundance of the target stocks.

Table1. Summary of TACs, TACCs and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC	TACC	Landings 2008-09
RBT1	Auckland (East), Central (East)	1 and 2	20	19	2
RBT3	South-East, Southland, Sub-Antarctic	3, 4, 5 and 6	2,305	2,190	278
RBT7	Challenger, Central (West), Auckland (West)	7, 8 and 9	2,991	2,841	1,514
RBT10	Kermadec	10	0	0	0
Total			5,316	5,050	1,794

Management approach

All redbait stocks are managed as Tier 2 stocks. All redbait stocks will be monitored by characterisations of the fisheries every three years and CPUE analyses will be attempted. If feasible, catch-at-age data may also be used to measure fishing mortality in the main fisheries.

Harvest strategy

The following are generic reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for redbait

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fisheries plan status

Redbait is not yet included in the National Deepwater Fisheries Plan. Redbait will be included as a key bycatch in the jack mackerel fishery and work on a jack mackerel chapter will occur in the future.

Summary of current knowledge

Stock assessment

There is no stock assessment information and no estimates of biomass, stock status or sustainable yield for any redbait stock.

Stock structure

For management purposes stock boundaries for redbait are based on those used for jack mackerel. However, there is no biological information on stock structure, recruitment patterns, or other biological characteristics which might indicate stock boundaries.

Productivity

Redbait is believed to be a relatively fast-growing and short-lived species, but no New Zealand growth data is available.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All redbait stocks will be monitored by regular characterisation of the fisheries and possible CPUE analyses. If feasible, catch-at-age data may also be used to measure fishing mortality in the main fisheries.

Trawl surveys

No trawl surveys will be targeted specifically at redbait but the relative abundance will be monitored in the target jack mackerel survey on the west coast North Island.

CPUE analyses

CPUE has not previously been used to monitor redbait; this will be attempted for the target fisheries.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 3: Planned Redbait otolith sampling

Fishstock	Fishing method	Otolith numbers
RBT7	Trawl fishery Research survey (WCNI)	600 each sex 400 each sex
RBT3	Trawl fishery	600 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic Impacts

Redbait is taken by trawling which will have an impact on the seabed; particularly when fished using bottom trawl gear or midwater gear fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the redbait fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take redbait as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

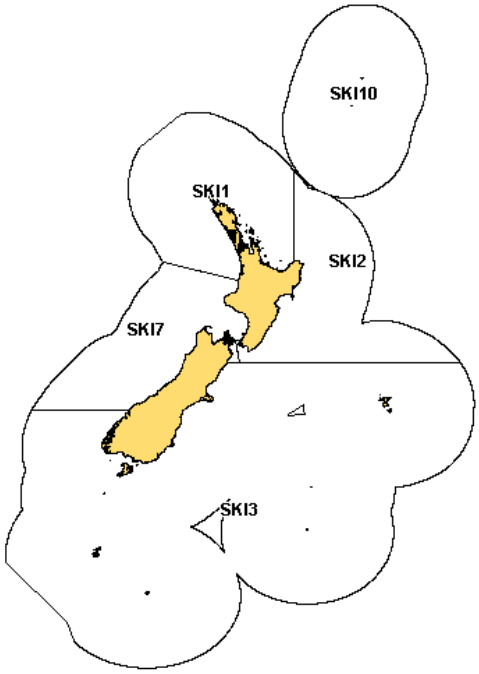
Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. However, in many cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information.

14. GEMFISH (SKI)



Introduction

Gemfish is caught in coastal waters around mainland New Zealand. Most of the historical catch was taken by trawlers off the eastern and northern coasts of the North Island. In the last four years catches have been concentrated in the Bay of Plenty area and on the east coast of the North Island. Catches off the west and southern coasts of the South Island are primarily bycatch of hoki and squid target fisheries.

Table1.Summary of TACs and TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-09
SKI1	Auckland (East)	1 & 9	218	210	191
SKI2	Central (East)	2	248	240	191
SKI3	South-East, Southland, Sub-Antarctic	3, 4, 5 and 6	300	300	11
SKI7	Challenger, Central (West), Auckland (West)	7 & 8	300	300	213
SKI10	Kermadec	10	10	10	0
Total			1076	1060	606

* There is no customary or recreational allowance for SKI3, SKI10 or SKI7 and nor is there an allocation for other sources of fishing related mortality. As a result the TAC and TACC are the same.

Management approach

Management of gemfish is split between deepwater and inshore. SKI1 and 2 are inshore stocks and are not considered here. The deepwater gemfish stocks (SKI3 and SKI7) are managed as Tier 2 stocks and will be monitored by characterisations of the fisheries every three years and CPUE analyses will be attempted. If feasible, catch-at-age data may also be used to measure fishing mortality in the main fisheries.

Harvest strategy

The following are generic reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for gemfish

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fisheries plan status

Deepwater gemfish stocks (SKI 3 and 7) will be included in the hoki chapter of the National Deepwater Fisheries Plan as a key bycatch species. Management of gemfish under the Deepwater Fisheries Plan will focus on ensuring that better information is available to assess the current status of gemfish against agreed management targets.

Inshore gemfish stocks (SKI1 and 2) will be included in the National Inshore Fisheries Plan.

Summary of current knowledge

Stock assessment

No estimates of current and reference biomass, or yield, are available for SKI3 or SKI7. The last assessment was attempted in 1997.

Stock structure

Analysis of seasonal trends in gemfish fisheries indicates that there may be at least 2 stocks:

1. A southern/west coast stock (SKI 3 & 7), caught in the southern area in spring, summer and autumn, which presumably migrates to the west coast of the South Island to spawn and is caught there mainly in August-September. Spawning is thought to occur in late August/early September.
2. A northern/east coast stock (SKI 1E & SKI 2), caught mainly on the east coast in spring and summer, which migrates in May-June to spawn north of the North Island.

Productivity

Ageing of southern gemfish indicate that fish attain about 30 cm at the end of the first year, 45 cm at the end of the second year, 53 cm at the end of the third year and 63 cm at the end of the fourth year. Gemfish are routinely aged in SKI1 and SKI2 for use in the stock assessment. Based on a maximum age of 17 years natural mortality is assumed to be 0.25.

Stock monitoring

No biomass estimates are available and catch at age data has not been collected routinely from the commercial trawl fishery from SKI3 or SKI7.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

SKI 3 and SKI7 stocks will be monitored by regular characterisation of the fisheries and catch-per-unit-effort analyses. If possible catch-at-age data may also be used to measure fishing mortality in SKI7.

Trawl surveys

No trawl surveys will be targeted specifically at gemfish but the relative abundance will be monitored in the west coast South Island trawl survey.

CPUE analyses

A CPUE time series will be incorporated into regular characterisations for gemfish.

Observer sampling

Observer biological sampling from the commercial trawl fishery will collect otoliths and undertake length frequency sampling to inform regular characterisations. Otoliths will be collected annually from the main commercial trawl fishery by Observers and on the trawl surveys by researchers as described below. Targeted ageing studies will only be conducted when required to address specific research questions.

Table 3: Planned gemfish otolith sampling

Fishstock	Fishing method	Otolith numbers
SKI7	Trawl fishery	600 each sex

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic Impacts

Gemfish is taken by trawling which will have an impact on the seabed; particularly when fished using bottom trawl gear or midwater gear fished hard on the seabed. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the redbait fishery against any relevant environmental standards.

Endangered, threatened or protected species

Target trawl fisheries and those that take gemfish as a bycatch are known to have interactions with seabirds and marine mammals. Monitoring information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of the major target and bycatch fisheries against any relevant environmental standards.

Fish bycatch

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

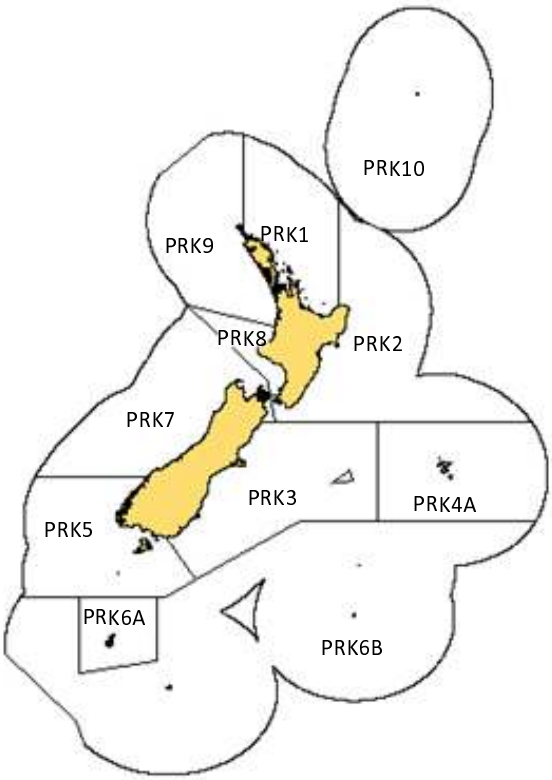
Outstanding issues

Stock assessment

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. However, in many cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information.

15. PRAWN KILLER (PRK)



Introduction

Prawn killer is almost all taken as bycatch of scampi target trawl fisheries. Catch has primarily come from Auckland East (PRK1) with catch also coming from east coast North Island (PRK2). In the last two years there has been an increase in the catch on the west coast of south island (PRK7).

Table 1: Summary of TACCs (tonnes) for 2009-2010, and reported landings (tonnes)

Fishstock	QMA	FMA	TACC	Landings (2008-09)
PRK1	Auckland (East)	1	24.5	0.22
PRK2	Central (East)	2	3.5	0.08
PRK3	South-east (Coast)	3 & part of 4	1	0
PRK4A	South-east (Chatham)	Rest of 4	1	0
PRK5	Southland	5	1	0
PRK6A	Auckland Islands	Part of 6	1	0
PRK6B	Sub-Antarctic	6 excluding Auckland Is	1	0
PRK7	Challenger	7	1	0.88
PRK8	Central (West)	8	1	0
PRK9	Auckland (West)	9	1	0
PRK10	Kermadec	10	0	0
Total			36	1.18

Management objectives and approach

All prawn killer stocks are managed as Tier 2 stocks. The abundance of prawn killer will be monitored using CPUE in the trawl fisheries and supported by regular sampling by observers. All stocks will undergo CPUE standardisation and a characterisation at 3 year intervals.

Harvest strategy

The following are generic reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fisheries plan status

Prawn killer is not yet included in the National Deepwater Fisheries Plan. Prawn killer will be included as a key bycatch in the scampi fishery and work on a scampi chapter will occur in the future.

Summary of current knowledge

Stock assessment

Little is known about the status of prawn killer stocks and no estimates of current and reference biomass, or yield, are available for any prawn killer fishery.

Stock structure

For management purposes stock boundaries are based on those used for scampi. However, there is no biological information on stock structure, recruitment patterns, or other biological characteristics which might indicate stock boundaries.

Productivity

Longevity is thought to be five years or more but no growth data are available.

10 Year Research Plan – Stock Monitoring & Assessment

Overview

All prawn killer stocks will be monitored by regular characterisation of the fisheries and catch-per-unit-effort analyses.

Observer sampling

Observer biological sampling to inform the annual stock assessment will consist of length frequency sampling the prawn killer bycatch in the scampi fisheries

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed above, this information will be used to produce annual reports on interactions with endangered, threatened and protected species, quantifying bycatch, and assessing the trawl footprint. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic Impacts

Prawn Killer is taken as a bycatch of scampi trawling which will have an impact on the seabed; particularly when fished using bottom trawl gear or midwater gear fished hard on the seabed. Previous research has shown that scampi trawl activity has an impact on benthic community structure. Data from vessels' catch and effort reporting will be used to monitor this impact. In time, this information will be used to assess the performance of the scampi fishery against any relevant environmental standards.

Endangered, threatened or protected species

The scampi fishery is known to have interactions with seabirds and marine mammals including sea lions in the SCI6A/PRK6A fishery around the Auckland Islands. Previous estimates on the extent of these interactions have been difficult because of the low level of observer coverage in the scampi fishery.

Fish bycatch

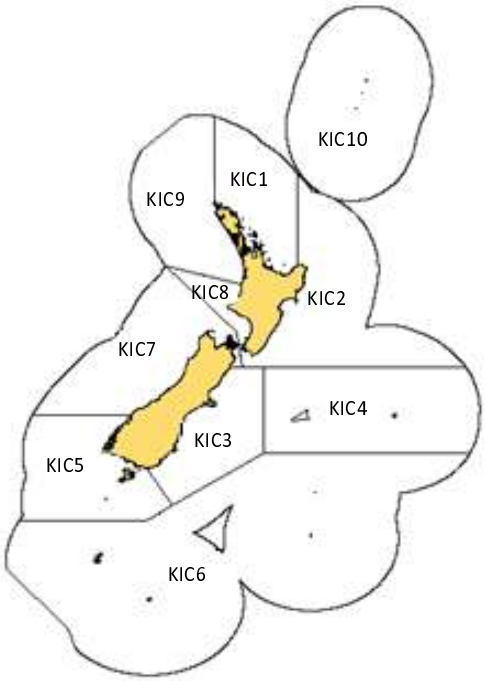
Prawn killer is rarely a target species, but trawling for prawn killer would be likely to take similar bycatch species to the scampi fishery including other benthic species and some QMS species such as hoki, hake and ling. There is also the possibility of catching juvenile finfish in the fine mesh scampi trawl. If potting was introduced as a fishing method this by-catch relationship to scampi may change

Outstanding issues

- Currently there are no indices of abundance available.

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. However, in many cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information.

16. DEEPWATER CRABS – KING CRAB (KIC)



Introduction

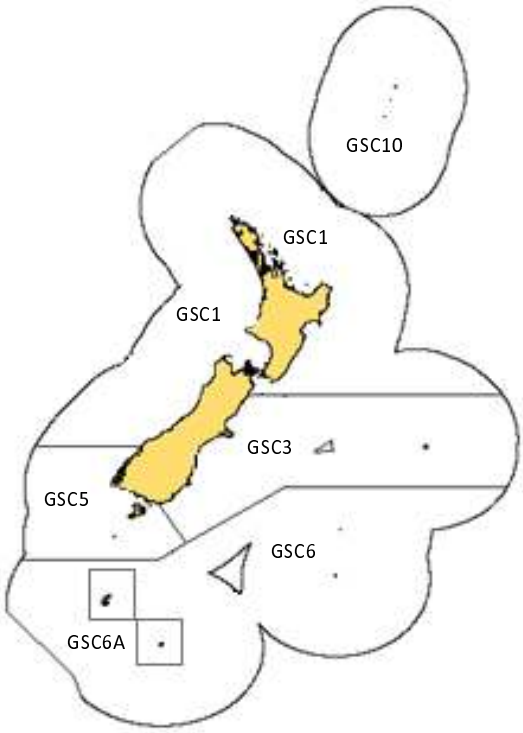
King crab consists of two separate species (*Lithodes murrayi* and *Neolithodes brodiei*) that are found at different depths. Landings have been reported from all QMAs except KIC7; however, these landings are small and are unlikely to reflect the real catch as these crabs were probably legally discarded prior to entry into the QMS in 2004. Target fishing is by potting, although the crabs are taken as bycatch in the orange roughy fishery off the Wairarapa coast and when dredging for Queen Scallop off the Otago coast.

Table1.Summary of TACs and TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-09
KIC 1	Auckland (East)	1	10	10	0
KIC 2	Central (East)	2	10	10	0
KIC 3	South-East (Coast)	3	10	10	0
KIC 4	Chatham Rise	4	10	10	2
KIC 5	Southland	5	10	10	0
KIC 6	Sub-Antarctic	6	10	10	0
KIC 7	Challenger	7	10	10	0
KIC 8	Central (West)	8	10	10	0
KIC 9	Auckland (West)	9	10	10	0
KIC 10	Kermadec	10	0	0	0
Total			90	90	2

* Note that the king crab TACs do not include an allowance for other sources of fishing related mortality nor is there allocation for customary and recreational fishers.

DEEPWATER CRABS – GIANT SPIDER CRAB (GSC)



Introduction

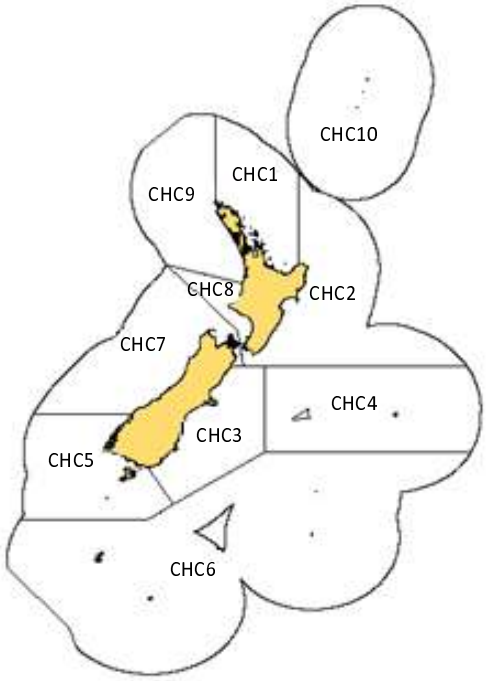
There was exploratory fishing for giant spider crab in the late 1960s and early 1970s around the Auckland Islands and on the Pukaki Rise. Giant spider crab has since been introduced into the QMS in 2004 and quota has been tendered.

Table1.Summary of TACs and TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-9
GSC 1	Auckland (East), Auckland (West), Central (East), Central (West), Challenger	1, 2, 7, 8, 9	1	1	0
GSC 3	South-East (Coast), Chatham Rise	3 and 4	15	14	13
GSC 5	Southland	5	20	19	10
GSC 6A	Auckland Islands	6 (part)	165	148	13
GSC 6B	Sub-Antarctic	6 (part)	250	237	0
GSC 10	Kermadec	10	0	0	0
Total			451	418	36

* Note that the giant spider crab TACs for GSC1 do not include an allowance for other sources of fishing related mortality (the remainder do). There is no allocation for customary or recreational fishers for any stock.

DEEPWATER CRABS – RED CRAB (CHC)



Introduction

There were no commercial catches of this crab until 2001–02, when landings of about 1.5 t were reported. Red crab (*C. bicolour)*, along with several other deepwater crabs, was the focus of an exploratory fishing (potting) permit during 2000–02. Significant quantities have been found in the Bay of Plenty, east of Great Barrier Island, and east of Northland. The other region fished was the east coast of the North Island south of East Cape, where smaller catches were periodically reported.

Table1.Summary of TACs and TACCs (tonnes), and reported landings (tonnes) for the most recent fishing year

Fishstock	QMA	FMA	TAC*	TACC	Landings 2008-09
CHC 1	Auckland (East)	1	10	10	0
CHC 2	Central (East)	2	10	10	0
CHC 3	South-East (Coast)	3	4	4	0
CHC 4	Chatham Rise	4	4	4	0
CHC 5	Southland	5	4	4	0
CHC 6	Sub-Antarctic	6	4	4	0
CHC 7	Challenger,	7	4	4	0
CHC 8	Central (West)	8	4	4	0
CHC 9	Auckland (West)	9	4	4	0
CHC 10	Kermadec	10	0	0	0
Total			48	48	0

* Note that the red crab TACs do not include an allowance for other sources of fishing related mortality nor is there allocation for customary or recreational fishers.

Management approach

All deepwater crab stocks are managed as Tier 2 stocks. MFish is currently working with owners of deepwater crab quota to establish a research programme to determine productivity and distribution of deepwater crab stocks.

Harvest strategy

The following are generic reference points and corresponding management responses that are derived from the Ministry's Harvest Strategy Standard.

Table 2: Harvest strategy for deepwater crabs

Reference point	Management response
Management target of 40% B_0	Stock permitted to fluctuate around this management target. TAC changes will be employed to move stock toward or above target.
Soft limit of 20% B_0	A formal time constrained rebuilding plan will be implemented if this limit is reached.
Hard limit of 10% B_0	The limit below which fisheries will be considered for closure.
Rebuild strategy	To be determined.
Harvest control rule	To be determined.

Fisheries plan status

No deepwater crabs are yet included in the National Deepwater Fisheries Plan.

Summary of current knowledge

Stock assessment

There are no estimates of reference or current biomass for any deepwater crab stock.

Stock structure

For management purposes stock boundaries are based on FMAs for CHC and KIC. The stock boundaries are slightly different for GSC. However, there is currently no biological or fishery information which could be used to identify better stock boundaries.

Productivity

King crab: There is no information on reproduction, age, growth, or natural mortality of king crab in New Zealand waters.

Giant spider crab: There is little information available on age, growth or natural mortality. Moulting appears to take place between November and March. Males reach 220 mm CL and

females 144 mm. Natural mortality (*M*) for mature females is thought to be 13–25%, and may be slightly higher for mature males.

Red crab: Red crab belongs to the family Geryonidae which has an almost world-wide distribution. There is no information on reproduction, age, growth, or natural mortality in New Zealand waters—which may or may not be similar to the same or similar to *Chaceon* species elsewhere.

10 Year Research Plan – Stock Monitoring & Assessment

MFish is currently working with owners of deepwater crab quota to establish a research programme to determine productivity and distribution of deepwater crab stocks.

10 Year Research plan – Monitoring environmental interactions

Environmental monitoring

The 10 year plan assumes that all deepwater vessels will carry an Observer who will be tasked with, among other things, collecting information on environmental interactions. As detailed below, this information will be used to produce annual reports on interactions with endangered, threatened and protected species. Data from Observers will also be used for periodic identification of benthic samples and other aquatic environment research such as establishing trophic relationships among species.

Benthic Impacts

Target crab fishing is done with pots and is a relatively benign method of fishing compared with some other methods. Direct effects on the seabed may arise from the pot landing on the seabed. These are unlikely to be harmful on either hard or soft substrates, and the proportion of the habitat affected is likely to be low. The greatest impact is likely to be on fragile biogenic substrate.

Deepwater crabs are sometimes taken as bycatch in trawl fisheries. Trawling and dredging will have an impact on the seabed; particularly when fished using bottom trawl/dredge gear or midwater gear fished hard on the seabed. These impacts will be managed as part of those target fisheries to ensure these fisheries meet any relevant environmental standards.

Endangered, threatened or protected species

Information from observers will be used to compile annual reports on interactions with endangered, threatened or protected species. In time, this information will be used to assess the performance of target crab fisheries against any relevant environmental standards. Such interactions are likely to be minimal given the selective nature of potting.

Fish bycatch

Incidental catch of fish and invertebrates has been recorded at the Auckland Islands where three other species were recorded: mainly *Nectocarcinus bennetti*, but also *N. antarcticus*, and occasionally *Cancer novaezelandiae*. Two notothenid fish, *Notothenia microlepidota* and *N. filholi*, commonly entered pots set on reef areas. Unnamed species of octopus and whelk have also been observed in pots at the Auckland Islands in reasonable numbers.

Monitoring of QMS bycatch occurs through the reporting requirements associated with the QMS. For those species that are outside the QMS, increased observer coverage will provide annual reports that quantify bycatch from major deepwater fisheries and allow trends to be monitored. A Level 1 risk assessment is also planned for non-QMS bycatch.

Outstanding issues

All Tier 2 stocks will undergo characterisation studies to determine whether CPUE is likely to be a useful monitoring tool in any of these fisheries. However, in many cases the fishery will not be able to be closely monitored and alternative management approaches will need to be developed to address the risk inherent in managing without good information.

Part 3: Aquatic Environment Research

10 Year Research Plan: Aquatic Environment Research

Overview

Fisheries 2030 sets a long-term goal of New Zealanders maximising benefits from the use of fisheries within environmental limits. This goal encapsulates the ideal or aspirational state for New Zealand's deepwater fisheries.

The Fisheries 2030 goal and supporting outcomes recognise that the purpose of New Zealand's deepwater fisheries is to derive value both in terms of economic and intrinsic value (the value an individual or community places on preserving a resource or environment in its own right). In turn the realisation of this value must occur in a way that ensures the sustainability of the resource and avoids, remedies or mitigates adverse effects of fishing on the aquatic environment. Specifically Fisheries 2030 recognises that:

- The biological realities of harvesting our deepwater fisheries mean that the future value of these fisheries can only be assured if the resource is managed sustainably. Measures to increase value must always be considered in the context of ensuring long-term maintenance of both target and bycatch stocks.

- Deepwater target and key bycatch fish stocks exist as part of the broader aquatic environment, and that this broader environment has value, including an intrinsic value, to New Zealanders. It also recognises that, while fishing activities may have an environmental impact, not all environmental impacts have an adverse effect on the aquatic environment.

- Avoiding or minimising adverse effects on the aquatic environment will ensure that the long-term viability of associated or dependent species is assured and that the biological diversity and functionality of marine communities is maintained.

- The purpose of commercial fishing is to derive value, and that the purpose of fisheries management is to enable value to be derived from New Zealand's deepwater fisheries. Fisheries 2030 also recognises that in the long-term, economic value relies on the environmental sustainability of these fisheries.

The specific management objectives that will apply across all deepwater fisheries and which will set the management response and consequently the research requirements are to:[12]

- Ensure deepwater and middle-depth fish stocks and key bycatch fish stocks are managed to an agreed harvest strategy
- Maintain the genetic diversity of deepwater and middle-depth target and bycatch species
- Protect habitats of particular significance for fisheries management

[12] These are the management objectives included in the draft National Deepwater Fisheries Plan which were developed in collaboration with environmental and industry stakeholders.

- Identify and avoid or minimise adverse effects of deepwater and middle-depth fisheries on incidental bycatch species
- Manage deepwater and middle-depth fisheries to avoid or minimise adverse effects on the long term viability of protected, endangered and threatened species
- Manage deepwater and middle-depth fisheries to avoid or minimise adverse effects on biological diversity
- Identify and avoid or minimise adverse effects of deepwater fishing activity on the benthic habitat

The following papers set out the rationale for the aquatic environment research scheduled for delivery through the 10 Year Plan. This research is necessary to identify significant environmental impacts on the marine environment caused by deepwater fishing activity.

Specifically these papers describe (1) the management objectives which underpin the research described in the 10 Year Plan, (2) an overview of the extent of our current knowledge with respect to the aquatic environment impacts identified and, (3) details of the research that will be delivered through the research plan.

This description is provided across the following four areas:

1. Benthic habitat interactions
2. Endangered, threatened or protected species interactions
3. Fish bycatch and discards
4. Ecosystem functioning and trophic linkages

Benthic habitat interactions

Introduction

This section includes information on the interactions of trawl and other bottom tending gear with benthic (seabed) habitats. A wide variety of deepwater species are taken using bottom trawl gear (see species-specific information chapters), and this is likely to be the most important interaction between deepwater fisheries and the seabed.

Management approach

The Ministry of Fisheries has legal obligations under the Fisheries Act 1996 to avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment. In addition to these legal requirements many third party certification schemes also require that measures are in place to ensure fishing activity does not have significant adverse effects on the marine environment. In the National Deepwater Fisheries Plan, the relevant management objective is "to Identify and avoid or minimise adverse effects of deepwater fishing activity on the benthic habitat".

This will be achieved through a spatial management approach by protecting a portion of each habitat that is inversely proportional to that habitat's ability to recover from bottom trawl impacts. This approach builds on the 19 seamounts closed to fishing in 2001 and the BPA closures to bottom trawling introduced in 2007. A benthic impact standard will be developed which will provide guidance on the proportion of a specific habitat that should be protected. Until such a standard is in place the management approach will be to continue to manage through spatial closures based on the best available information while recognising the terms of the BPA Accord.

Summary of current knowledge

The management approach described above requires, at a minimum, information on the distribution of benthic habitats throughout the EEZ and the ability of each of these habitats to recover from disturbance by bottom trawl gear. This approach assumes that benthic habitats with limited ability to recover from disturbance will have larger proportions protected from fishing. A "least cost" implementation of this approach requires information on the distribution and value of bottom trawl fishing at sites throughout the EEZ.

There is good information in the international and New Zealand literature on the environmental effects of bottom contacting fishing gear, although most of this work has been conducted in coastal waters and only a few studies relate directly to habitats likely to be affected by New Zealand's deepwater fisheries.

Rice (2006) examined the findings of five international reviews (published 2000–2005) of the impacts of bottom contact fishing activity on benthic species, communities, and habitats.[13] His conclusions can be summarised as follows:

- Mobile bottom gears can damage or reduce structural biota (*All reviews, strong support*).
- Mobile bottom gears can damage or reduce habitat complexity (*All reviews, variable support*).
- Mobile bottom gears can reduce or remove major habitat features such as boulders (*Some reviews, strong support*).
- Mobile bottom gears can alter seafloor structure (*Some reviews, conflicting evidence for benefits or harm*).
- There is a gradient of impacts, with greatest impacts on hard, complex bottoms and least impact on sandy bottoms (*All reviews, strong support, with qualifications*).
- There is a gradient of impacts, with greatest impacts on low energy environments and least (often negligible) impact on high-energy environments (*All reviews, strong support*).
- Trawls and mobile dredges are the most damaging of the gears considered (*Three of the reviews considered other gears; all drew this conclusion, often with qualifications*).
- Mobile bottom gears can change the relative abundance of species (*All reviews, strong support*).
- Mobile bottom gears can decrease the abundance of long-lived species with low turnover rates (*All reviews, moderate to strong support*).
- Mobile bottom gears can increase the abundance of short-lived species with high turnover rates (*All reviews, moderate to occasionally strong support*).
- Mobile bottom gears affect populations of surface-living species more often and to greater extents than populations of burrowing species (*All reviews, weak to strong support*).
- Impacts of mobile bottom gears are less in high-energy or frequent natural disturbance environments than in low energy environments where natural disturbances are uncommon (*All reviews that addressed the issue, strong support*).
- Mobile bottom gears affect populations of structurally fragile species more often and to greater extents than populations of "robust" species (*All reviews, variable support*).
- Abundance of scavengers increases temporarily in areas where bottom trawls have been used (*Three reviews, variable support, all suggest only a transient effect*).
- Rates of nutrient cycling or sedimentation are increased in areas where bottom trawls have been used (*Two reviews, mixed views on magnitude and likelihood of effects*).
- The impact of mobile fishing gears on benthic habitats and communities is not uniform. It depends on:

[13] Rice, J. 2006. Impacts of mobile bottom gears on seafloor habitats, species, and communities: a review and synthesis of selected international reviews. Canadian Science Advisory Secretariat, Research Document 2006/057.

- the features of the seafloor habitats, including the natural disturbance regime (*All reviews, strong support*);
- the species present (*All reviews where mentioned, strong support*);
- the type of gear used and methods of deployment (*All reviews, moderate to strong support*);
- the history of human activities, particularly past fishing, in the area of concern (*All reviews, strong support*).

- Recovery time from trawl-induced disturbance can take from days to centuries, and depends on the same factors as listed above (*All reviews, strong support*).
- Given the above considerations, the impact of mobile bottom gears has a monotonic relationship with fishing effort, and the greatest impacts are caused by the first few fishing events (*All reviews, moderate to strong support*).
- Application of mitigation measures requires case specific analyses and planning; there are no universally appropriate fixes (*Three reviews, moderate to strong support).*

Rice (2006) concluded that the effects of mobile bottom gears on the seabed are consistent enough with well-established ecological theory, and across studies, that extensive local data are not necessary for case-specific planning: "*These overall conclusions on impacts and mitigation measures … form a coherent and consistent whole. They are relevant to the general circumstances likely to be encountered in temperate, sub-boreal, and boreal seas on coastal shelves and slopes, and probably areas … beyond the continental shelves. They allow use of all relevant information that can be made available on a case by case basis, but also guide approaches to management in areas where there is little site-specific information*."

Kaiser et al (2006) analysed 101 published small-scale experiments and concluded: shellfish dredges have the most intense impact; biogenic habitats are the most sensitive to such disturbance (especially for attached fauna on hard substrates); unconsolidated, coarse sediments (e.g., sands) are least sensitive; and recovery from disturbance events can take months or years.

This analysis reinforces the inferences drawn from observations made at the broader scales and depths of relevance to deepwater fisheries management in New Zealand (e.g., Cryer et al. 2002 who considered the effects of scampi trawl fisheries on the soft sediment of the continental slope to 600 m depth, and Clark & Rowden 2009 who considered the impacts of orange roughy trawl fisheries on the benthic invertebrates of seamounts and other features to about 1000 m depth) and overseas (e.g., McConnaughey et al. 2000, Hiddink et al. 2006 who both considered sedimentary systems).

The consistency of ecological expectation, broad-scale observation, and focussed experiments leads to robust conclusions about the impacts of bottom trawling on benthic habitats and at least some ability to rank benthic habitats according to their ability to recover from bottom trawling impacts. However, aside from the New Zealand studies, very little research has been conducted on benthic habitats at depths relevant to deepwater fisheries management (>200 m), so our predictions about the likely intensity of impacts and the ability

of habitats to recover are, at least to some extent, uncertain. The additional research to fill this information gap has already been commissioned.

The first realistic attempt to assess the distribution of habitats throughout New Zealand's huge EEZ was the Marine Environment Classification (MEC) published in 2005. This hierarchical classification scheme was designed to predict plankton, fish, and benthic invertebrate communities using physical or chemical data from the water column that was available across the entire EEZ. The classification was "tuned" and assessed against biological information and found to perform least well for benthic invertebrates. In response, a benthic-optimised classification (BOMEC) has been developed. This newer classification uses more modern and powerful statistical techniques and incorporates many more physical and chemical data layers, including some that are likely to be important for benthic invertebrates like sediment composition, as well as a wide variety of benthic invertebrate data sets.

The BOMEC is the classification of choice for predicting the distribution of extensive (mostly sedimentary) benthic habitats in the EEZ. However, less extensive habitats such as seamounts, canyons, hydrothermal vents, and biogenic habitats, are less well predicted by this broad-scale approach and will probably need to be considered separately if we are to compile a complete inventory and distribution map of all benthic habitats.

The history and distribution of bottom trawl fishing effort throughout the EEZ between 1988/89 and 2004/05 (the trawl "footprint") was summarised by Baird et al (project BEN2006/01, report undergoing final review) using trawl-by-trawl records from TCEPR catch reporting forms.

10 Year Research plan – Benthic habitat interactions

To underpin the management approach and assess performance against a spatially-based Benthic or Habitat Standard, annual updates to the trawl footprint are planned. Additional information will be collected at low marginal cost by observers and researchers on trawl surveys that will allow the development and/or fine-tuning of the Standard. This work will include:

- on-site identification and collection of benthic invertebrate bycatch by observers (full coverage, bearing in mind that it will not be possible for all trawl tows to be assessed for benthic invertebrates) and researchers on trawl surveys (who may also be time-constrained)
- periodic identification and assessment of benthic invertebrates (every 4 years)
- one-off appraisal and analysis of any benthic samples, photographs, and video footage from trawl surveys (after 5 years)
- one-off analysis of ecosystem indicators that could include benthic indicators (after 5 years)

In addition, periodic ecological risk assessments (ERAs) will be conducted for specific fisheries and these will include assessment of risks to benthic species, habitats, function, and

productivity posed by the bottom trawl method (and other bottom-contacting methods that might be developed). The conclusions of the ERAs and other analyses may lead to changes in the research and monitoring programme.

Outstanding issues

The main outstanding issues are

- our relatively poor information on the detailed distribution of benthic habitats throughout the EEZ,
- uncertainty about the ability of classification approaches to predict benthic habitats and communities in deep waters where biological data are scarce and expensive,
- uncertainty about the ability of different benthic habitats to recover from disturbance by bottom trawling,
- uncertainty about the overall proportion, minimum patch size, and distribution of patches of each habitat that need to be protected to ensure the continued function and productivity of the habitat as a whole.

These issues relate almost entirely to the setting and fine-tuning of a Benthic or Habitat Standard rather than monitoring against a standard (which can, in theory, be achieved using a combination of existing classifications, imputed recoverability by habitat, and an annual assessment of the trawl footprint). Current research commissioned by MFish and underway under other funding streams will address some of these information gaps, but the additional information on species and habitat distribution and trends being collected by observers and researchers under the 10-year programme is also likely to contribute to the setting and fine-tuning of a Benthic or Habitat Standard.

Endangered, threatened, and protected (ETP) species

Introduction

Endangered, threatened, and protected (ETP) species that may be impacted by fishing include almost all New Zealand seabirds, all marine mammals, some marine reptiles (turtles, sea-snakes, and iguanas), red and black corals (although the former are not well defined), and two species of marine fish (the black-spotted groper and the great white shark). Fishing has the potential to affect all of these groups though direct (e.g., incidental capture) or indirect (e.g., habitat modification or destruction, competition) effects.

This section will deal exclusively with those ETP species that are affected by deepwater fisheries (primarily seabirds and marine mammals). A comprehensive summary of protected species captures from a variety of fisheries spanning the years 1998-99 to 2006-07 can be found in Abraham and Thompson (2009).

New Zealand's Department of Conservation has developed a threat classification scheme for New Zealand fauna and flora, and a complete listing of ETP species can be found in Hitchmough et al. (2007) and the accompanying data sheets.

A wide variety of ETP species interactions occur in deepwater fisheries. The most common seabird-fishing interactions involve the following seabird species - sooty shearwater (*Puffinus griseus*), white-capped albatross (*Thalassarche steadi*), white-chinned petrel (*Procellaria aequinoctialis*), and, to a lesser extent, cape pigeon (*Daption* species) and flesh-footed shearwater (*Puffinus carneipes*). Of the marine mammals, the most frequent fisheries interactions involve New Zealand fur seals (*Arctocephalus fosteri*), New Zealand sea lions (*Phocarctos hookeri*), and common dolphins (*Delphinus delphis*), with dusky (*Lagenorhynchus obscurus*) and bottlenose (*Tursiops truncatus*) dolphins being taken less frequently.

Some marine turtles have also been observed captured predominantly by surface and bottom longline fisheries, and this issue is addressed through the Highly Migratory Species Fish Plan.

The incidental capture of corals is addressed in the benthic impacts section.

Management Approach

The Ministry of Fisheries has legal obligations under the Fisheries Act 1996 to avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment including ETP species. In addition to these legal requirements many third party certification schemes also require that measures are in place to ensure fishing activity does not have significant adverse effects on the marine environment. To meet these obligations information on the level of ETP species interactions that occur with deepwater fisheries and the likely impact of these interactions on ETP species population viability is required.

The deepwater management objective that relates to ETP species is specified in the draft National Deepwater Fisheries Plan

Manage deepwater and middle-depth fisheries to avoid or minimise adverse effects on the long-term viability of endangered, threatened and protected species.

The delivery of this management objective across individual fisheries is specified in the operational objectives in the fishery specific chapters of the deepwater plan,

The planned research to support this objective is to monitor trends in ETP species interactions with fisheries and to assess these trends against standards to ensure they are within acceptable limits. In the absence of standards the approach will be to ensure that trends in interactions decline and continue to decline in the future.

If the results of this monitoring indicate that trends in ETP species interactions with fisheries are increasing or if a fishery fails to meet the requirements of an environmental standard then further research (including research into possible mitigation measures) will be required.

Summary of Current Knowledge

Seabirds

New Zealand is an important breeding ground for approximately 80 seabird species and has the greatest variety of albatross and petrel species in the world. As well as being a significant and unique part of the ecosystem, many species of albatross and petrel hold iconic status in the minds of the public of New Zealand.

A key threat to seabirds is fishing related incidental mortality. In longline fisheries, the baited hooks float on or just below the surface for a short time before they start sinking, and they can attract foraging seabirds that become hooked and drown. In some target fisheries the hooks can remain within reach of diving seabirds for a considerable length of time.

In trawl fisheries, contact with the warp cables can cause seabird mortality when seabirds forage on offal and discards from the vessel. Mortalities can also occur when birds dive into the trawl net or become entangled in the mesh when trying to seize fish.

Several population characteristics of albatrosses and petrels make them susceptible to long-term population decline from fishing-related mortalities. Albatrosses and petrels typically have an extended maturity time (3-15 years), low productivity (maximum of one nestling per year), and take a long time to re-form pair bonds if one partner is killed. If the death of a breeding individual occurs, the chick almost always dies and the remaining partner may take several years to start nesting again with a new partner. The intrinsic rate of population increase for these species is very low (around 1% per year), meaning that birds may not be able to reproduce sufficiently rapidly to compensate for fishing related removals at the

population level. As a result, decreases in population sizes and an associated increase in threat status are likely to occur if fishing-related mortality is too high.

There has been some suggestion that the provision of waste from fishing vessels may provide benefits to seabird populations. Although some seabird species that breed in New Zealand use fisheries waste for feeding during parts of their annual cycle, the effects on population growth are debatable for long-lived species. Some gull populations have expanded in response to abundant fisheries waste, but the overall effect of fisheries waste on higher-predator communities is likely to cause some harm. For example, slower-breeding and more vulnerable populations might be negatively affected by increased competition with, and interference by, species that can rapidly respond to changes in food supply.

Marine mammals

The two pinniped species found within the New Zealand region that most often interact with commercial trawl fisheries are the New Zealand fur seal and the New Zealand sea lion. Although the status of fur seals is unknown, they appear to be increasing in numbers throughout much of their range.

By contrast, sea lions appear to be declining in abundance at the Auckland Islands (the centre of their current range). Smaller numbers are found at Campbell Island, and non-breeding animals visit Macquarie Island. A small colony is potentially being established on the New Zealand mainland in Otago. The majority of sea lion interactions are from the Auckland Islands squid fishery (SQU6T), with additional mortalities from the scampi trawl fishery around the same general area, in the southern blue whiting trawl fishery east of Campbell Island, and in trawl fisheries in the Stewart-Snares region . An annual Fishing Related Mortality Limit (FRML) is placed on the number of sea lions that can be taken in the SQU6T squid fishery before that fishery is closed.

Common dolphins are the most regularly caught species of cetacean in deepwater fisheries. They are primarily caught in trawl nets when the fishers are targeting jack mackerel off the West Coast of the North Island. It is not known whether the levels of bycatch estimated by Thompson et al. (2009) are sustainable as the total population size and reproductive output of common dolphins are not well known. Analysis by has shown that captures of common dolphins occur most frequently when the trawl nets are fished closed to the sea surface (with a headline depth of 30 m or less).

Historic research and monitoring

Over the past five years, research conducted by the Ministry of Fisheries into protected species interactions with fisheries has focussed on the following main areas:

a) Estimating fishing mortality and incident rates: the focus of this research has been on estimating total fishing related mortality of primarily seabirds and marine mammals in a few selected fisheries, namely the joint-venture tuna surface longline fishery, the ling bottom longline fishery, and trawl fisheries for hoki, squid, orange roughy, southern blue whiting,

and scampi. The spatial distribution of captures is described by species and by fishing year, target fishery, and area, with total captures extrapolated using Bayesian estimation procedures.

b) Modelling of effects of fisheries-related mortalities on seabird populations and assessing relative risk: The effects of fisheries interactions on population growth and sustainability have been modelled for four species of seabirds (Black petrel, Gibson's petrel, Antipodean wandering albatross, and Chatham Island albatross). Long-term field studies have also been initiated to gather additional demographic and distributional information of several seabird populations (Chatham Island albatross, Pacific albatross, Northern royal albatross, Salvin's albatross, various Antipodes Islands seabirds, flesh-footed shearwaters, white-capped albatross and the Westland petrel) to help assess the effects of fishing on their long-term viability.

c) Examining factors affecting protected species capture in fisheries: Data from fisheries observers are used to examine what factors might be most influential in affecting the capture of protected species (e.g., the fishing and mitigation practices in use when captures occur, fishing effort, distance from colonies, and the sex and age of animals that are caught).

d) Examining efficacy of alternative management strategies: The main focus of this research has been to develop a series of population models for New Zealand sea lions that take into account a variety of age-specific factors (breeding, survival, maturity, vulnerability to fishing, and the proportion incidentally captured by fishing), as well as data on the re-sighting of tagged animals and pup production estimates, to generate estimates of the overall size of the population inhabiting the Auckland Islands. These data are fed into integrated Bayesian models that are used to assess the performance of a variety of management control rules against specified management goals, the results of which are then used to determine a FRML for the squid trawl fishery (SQU6T) in a given year.

e) Examining approaches to avoid or mitigate incidental interactions: The focus of this research has been on developing and assessing the efficacy of mitigation measures to avoid or mitigate incidental bycatch. Examples include the use of sea lion exclusion devices (SLEDs) to allow sea lions to exit from trawl nets, the use of tori lines and bird bafflers to reduce seabird warp strikes, and offal management to make fishing vessels less attractive to seabirds.

f) Assessment of risk to protected species from fishing related mortality: Research in this area has focussed primarily on developing a risk-assessment framework for seabirds to examine the relative risk posed by fisheries in different areas. Preliminary results suggest that a Productivity Susceptibility Assessment (PSA) approach to risk assessment (which takes into account the productivity of protected species in relation to their susceptibility to fisheries impacts) can deliver comparable estimates of risk across a wide variety of seabird species without the need for data on actual captures. It would thus allow ranking of potential risks from fisheries that are not well covered by observers.

10 Year Research Plan – ETP species research

ETP research delivered through the 10 Year Plan will focus on monitoring interactions between fishing and ETP species and initiating research when these interactions are not deemed to be acceptable (either because an environmental standard has been breached or because trends in the monitoring show that interactions are increasing).

A core focus of the the 10 Year Plan is the expansion of observer coverage in deepwater fisheries to full vessel coverage (i.e. one observer on every vessel at all times) over three years. This will greatly increase the potential for observations of interactions with ETP species. It will also increase the chances of observing interactions with the more rare or less frequently caught ETP species.

The monitoring data collected by observers will be analysed annually to quantify the nature and extent of protected species interactions.

The completion of a regular programme of ecological risk assessments (ERAs) through the plan will likely identify the risk status of ETP species interacting with deepwater fisheries. If further research or mitigation is required (either in response to ERA findings or because a fishery has not met the requirements of an environmental standard) then this research will be delivered as a stand-alone research project through the Additional Research component of the 10 Year Plan. This research would likely include assessing mitigation measures to further reduce ETP species interactions, as required.

Some projects have already been identified for delivery through the Additional Research fund. These include:

- Developing a methodology to assess cryptic mortalities of ETP species – 2010-2011
- Reviewing the sea lion population model - 2013-2014.
- Necropsy studies on ETP species - as required

Outstanding Issues

Seabirds

- The magnitude of cryptic mortality of protected species that interact with fishing gear or vessels is a key information gap, particularly for birds struck by trawl warps or caught in trawl nets, and, to a lesser degree those struck by mitigation devices. Research to develop a methodology to address this issue is planned for 2010-2011.

- The indirect effects of fishing on seabird populations, including depletion of their natural prey, have not been studied. This is a difficult area to quantify but a review of the international literature will likely prove useful. This issue will likely be addressed outside the 10 Year Plan.

Marine mammals

- The impact of fur seal captures on the wider fur seal population, particularly on the West Coast South Island is not known. Although fur seals, as a species, are not threatened but our information on trends at rookery or population level is unclear. Anecdotally, fur seals may be increasing in number and/or increasing their range in New Zealand waters. Assessing the feasibility of developing indicators of population size or distribution would therefore be useful. This research will likely be addressed outside the 10 Year Plan.

- Sea Lion Exclusion Devices (SLEDs) are being extensively used in the squid fishery around the Auckland Islands. The observed capture rate for sea lions has decreased over the past few years, but there is still uncertainty around the survival of those that exit trawl nets via SLEDs. No research is currently planned to address this issue through the 10 Year Plan but any required research will be delivered through the Additional Research fund of the 10 Year Plan.

- Pup counts at sea lion rookeries on the Auckland Islands have decreased by about 50% since a high point in 1998. Research to determine the factors that may have contributed to this decline will not be included in the 10 Year Research Plan unless the research is directly related to the effects of fishing. If this is the case then it will be delivered through the Additional Research fund.

- Research is needed on the trophic effects that fishing may have on ETP species. For example, where fisheries operations overlap with foraging areas, fishing may alter prey abundance and distribution and reduce not only the amount but also the nutritional quality of food that remains available to higher predators like seabirds and marine mammals. The indirect effects of resource competition and potential changes in prey availability and diet on condition, reproduction, and survival of protected species are poorly known, and may be assessed using a bioenergetics modelling approach.

- Such an approach allows for a quantification of an individual's nutritional requirements and thus an assessment of whether animals are nutritionally stressed. Although this research will be delivered outside the 10 year Plan the option to collect data and samples through the Observer programme will be used to support this research.

Fish Bycatch & Discards Research

Introduction

Bycatch constitutes the incidental catch of non-target species (fish, invertebrates and benthos) when fishing for target species or target species mix. This may include species already in the QMS, species of commercial interest and other species for which there is no current market.[14]

Discards include all material returned to the sea, dead or alive, and under normal circumstances excludes QMS species which must be retained. Other sources of mortality such as that caused by ghost fishing (by abandoned equipment) or unaccounted mortality (animals that are killed by fishing but are not retained by the gear) are not included.

The three components to successful monitoring of bycatch trends include regular characterisation of bycatch trends (e.g. every 3-5 years), comprehensive field identification guides and an understanding of the risks to bycatch species (e.g. productivity, distribution and abundance, role in the ecosystem).

In deepwater fisheries all fish species both target and bycatch have been categorised into three groups as follows:

- Tier 1 species are high volume and/or high value fisheries and are traditionally targeted. They are important export revenue earners, which is reflected in the high quota value associated with these species
- Tier 2 species are typically bycatch fisheries or occasionally target fisheries at certain times of the year. The size/value of the fishery means that research needs will be met primarily through observer sampling but may be possible to use data from wide-area trawl surveys (Chatham Rise survey/ Sub-Antarctic/WCSI)
- Tier 3 species are incidental bycatch species that are not currently managed under the QMS but are caught during deepwater fishing activity. Research focus will be observer sampling, monitoring trends in capture and monitoring capture trends against likely risk status

[14] Note that incidental captures of ETP species are included in a separate section.

Table 1: Species included in Tiers 1-3

Tier	Species
1	Hoki, hake, ling, southern blue whiting, jack mackerel, orange roughy, oreo, scampi, squid
2	Alfonsino, silver warehou, barracouta, cardinal fish, frostfish, ribaldo, ruby fish, spiny dogfish, white warehou, lookdown dory, pale ghost shark, blue mackerel, prawn killer, redbait, gemfish, deepwater crabs, Patagonian toothfish
3	Incidental bycatch species - non-QMS species which are usually discarded or rendered to fish meal and are considered to be of little commercial value

Tier 1 and Tier 2 QMS species are caught as a bycatch in deepwater fisheries. However the management and supporting research for these species is addressed in the accompanying species specific sections of this report. This section only addresses the management and monitoring of Tier 3 species.

This Tier 3 bycatch includes fish and invertebrate species caught and recorded by commercial vessels, by scientific observers, and trends in the relative abundance of these species from fisheries independent trawl surveys where possible.

Research planned to address impacts of fishing on ETP species, benthic habitats and the broader marine ecosystem are also addressed in the accompanying sections of this report.

Management approach

The Ministry of Fisheries has legal obligations under the Fisheries Act 1996 to avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment. In addition to these legal requirements many third party certification schemes also require that measures are in place to ensure fishing activity does not have significant adverse effects on the marine environment.
To meet these obligations, information on the level of bycatch of Tier 3 species and the likely effect this will have on the both the long-term viability of individual species and the wider aquatic environment is required.

In the draft National Deepwater Fisheries Plan, the relevant management objective is "to *Identify and avoid or minimise adverse effects of deepwater and middle-depth fisheries on incidental bycatch species"*

The research planned to underpin this objective is to monitor bycatch trends for Tier 3 species and compare them with trends in their relative abundance as observed in trawl surveys. In addition, Tier 3 bycatch species identified as being high risk may require further research to assess their long-term viability.

Summary of current knowledge

Overview

Studies of trawl bycatch in New Zealand deepwater fisheries to date show that the amount of bycatch varies greatly between fisheries, both in terms proportion of catch and the size of the fishery. Some non-QMS species bycatch has commercial value and is retained, but a substantial portion of the bycatch can be of low commercial value and is discarded. [15]

The table below describes for several species the proportion of catch from each target tow that consists of bycatch (Tier 1-3):

Target Fishery or Target Species	Average bycatch (greenweight) as a proportion of the total target catch summed across several years
Southern blue whiting	2%
Hoki	5%
Orange roughy	6%
Jack mackerel	12%
Squid	14%
Ling	18%
Scampi	72%

*Note that some of this bycatch includes Tier 1 and Tier 2 QMS species

Bycatch is not restricted to trawl fisheries, however, and most fisheries have some level of unwanted catch.

In some fisheries, bycatch species can be successfully returned alive to the sea (e.g., from cod pots or from snapper longlines), but in others there is likely to be a low survival rate (e.g., from set nets, deepwater longlines, etc.). Species that sink slowly when discarded are exposed to predation by seabirds and pelagic predators in the sea. Even animals that survive capture and return to the seabed alive are likely to remain at risk through injury, stress, displacement from their preferred habitat, and short-term vulnerability to scavengers.

Discard mortality is expected to be higher in deepwater fisheries (possibly as high a 100%) because of the greater pressure and temperature changes experienced during capture, and the longer exposure to pelagic predators during sinking.

Bycatch Characterisation

Most work up to the end of June 2007 focussed on the estimation of bycatch in particular fisheries (see Table 1). Some of these projects have included objectives to assess the factors that affect the level of bycatch, and a few projects have examined methods by which bycatch might be avoided or minimised (principally a general review in project ENV2000/06 and a focussed analysis and review for the scampi fishery in project ENV2001/07).

[15] Note that only those QMS species that are listed on Schedule 6 of the Fisheries Act 1996 can be returned to the sea alive. There are no legal restrictions on the non-QMS species that can be discarded.

Only one project examined bycatch data for trends in the more important associated or dependent species (ENV1999/05). Some work has been done on unobserved fishing mortality in target species (e.g., hoki juveniles), but to date there has been no research on unobserved mortality in "bycatch" species in New Zealand.

Table 1: Overview of the completed characterisation of deepwater bycatch in trawl (BT) bottom longline (BLL) fisheries for hoki (including other middle depth fisheries for hake and ling since 2003/04), orange roughy, oreos, southern blue whiting, jack mackerels, squid, scampi, and ling, by fishing year since 1990-91

Method	BT	BT	BT	BT	BT	BT	BT	BLL
Target	HOK	ORH	OEO	SBW	SQU	JMA	SCI	LIN
Period covered	1990-91 to 2006-07	1990-91 to 2007-08	1990-91 to 2001-02	1990-91 to 2006-07	1990-91 to 2005-06	1990-91 to 2006-07	1990-91 to 2005-06	1990-91 to 2005-06

Projects to characterise the bycatch of hoki, hake and ling (ENV2008/02), orange roughy and oreos (ENV2009/02), and basking sharks in New Zealand waters (ENV2008/03) are underway.

Identification Guides

Three field identification guides have been produced in recent years on deepwater sharks (ENV2001/05), deep-sea invertebrates (ENV2002/04), and offshore crabs (MOF2003/03A, IPA 2005/02). A project to update and expand the deep-sea invertebrate guide was conducted in 2005/06 (ENV2005/20), and this was supported by a project to identify and process archived samples of the invertebrate bycatch of trawl surveys (IPA2005/08). A photographic identification guide for common finfish and shark species has been drafted (IDG2006/01). A new project to complete the remaining 120 less common species caught and reported through the observed catch has been approved to commence in the 2009/10 year (IDG2009/01). This research occurs outside the 10 Year Research Plan

Productivity of bycatch species

A project on the productivity of rattail species began in 2007/08 (ENV2007/03). Two projects on productivity of deepwater sharks began in the 2008/09 year (ENV2008/01 and ENV2008/04). The conclusions of this research are not currently available.

10 Year Research plan – Fish Bycatch and Discards Research

The following research is planned to occur under the 10 Year Plan:

- Annual quantification of bycatch species (all tiers) including benthic invertebrates and species at risk so that trends in bycatch and discards can be monitored. This research will occur on a rotating basis so that every 3-5 years bycatch trends from each of the Tier 1 species fisheries is recorded.
- Periodic identification of species collected through increased observer coverage and research surveys
- Regular analysis of bycatch trends in Tier 3 species from trawl surveys

- One-off appraisal and analysis of any benthic samples, photographs, and video footage from trawl surveys (after 5 years)
- Completion of a Level 1 Risk Assessment on Tier 3 bycatch species

In addition, periodic ecological risk assessments (ERAs) will be conducted for specific fisheries which will include assessment of risks to all bycatch species. The conclusions of the ERAs and other analyses may lead to changes in the research and monitoring programme for bycatch fish species.

Outstanding issues

Ecosystem consequences

The biggest gap in current knowledge is around the consequences of bycatch mortality on the long-term viability of bycatch species, and the knock-on effects on ecosystem structure and function.

The full extent of mortality is largely unknown for most affected species as is the effect on ecosystem structure and function. The effects will reflect the productivity of the species and the extent of bycatch. For example, the occasional bycatch of rare species or species that are vulnerable to overfishing, such as oceanic sharks, may be more important and entail more risk than the frequent, heavy discarding of widespread, more abundant species such as javelinfish and other rattails.

However, large-scale removal of species like rattails in popular fishing areas may have important implications for processes that we do not yet understand, such as trophic interactions. It is, therefore, important to understand how deepwater marine systems function and how direct and indirect fishing mortality may be affecting them.

Completion of the Level 1 Risk Assessment during 2011-12 will go some way to identifying these high risk bycatch species. Further monitoring and management measures can be explored subsequently through the Additional Research component of the 10 Year Research Plan.

Bycatch mitigation

There is currently little quantitative information on mitigation methods designed to reduce bycatch in New Zealand fisheries, apart from in certain crustacean trawl fisheries

Depending on the results of the programme of risk assessments delivered through the 10 Year Plan further mitigation research may be necessary to limit bycatch of high risk Tier 3 species. This mitigation research will be delivered through the Additional Research component of the 10 Year Plan.

Stock monitoring

Little information is currently available on the long term viability of Tier 3 bycatch species and the likely impact that continuous fishing related mortality will have on these species. The

results of the Level 1 Risk assessment should help identify at-risk species. If necessary these species may be the subject of further species specific research to assess their long-term viability. This research will be delivered through the Additional Research component of the 10 Year plan as required.

Ecosystem functioning and trophic linkages

Introduction

In recent years, the Ministry has been moving towards reviewing fisheries management and stock assessment procedures within an ecological context. This is effectively an "Ecosystem Approach to Fisheries Management". This requires a better understanding of ecosystem structure and functioning so as to develop useful conceptual and analytical tools that can contribute to good fisheries management.

Our approach to deepwater fisheries management recognises that our ability to predict ecosystem behaviour is currently incomplete, but accepts that all ecosystems have limits to the level of biological perturbation they can sustain within the physical, chemical and biological constraints that characterise different ecosystems. When these constraints are exceeded, the goods and services that an ecosystem can provide may change in ways that are difficult or impossible to reverse. Such changes can also impact on the productivity of fishstocks. For example, removal of key components of the food-web can have a knock on effect to a wide range of species. Maintaining biological diversity at a range of spatial and organisational scales is regarded as being of major importance to ecosystem functioning and productive fisheries as well as providing resilience against "regime shifts" and flexibility for future uses. Maintaining genetic diversity is also regarded as being important to maintain fishstock resilience to disease and changing environmental conditions.

In New Zealand, ecosystem functioning of the deepwater marine environment is being explored primarily through studies of fish diet and trophic relationships and the development of ecosystem indicators for monitoring purposes. This is the focus of the research described in the 10 Year Research Plan.

Management approach

The Ministry of Fisheries has legal obligations under the Fisheries Act 1996 to avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment. In addition to these legal requirements many third party certification schemes also require that measures are in place to ensure fishing activity does not have significant adverse effects on the marine environment.

It is important that our management of deepwater fisheries takes account of the ecosystem within which these fisheries exists. To successfully achieve this management approach must take into account the key interactions between fisheries and ecosystems, and recognise that both are affected by natural long term variability as well as non fishery extractive and pollution activities.

Our ability to predict the consequences of fishing upon deepwater ecosystem functions is currently weak. This is due to the interaction of multiple factors in the marine ecosystem, for example, temperature, currents, food availability and predator abundance and the ability of these factors to collectively influence biomass production in a fishery. Disentangling these

causative mechanisms requires long-term datasets which will only be achieved through extensive monitoring.

The management objectives described in the draft National Deepwater Fisheries Plan that directly relate to ecosystem functioning include:

- Maintain the genetic diversity of deepwater and middle-depth fisheries
- Protect habitats of particular significance for fisheries management
- Manage deepwater and middle-depth fisheries to avoid or minimise adverse effects on biological diversity.

Summary of Current Knowledge

Trophic interactions

Internationally the most thoroughly researched ecosystem effects of fishing are trophic interrelationships. Fishing down the food web (removal of top predators and larger organisms) can increase biomass at lower trophic levels (e.g. shift from cod to prawn based fisheries after the cod collapse). In New Zealand, a three year study to quantify the trophic interrelationships among hoki, hake, ling and about 20 other fish species on the Chatham Rise in depths of 200 to 800 m has been completed (ZBD2004/02).

A separate, but related projected was commissioned by the Ministry in 2007 to analyse stomach samples of hoki, hake and ling collected by observers on commercial vessels operating on the Chatham Rise over a 2 year period (ENV2007-06). Additional FRST[16] funded research includes an analysis of trophic linkages between zooplankton and small mesopelagic fishes.

Finally, a review of all New Zealand trophic studies completed to date will shortly be published (IPA2009-11).

Ecosystem indicators

An analysis of ecosystem indicators from existing trawl surveys in New Zealand was recently completed (ENV2007-06). As a result of this research, some changes will be made to data collection methods and routine analysis conducted in trawl surveys.

Acoustic records that contain data on midwater biomass of mesopelagic fish and zooplankton have been routinely collected during summer trawl surveys on the Chatham Rise and in the Sub-Antarctic. Pilot studies funded by FRST have shown that these data can yield useful insights, and further research will be delivered to determine trends in the distribution and total abundance of mesopelagic fish and zooplankton (ENV2009/04) as well as linking to trophic studies and environmental variables.

Climate and oceanographic variability

[16] Foundation for Research Science and Technology.

Research to date has focussed on the links between specific climate variables and measurable aspects of fish populations such as relative abundance, catch, and year class strength. Our current understanding of the interaction between climate variables, oceanography, and fisheries is based mostly on correlative studies. Usually, some index of abundance (e.g., year class strength, catch, CPUE e.g. SAM2005/02) has been correlated with one or more physical variables such as sea surface temperature or the Southern Oscillation Index. However, few studies have teased out the causal processes and it is likely that some of our correlative results are spurious and have not identified the best predictors of change. Nevertheless, an understanding of the links between climate cycles, oceanographic conditions and their effect on our fisheries provides an essential backdrop to both environmental and stock assessment.

A project to assess climate and oceanographic trends relevant to New Zealand fisheries (ENV2007/04) reviewed trends in four climate and six oceanographic indicators across a variety of scales and showed evidence of a regime shift into a negative phase of the IPO in about 2000. El Niño conditions (increased westerly and south-westerly winds, cooler sea surface temperatures and enhanced upwelling in some areas) were less frequent after 2000.

Habitats of particular significance for fisheries management

From trawl surveys and observer records, we have some information on the Juvenile and spawning grounds for deepwater species. The distribution of many species have also been mapped andis available on NABIS. A focus of the draft National Deepwater Fisheries Plan is to define what is meant by habitats of significance for fisheries management with respect to deepwater fisheries and to ensure that where necessary measures are in place to protect such habitats.

10 Year Research plan – Ecosystem functioning and trophic linkages

The monitoring programme delivered through the 10 Year Plan will seek to:

- Improve the information on ecosystem functioning and trophic linkages to allow for more detailed research to be undertaken either through the additional research component of the 10 Year Research Plan or the Ministry of Fisheries Biodiversity Research Programme
- Routinely monitor trends in an agreed suite of ecosystem indicators. There may be opportunities to link this information with the Ministry for the Environment ecosystem indicator programme

The planned research programme to support the ecosystem functioning management objectives is focused on delivering baseline information through routine data collection and regular analysis of these data:

- A workshop will be held during 2010-11 to identify ecosystem indicators that can be opportunistically collected through observer coverage.

- Regular sampling, through the observer programme, of the routine ecosystem indicators specified through the workshop described above.
- Mesopelagic layer productivity will be monitored opportunistically via acoustic surveys to provide an indicator of secondary productivity.
- Analysis of ecosystem indicator data will occur five-yearly or more frequently if required by standards or Marine Stewardship Council certification.

In addition, periodic ecological risk assessments will be conducted for specific fisheries and these will include assessment of risks to function and productivity from the fishery. These ERAs may lead to alteration of the research and monitoring programmes.

Outstanding issues

Trophic interactions

Trophic interactions is the area where the most direct effect of fisheries removals is likely to be seen. In order to predict the impact of fisheries removals, trophic interactions between fish species from areas other than the Chatham Rise, or between fish species and marine mammals and seabirds should be studied. The influence of offal and discards on diets should be part of this examination. Observer sampling could also be used (i.e. to collect stomach samples)

Further trophic studies may be considered through the Biodiversity Research Programme but, irrespective of how this research is funded, the intention is this research would utilise the datasets collected through the ecosystem monitoring work delivered through the 10 Year Plan.

Genetic diversity

Genetic diversity, connectivity and the influence of this on stock resilience and the resilience of deepwater ecosystems to fishing disturbance is unknown. Further, the source-sink relationship between different parts of the marine ecosystem (as elucidated by genetic relationships) could add new insight to habitats of significance to fisheries management. Although there is no clear research programme identified to address this issue, the observer sampling programme may be used to collect data to support this research. Further research may be contracted through the Additional Research component of the 10 Year Plan as required.