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Does the commercial fishing of Antarctic toothfish have a future?

A critical assessment from a Ngai Tahu tikanga perspective

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Nigel Scott – 67420004

Cover Photo

Figure 1. New Zealand toothfish vessel San Aotea II in the Ross Sea as seen from an RNZAF P-3K Orion Aircraft, 20 January 2005 (photo courtesy of the Ministry of Foreign Affairs and Trade website).

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1. Introduction

This paper critically assesses the long-term sustainability of the Antarctic toothfish fishery from a Ngai Tahu tikanga (customary practices) perspective. The investigation assesses the current toothfish fishery, as determined by the Commission for the Convention on the Conservation of Antarctic Marine Living Resources, against key Ngai Tahu 'best practice' fishing customs.

'Best practice' fisheries management criteria from various international sources have also been incorporated into the assessment, as and when appropriate, to add emphasis.

To critically assess the true, long-term sustainability of the toothfish fishery within Antarctic waters, the investigation focuses on key aspects of fisheries management, including:

- Catch limits;
- Size limits;
- The use of seasonal and spatial closures;
- Protection of important habitats for fisheries management;
- Protection of associated and dependant species; and
- Compliance and enforcement.

The assessment also touches on key environmental management issues associated with commercial fishing such as pollution and bioinvasion of alien species.

2. Background

2.1 Ngai Tahu tikanga (customary practices and guardianship)

2.1.1 Whakapapa

Whakapapa explains the origins of all things, past and present, within the Maori world (Te Ao Maori). It is the foundation upon which all things are built and the vehicle by which all things link back to the beginning of time.

Whakapapa accounts for the way in which the earth, the sky, oceans, rivers, elements, minerals, plants, animals and people have been created. It is through whakapapa that all things are intricately linked. Ultimately, it is whakapapa that connects people to each other, to their ancestors, to the land and natural resources. For Ngai Tahu, it is whakapapa that explains their descent from the gods of creation and explains their relationships to the natural world around them (Te Runanga o Ngai Tahu and the Department of Conservation, 2005).

These traditions underpin the environmental values and beliefs of the Ngai Tahu iwi (tribe), and hapu (sub-tribes) who by whakapapa retain the customary rights and responsibilities associated with nga taonga tuku iho o nga tupuna (the treasures handed down from the ancestors – including flora, fauna and natural resources). For Ngai Tahu, the natural resources, species and taonga (treasures) found within their takiwa (tribal area) are tangible treasures that transcend the generations.

Ngai Tahu beliefs and ancestral stories explain all things from the time of nothingness – Te Kore, through the vast ages of darkness – Te Po, through to the emergence of moisture – Te Maku (Te Runanga o Ngai Tahu, 2002).

In the beginning a void, a parentless void with the potential for life encompassed all. In due course Te Maku emerged and coupled with Mahoranui-a-Tea from which came Rakinui, who coupled with Pokoharua-Te-Po. Their first child was Aoraki, who stands as the supreme mountain of Ngai Tahu.

From the union of Rakinui and Pokoharua-Te-Po also came the source of the great winds – Tawhirimatea. The elder brother of Pokoharua-Te-Po was Te Moretu. From Te Moretu came Takaroa[1] – the great progenitor of the oceans. The first wife of Takaroa was the flat earth – Papatuanuku.

While Takaroa was occupied with his work far out in the oceans, Papatuanuku went to be with Rakinui. It was from this union between Rakinui and Papatuanuku that begat Rehua, and Tane-Mahuta.

[1] Or 'Tangaroa' when using the 'ng' instead of the 'k' dialect.

The strong and loving embrace of Rakinui and Papatuanuku caused an extended darkness, which expunged all shreds of light from the face of the earth, trapping their many children in a world of darkness.

The children of Raki and Papa vowed to separate their parents, first one then the other tried, finally it was Tane-Mahuta who with great effort forced his parents apart, sending Rakinui skyward, and wedging great poles between him and Papa. This separation brought in the age of light, the long light. The separation brought great sadness for Raki and Papa – great clouds and huge rainfall represents the tears of Raki and shrouding mist represents the tears of Papa. The separation left Papa naked and exposed, her son Tane-Mahuta decided to clothe her, using trees and vegetation to adorn her. This was the beginning of the great forests; Täne also stocked the forests with birds and animals.

Takaroa, performed prodigious deeds including stocking the sea with fish life, while Tawhirimatea took the atmosphere as his domain, influencing the daily weather patterns.

Aoraki and his brothers went in search of his father's new wife, however, disaster struck and Aoraki's waka collided with a submerged reef and was wrecked. The wreckage of Te Waka o Aoraki (the canoe of Aoraki) became the South Island (also known as Te Wai Pounamu – the greenstone water). After Aoraki came several of his mokopuna (grandchildren), Tuterakiwhanoa, to fashion the waka and prepare it for human habitation.

There are many other atua (deity) that fill the cosmological world of Ngai Tahu, who contributed to the beginnings of Te Ao Turoa, the natural world. It is this whakapapa that links and binds Ngai Tahu to the natural resources of Te Waipounamu and that guides them in their interactions with, and use of, these resources (Te Runanga o Ngai Tahu, 2002).

It is whakapapa that can help explain what it may be appropriate to do with natural resources, who may hold mana (traditional authority) over particular resources, who has a right to be involved in decisions relating to the use of resources and any other spiritual, cultural and social considerations that need to be made when using natural resources.

2.1.2 Customary fishing (mahinga kai hi ika)

The mahinga kai custom underpins Ngai Tahu culture. It is central to the relationships with places, species and resources, to the cultural, spiritual, social and economic well-being of Ngai Tahu, and it is a vehicle for the transfer of traditional knowledge from generation to generation.

Mahinga kai refers to the custom of gathering food (literally the 'working of food'), the life-supporting natural resources themselves, the practices involved, and the

places where they are gathered. Mahinga kai involved great seasonal hikoi (journeys) to gather kai (food) from the mountains to the sea.

Mahinga kai hi ika (customary fishing) was, and still is today, the source of economic and cultural well-being – providing for the sustenance of people, the appropriate hosting of visitors (manaakitanga) and allowing for the trade and sale of resources (kai hau kai) with other iwi and hapu in traditional times and to domestic and international markets today.

The trade and exchange of food was the means by which social networks and tribal alliances were developed or maintained in traditional times. The mana (status, authority or prestige) of a tribe is often governed by the abundance and edibility of the food that they trade or by the hospitality they show to visitors. A failure to manage natural resources properly could result in a tribe losing its mana (Te Runanga o Ngai Tahu, 2010).

Along with whakapapa (which provides the genealogical connection to resources), mahinga kai explains the customs of use associated with flora, fauna and resources, from which springs matauranga (traditional knowledge), and traditional practices (tikanga) relating to their sustainable use.

2.1.3 Kaitiakitanga (guardianship)

Kaitiakitanga is the exercise of guardianship by the Tangata Whenua (the tribe/sub-tribe with traditional authority over an area) in accordance with their tikanga (customs or practices). Kaitiaki is derived from the verb tiaki (to guard, to protect, to keep, to watch for). Kaitiakitanga is essentially aimed at the protection of mauri.

Mauri may be described as the life force, present in all objects living and inanimate, a force that stems from the beginnings and a value that can be represented by qualities of health, abundance, vitality, the pristine, the unpolluted and the presence of indigenous flora and fauna. For Ngai Tahu, mauri is the life-force that flows from wairua – which is the spiritual source of life or existence. It is something sacred to whakapapa, a spiritual link in the widest sense, to the past, the present and to the future, an influence that maintains Ngai Tahu's culture with particular values and beliefs (Te Runanga o Ngai Tahu, 2010; Te Runanga o Ngai Tahu and the Department of Conservation, 2005).

Ngai Tahu are working to ensure that the mauri of their taonga (treasures) is healthy and strong. A taonga whose life force has been adversely affected means that the mana (status) of the Tangata Whenua, as guardians, are adversely affected also and so they must do all in their power to restore the mauri of the taonga to its original strength.

The protection of mauri is enhanced through the gathering of food. The use of important mahinga kai species ensures the matauranga (knowledge) of how to protect the mauri of these resources is passed on from one generation to the next.

Tikanga denotes those customs and traditions that have been handed down through many generations and accepted as reliable and appropriate ways of achieving and fulfilling certain objectives and goals. Tikanga enabled Ngai Tahu to sustainably harvest and conserve their natural resources in traditional times and these proven methods, are still the basis for Ngai Tahu's management of natural resources today. Traditional management practises include the use of rahui (temporary restrictions or prohibitions). Rahui are used to restore the health of resources or the environment.

For Ngai Tahu there is a whakapapa obligation and right to safeguard the well-being and mauri of ancestral land, water, sites, valued flora and fauna, and other taonga in the Ngai Tahu tribal area for future generations.

This is encapsulated within the following proverb:

Mo tatou, a, mo nga uri a muri ake nei
For us and our children after us.

To be a kaitiaki (guardian or manager) is an important responsibility. The kaitiaki system is based on whakapapa lineage, and inherited responsibility. It is traditional and inalienable.

2.1.4 Contemporary customary fisheries management

Due to the fisheries settlements reached with the Crown, customary fishing rights were split into their commercial and non-commercial parts and each was dealt with separately in terms of the redress provided. The customary non-commercial fishing rights are now managed under a regulatory framework – using law to give effect to lore. To exercise their customary fishing rights that are now administered under the customary regulations, Ngai Tahu must obtain an authorisation from one of their Tangata Tiaki/Kaitiaki (customary fisheries managers – who generally are the descendants of the kaitiaki who managed fisheries in traditional times).

The commercial component of these rights are now managed under the Quota Management System (referred to in more detail below) and the fishing practices employed by the commercial fishing arm of Ngai Tahu follow standard industry practises that may or may not conform to a tikanga-based approach to fisheries management. As such, when the term "Ngai Tahu tikanga" is used in this paper in a contemporary context, this refers to the <u>customary non-commercial fishing practises</u> only.

The customary fishing regulations also provide the framework for the protection and management of areas of particular importance for customary fishing. Rahui are still used today to manage these important areas much like they were employed in the past.

2.2 Antarctic Treaty System

2.2.1 The Antarctic Treaty

The Antarctic Treaty was negotiated in 1959 and it establishes Antarctica as a reserve dedicated to scientific investigation and peace. The Treaty applies to the area south of 60º South Latitude. The Treaty established the Antarctic Treaty Consultative Meetings (ATCM) of the Treaty Consultative Parties (ATCP) that meet yearly to exchange information and to develop measures to further the principles and objectives of the Treaty including measures regarding the preservation and conservation of living resources of Antarctica. The Treaty is implemented in New Zealand through the Antarctic Act 1960.

2.2.2 CCAMLR

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was enacted in 1980 in response to concerns over the growing interest in krill fishing and the serious impacts of this fishing on the Southern Ocean ecosystem and on the associated and dependant species (T. Hughes, Antarctic Policy Unit – Ministry of Foreign Affairs and Trade, personal communication, 15 December 2009). These concerns were raised in 1977 at the ninth meeting of the ATCM – recommendation IX-2 led to the establishment of the CCAMLR Convention.[2]

As well as conserving the marine living resources, the Convention sets out to safeguard the environment and protect the integrity of the ecosystem of the seas surrounding Antarctica. The Convention applies to the area south of 60º South Latitude and to the area between that latitude and the Antarctic convergence (as shown in the map below). This area includes both high seas and territorial waters.

The Convention established a Commission (also known as CCAMLR) as an executive arm to conduct the necessary functions associated with the Convention – in particular the adoption of conservation measures. The Commission meets yearly to exchange information and to set mandatory standards for fishing activity through agreed conservation measures.

[2] Recommendation 2, September – October 1977, ATCM IX.

The Convention also established a Scientific Committee to provide a forum for the collection, exchange and analysis of information on Antarctic marine living resources and to encourage and promote scientific research.

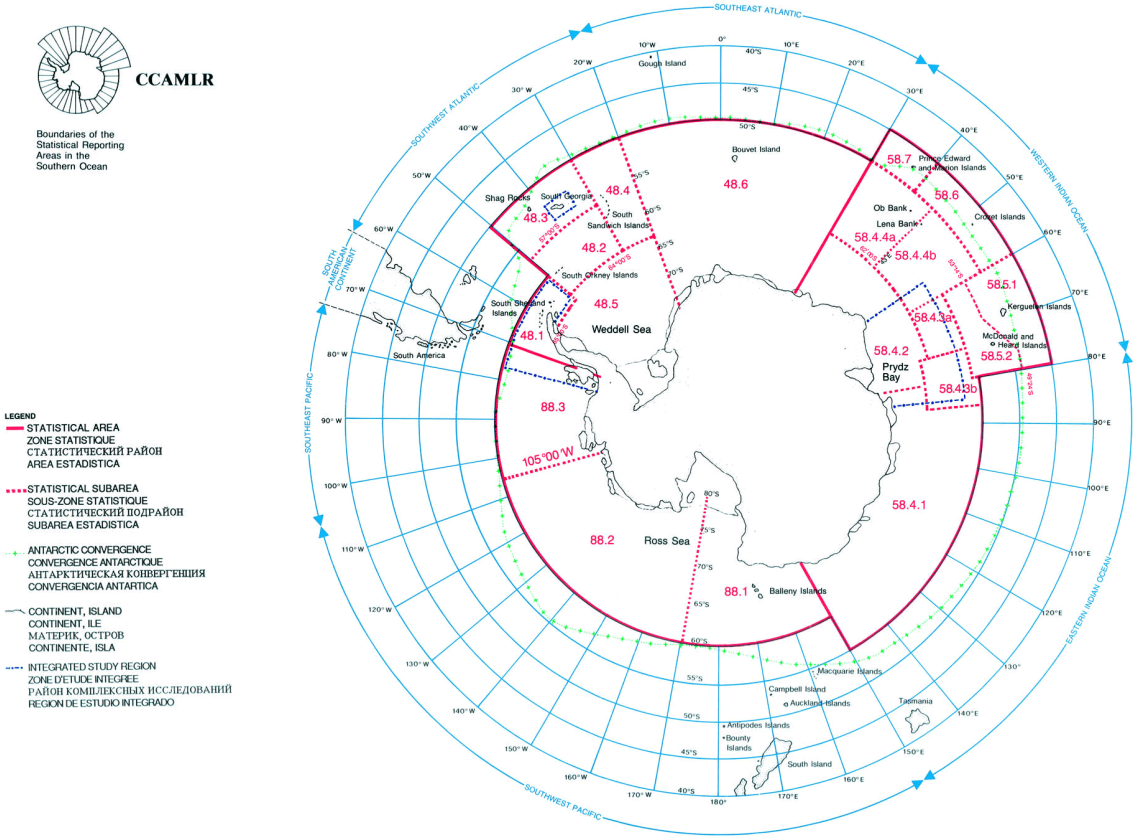

Figure 2. CCAMLR Convention Area

For the purposes of the Convention, 'conservation' includes rational use. Such that the following conservation principles are set out in the Convention:

(a) Prevention of the size of any harvested population from decreasing to levels below those which ensure stable recruitment;

(b) Maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in the first principle;

(c) Prevention or minimisation of changes or the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades.

These principles (along with the staged approach to fisheries development) are said to constitute a precautionary, ecosystem-based approach to fisheries management (Fabra & Gascon, 2008; I. Jamieson, Fisheries Advisor – Ministry of Fisheries, personal communication, 12 January 2010; Kock, Reid, Croxall & Nicol, 2007). A staged approach is adopted to fisheries development

The Convention is given legal effect in New Zealand through the Antarctic Marine Living Resources Act 1981. No New Zealand flagged vessel (whether scientific or exploratory commercial fishing) may take any marine organism in the Convention area without a permit issued by the Minister of Fisheries under section 5 of this Act. The Minister of Fisheries can grant permits for fishing at the level set by CCAMLR each year.

Under section 5 of this Act the Minister may set conditions on the permit as he thinks fit[3], including conditions relating to:

(a) The quantity of toothfish which may be taken in the Convention Area;

(b) The regions and subregions in the Convention Area where the toothfish may be taken;

(c) The designation of protected species of marine organisms;

(d) The size, age, or sex of toothfish which may be taken;

(e) The designation of open and closed seasons for taking toothfish (including for scientific study);

(f) The regulation of the effort employed and methods of taking (including the vessels, gear, and equipment to be used);

(g) The implementation of any system or interim arrangement relating to observation and inspection established under Article XXIV of the Convention;

(h) Any other conservation measure;

(i) The records that are to be kept and the data that is to be collected by the permit holder and any information which is to be supplied to the Minister.

Any permit may be revoked or suspended, and the conditions attached to it amended, at any time by the Minister.

[3] Which may pose serious problems should the Government appoint a female Minister of Fisheries.

2.2.3 The Environmental Protocol

The Protocol on Environmental Protection to the Antarctic Treaty was negotiated in 1991 to assist the Treaty Parties to implement measures regarding the preservation and conservation of living resources of Antarctica. The Protocol designates Antarctica as a natural reserve, devoted to peace and science. The Protocol applies to the area south of 60º South Latitude.

Annex V of the Protocol provides for Antarctic Specially Protected Areas (ASPA) to be established to protect areas that have outstanding environmental value. Article 3(2) of Annex V requires Parties to identify and protect, in a series of ASPA, representative examples of major marine ecosystems.

However, the Protocol records that it shall not derogate from the rights and obligations of the Parties under the other international instruments in force within the Antarctic Treaty System (ATS) – which relates to CCAMLR in particular. Thus, Article 6(2) of Annex V requires that proposed marine ASPA have the prior approval of CCAMLR before the ATCM may approve them (although, the ATCM clarified their policy on Article 6(2) in 2005[4] by confirming that the draft ASPA which require the prior approval of CCAMLR are those in which there is actual harvesting or potential capability of harvesting of marine living resources which might be affected by the proposal or where Management Plan provisions which might prevent or restrict CCAMLR related activities).

The Protocol is implemented in New Zealand through the Antarctic (Environmental Protection) Act 1994. This Act applies to all people except members of official expeditions of other Antarctic Treaty Parties.[5]

2.3 International best practise / obligations

2.3.1 Marine Stewardship Council

The Marine Stewardship Council (MSC) is a certification and eco-labelling entity. At the centre of the MSC is a set of *Principles and Criteria for Sustainable Fishing* which is used as a standard in a third party, independent and voluntary certification programme. The MSC Principles reflect a recognition that a sustainable fishery should be based upon:

- The maintenance and re-establishment of healthy populations of targeted species;
- The maintenance of the integrity of ecosystems;

[4] ATCM Decision 9, 17 June 2005, ATCM XXVIII.

[5] For New Zealand flagged fishing vessels, the obligation to submit an environmental impact assessment is incorporated into the permit issuing procedures conducted by the Ministry of Fisheries. Refer to section 53 of the Antarctic (Environmental Protection) Act 1994 for the derogation clause.

- The development and maintenance of effective fisheries management systems, taking into account all relevant biological, technological, economic, social, environmental and commercial aspects; and
- Compliance with relevant local and national local laws and standards and international understandings and agreements.

2.3.2 FAO Code of Practise for Responsible Fisheries

The purpose of this Code developed by the Food and Agriculture Organisation of the United Nations (FAO) is to establish principles, in accordance with the relevant rules of international law, for responsible fishing and fisheries activities.

The code sets out general fisheries management principles including:

- States and users of living aquatic resources should conserve aquatic ecosystems;
- Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources for present and future generations

Additionally the code then sets out specific principles including:

- States or regional fisheries management organizations (such as CCAMLR) should, *inter alia*, adopt appropriate measures, based on the best scientific evidence available, which are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield (B_{MSY}), as qualified by relevant environmental factors;
- Such measures should provide *inter alia* that:
    - Depleted stocks are allowed to recover or, where appropriate, are actively restored;
    - The Biodiversity of aquatic habitats and ecosystems is conserved and endangered species are protected;
    - Pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species are minimized, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost effective fishing gear and techniques.

2.3.3 Antarctic and Southern Ocean Coalition

The Antarctic and Southern Ocean Coalition (ASOC) have developed selection criteria for the establishment of Marine Protected Areas (MPA). The key selection criteria are:

- Comprehensiveness – all known elements of biodiversity, at a range of scales, must be captured within the network;
- Adequateness – the core components of adequacy include reserve size, connectivity and replication;
- Representativeness – representative examples of all habitats and ecosystems must be incorporated into the network;
- Rare, unique or vulnerable habitat to be protected.[6]

2.3.4 Fisheries Act 1996

The New Zealand Fisheries Act 1996 sets out the mechanics behind the Quota Management System (QMS). The QMS is an output control measure (ie: it sets a limit on the amount of 'target' fish that can be removed from the fishery).[7] The QMS is designed to maintain or restore populations of harvested species at or above levels which can produce the maximum sustainable yield (B_{MSY}).

All persons exercising or performing functions, duties, or powers under this Act are required to operate the QMS on the best available information and a cautious approach is required to be taken when information is uncertain. The following environmental principles must be taken into account:

(a) Associated or dependent species should be maintained above a level that ensures their long-term viability;

(b) Biological diversity of the aquatic environment should be maintained;

(c) Habitat of particular significance for fisheries management should be protected.

2.3.5 Department of Conservation – Marine Protected Areas Policy[8]

The Department has developed a number of network design and planning principles to establish a comprehensive and representative network of MPA in New Zealand. The main network planning principles are:

- Completeness – the network should protect examples of the full range of ecosystems;
- Viability – a viable network will be more likely to withstand or recover from the stresses placed upon it – both natural and human-induced (whether direct or indirect). Viability can be enhanced through appropriate MPA design (size,

[6] Antarctic and Southern Ocean Coalition (2009b).
[7] Examples of 'input controls' include limits on the size of fish that can be harvested or the type of gear that may be used for fishing.
[8] Department of Conservation and Ministry of Fisheries (2005).

shape), replication and connectivity between MPA. Where possible, MPA should ensure the maintenance of ecosystem functionality;
- Monitoring – a monitoring programme should be undertaken to ensure that each MPA is effective in protecting the values it has been established to safe-guard.

And the main planning principles in this policy are:

- Representativeness – representative examples of all habitats and ecosystems must be included;
- Effectiveness – the management tools used in the MPA should be sufficient to meet the required protection standards/guidelines set by CCAMLR and they should be consistent and secure in the long-term;
- Transparency – MPA establishment should be undertaken in a transparent and participatory manner;
- Minimising impacts – Adverse impacts on existing users (especially fishers) should be minimised;
- The best available information should be used as the basis for establishing the MPA.
- Decision making should be guided by a precautionary approach.
- The MPA network must be enforceable. The compliance and enforcement required will be based on the likely risks of non-compliance.

2.3.6 UNCLOS

The United Nations Convention on the Law of the Sea (UNCLOS) was concluded in 1982 and it covers matters such as territorial sea limits, the rights associated with 200 nautical mile exclusive economic zones (EEZ) and the continental shelf, the high seas and the status of resources outside the limits of any nations jurisdiction as well as the conservation and management of fisheries on the high seas[9] and the protection and preservation of the marine environment (eg, measures to prevent, reduce and control pollution).

For example, Section 2 of Part VII of UNCLOS records that all States have the right for their nationals to engage in fishing on the high seas <u>subject to</u>:

(a) Their <u>treaty obligations</u> (such as CCAMLR);
(b) The rights and duties as well as the interests of coastal States; and
(c) The provisions of this section.

[9] Forums such as the Ad Hoc Open-ended Informal Working Group to Study Issues Relating to the Conservation and Sustainable Use of Marine Biological Diversity Beyond Areas of National Jurisdiction are convened to discuss these matters.

Article 117 of Section 2, Part VII then goes on to record that:

All States have the duty to take, or to cooperate with other States in taking, such measures for their respective nationals as may be necessary for the conservation of the living resources of the high seas.

Article 118 – States shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, cooperate to establish regional fisheries organizations (such as CCAMLR).

And Article 119 then documents that:

1. In determining the allowable catch and establishing other conservation measures for the living resources in the high seas, States shall:

(a) Take measures which are designed, on the best scientific evidence available to the States concerned, to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental factors, and taking into account fishing patterns and the interdependence of stocks;

(b) Take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened.

2. Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations (such as CCAMLR), where appropriate and with participation by all States concerned.

And Article 211 of Section 5 of Part XII of UNCLOS records that:

1. States acting through the competent international organization (such as the International Maritime Organisation) or general diplomatic conference, shall establish international rules and standards to prevent, reduce and control pollution of the marine environment from vessels;

2. States shall adopt laws and regulations for the prevention, reduction and control of pollution of the marine environment from vessels flying their flag or of their registry.

The fisheries management components of UNCLOS are implemented in New Zealand through the Fisheries Act 1996. All New Zealand flagged vessels in CCAMLR fisheries must hold a high seas fishing permit issued under the Fisheries Act 1996.

2.4 Antarctic toothfish fishery

2.4.1 Antarctic Toothfish

Antarctic toothfish (*Dissostichus mawsoni*) are large, primarily demersal (dwelling at or near the bottom of a body of water), Nototheniids endemic to Antarctic waters, with circumpolar distribution (Hince, 2000; Ministry of Fisheries, 2009c). They can be found at depths deeper than 2000m (Kock, 1992). This species is seen as a key component of the Ross Sea ecosystem (DeVries, Ainley & Ballard, 2008; Pinkerton, Hanchet & Bradford-Grieve, 2007; Smith, Ainley & Cattaneo-Vietti, 2009).

Surveys conducted by the New Zealand Ministry of Fisheries (MFish), under the programme on 'Ecosystem Effects of Fishing in the Ross Sea' – which is a part of New Zealand's International Polar Year Census of Antarctic Marine Life (NZ IPY-CAML), show that in the Ross Sea smaller juvenile toothfish are found in shallower waters on the Ross Sea Shelf, in particular around the Balleny Islands at depths of 200-800m. Larger adult toothfish are commonly found on the Ross Sea Slope in depths of 800-1500m (Ministry of Fisheries, 2009a).

Information on fish movement, life-cycle and population has been compiled from two major tagging programmes[10] conducted on toothfish in the Ross Sea. The first was an American programme that ran from 1970s-2000 and the second was initiated by New Zealand in 2001 which later grew into a multi-national, multi-area programme co-ordinated by CCAMLR in 2006.

MFish state that up until March 2009 11,000 toothfish have been tagged under the New Zealand initiated programme, with 225 recaptures (Ministry of Fisheries, 2009a)[11] – some were multi-recaptures (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010), however, all recaptured individuals are now retained for their biological information (Conservation Measure 41-01 (2009)). Most of these recaptures were caught less than 50km from where they were tagged indicating that adults exhibit sedentary, resident behaviour at this stage in their life cycle.

[10] Tagging seen as the only real option to measure population dynamics as most recruits are in areas covered by ice for the majority of the year (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010).

[11] Although figures of 22,484 tagged toothfish, 18,954 tagged toothfish and 911 recaptures have also been quoted by MFish (Ministry of Fisheries, 2009c; N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010).

The age/growth studies, conducted using otoliths (which retain annual growth rings) extracted from fish landed within the fishery, show that toothfish grow relatively slowly and they are slow to mature. They grow to about 60cm after five years and about 100cm after ten years. Growth slows down after 25 years at a length of about 150cm. The maximum recorded age is 48 years, maximum length recorded is 250cm and they can weigh up to 150kg and live for up to 45 years. There is a significant difference in growth between sexes with maximum average lengths of 170cm males and 185cm for females (Horn, 2002; Ministry of Fisheries, 2009c).

The age and length at recruitment to the fishery varies between areas and between years. In the northern SSRUs (88.1A–88.1G), toothfish recruit to the fishery at a length of about 130cm, whereas in the southern SSRUs the length at recruitment depends on the depth of fishing. In some years fish have been fully recruited by about age 7–8, whereas in other years fish have not been fully recruited until at least age 10.

Estimates of maturity suggest the mean age and length at 50% spawning for females on the Ross Sea slope region were 16.6y and 133.2cm and 12.8y and 120.4cm for male (Ministry of Fisheries, 2009c).

The diet of toothfish is also reasonably well known. With the absence of sharks south of 60º South Latitude, toothfish are the top fish predator in Antarctic waters. Toothfish feed on a wide variety of prey but they are primarily piscivorous (fish eating).

Much of the detail about the toothfish life cycle is still yet to be discovered (Hanchet, Rickard, Fenaughty, Dunn & Williams, 2008; Pinkerton, Hanchet & Bradford-Grieve, 2007), however, using the best available information scientists have been able to develop a hypothetical life cycle.

This hypothetical life cycle has three main stages:

(a) Larvae and small juveniles living on or near the surface. Modelling has been used to predict how larvae spread around Antarctica in the water column from the breeding grounds situated at the Polar Front. The Ross Sea nursery grounds are thought to be in or near the Bay of Whales as the models indicate that larvae are funnelled towards this area by the clockwise rotating eastern Ross Gyre at depths of approximately 150m (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010). At the small juvenile stage in their life cycle their diet consists predominantly of Antarctic silverfish (*Pleuragramma antarcticum*) (Hanchet, Rickard, Fenaughty, Dunn & Williams, 2008; Pinkerton, Hanchet & Bradford-Grieve, 2007);

(b) Older juveniles and young adults living on or near the seabed in coastal waters. Their diet at this stage is principally silverfish (Hanchet, Rickard, Fenaughty, Dunn & Williams, 2008; Pinkerton, Hanchet & Bradford-Grieve, 2007); and

(c) Older adults which migrate north and offshore to the continental slope as they mature sexually (Fenaughty, 2006), and then further north to seamounts at the Polar Front to spawn (on the Pacific-Antarctic Ridge during winter and spring). It is thought that spawning fish may stay in the northern spawning grounds for 2-3 years – before moving south to the slope, where food is more plentiful, in order to regain condition for spawning again (Ministry of Fisheries, 2009c). On the continental slope, toothfish feed on a variety of deepwater demersal fish such as Whitson's grenadier/rattail (*Macrourus whitsoni*), icefish (*Chionobathyscus dewitti*) and squid.

As well as being the top fish predator south of 60° South Latitude, toothfish are also prey for species such as sperm whales, orca and Weddell seals (Ainley & Siniff, 2009; Hanchet, Rickard, Fenaughty, Dunn & Williams, 2008; La Mesa, Eastman & Vacchi, 2004; Pinkerton, Hanchet & Bradford-Grieve, 2007).

2.4.2 The Fishery

The toothfish fishery is one of many managed by CCAMLR (Koch, 1992). The Antarctic toothfish fishery is one of the deepest longline fisheries in the world with the average lines set from 500-1200m by bottom autoline longliners. The focal point for the fishery is on continental slopes (between 800-2000m) where the mature adults reside.

The fishery is permit access only. The permits are issued to fishing vessels by their respective flag States pursuant to the fishing limits and vessel limits set by CCAMLR each year. CCAMLR set competitive catch limits, where permitted vessels compete for an overall catch limit in what is termed an 'Olympic-style' fishery.

To date, the core fishery is located in the Ross Sea polynya in Subarea 88.1 (the western Ross Sea – refer to Figure 3 below) and to a much lesser extent in Subarea 88.2 (the eastern Ross Sea), Subarea 48.6 and several divisions in Subarea 58.4 to the west of Subarea 88.1.[12]

[12] Due to the information made availability within the time constraints imposed, this paper focuses on the long-term sustainability of the Ross Sea component of the toothfish fishery (Subareas 88.1 and 88.2) from this point on.

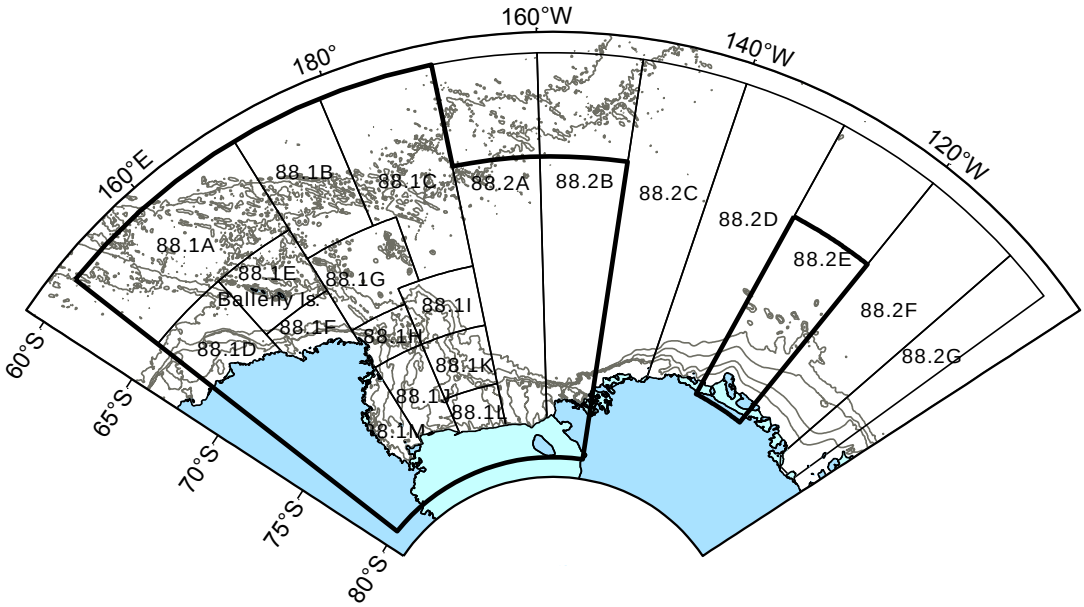

Figure 3. The Ross Sea Region – CCAMLR Subareas 88.1 and 88.2 showing the small-scale research units (SSRUs) used for management and depth contours plotted at 500, 1000, 2000, and 3000m

The exploratory longline fishery was initiated in Subarea 88.1 by a single New Zealand vessel in 1996/97 (refer to the estimated catches for the Subareas combined in Table 1 and for each small-scale research unit in Table 2 below). Since then, New Zealand vessels, and vessels from other countries, have fished the Ross Sea area each summer. The catch of toothfish has steadily increased, with the catch limit being reached in Subareas 88.1 and 88.2 between 2004/05 and 2006/07. The catch limit was under-caught in Subarea 88.1 in 2007/08 and 2008/09 due to the severe ice conditions in 2007/08 and the early closure of the fishery by CCAMLR in 2008/09 due to overestimation of catch rates.

Table 1: Estimated catches (tonnes) by area for the period 1996–97 to 2008–09

	Subarea 88.1				Subarea 88.2			
Season	Reported catch	Estimated IUU catch	Total	Catch limit	Reported catch	Estimated IUU catch	Total	Catch limit
1996/97	<1	0	<1	1 980*	0	0	0	1 980*
1997/98	42	0	42	1 510	0	0	0	63
1998/99	297	0	297	2 281	0	0	0	0
1999/00	751	0	751	2 090	0	0	0	250
2000/01	660	0	660	2 064	0	0	0	250
2001/02	1 325	92	1 417	2 508	41	0	41	250
2002/03	1 831	0	1 831	3 760	106	0	106	375
2003/04	2 197	240	2 437	3 250	375	0	375	375
2004/05	3 105	23	3 128	3 250	411	0	411	375
2005/06	2 969	0	2 969	2 964	514	15	529	487
2006/07	3 091	0	3 091	3 072	347	0	347	567
2007/08	2 259	186	2 445	2 700	416	0	416	567
2008/09	2 434	0	2 434	2 700	484	0	484	567

The catch records shown in Table 1 were derived from the various reports required by CCAMLR – specifically daily reports (vessel to flag State to

CCAMLR), weekly reports (vessel to CCAMLR), monthly reports (vessel to flag State to CCAMLR) and annual reports (FAO reports to CCAMLR from flag state).

Figure 4 shows the historical landings and Total Allowable Catches (TAC) for Subareas 88.1 and 88.2.

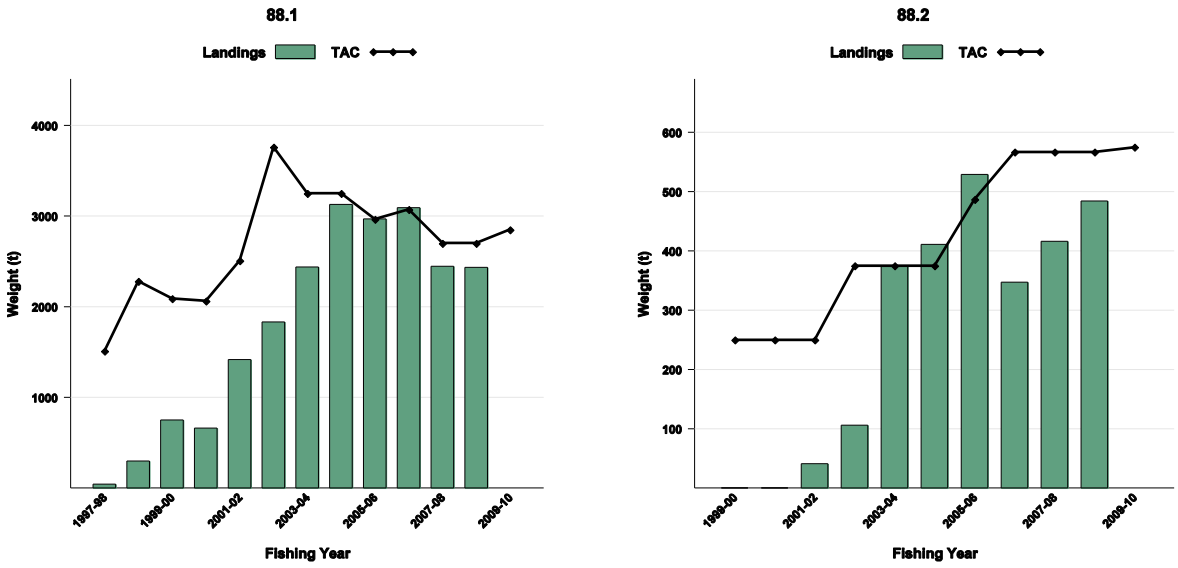

Figure 4: The landings of toothfish from 1997-98 to 2008-09 in Subarea 88.1, and 1999-00 to 2008-09 in Subarea 88.2. The TAC has been plotted for the 2009-10 fishing season which starts 01 December 2009.[13]

Table 2: Estimated catch in each small-scale research unit (SSRU) by year

SSRU	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	Catch limit
881A				1		13			2	<1			0
881B	<1			83	45	107	70	70	10	209	94	117	}
881C				34	363	1 001	232	428	333	375	165	292	} 352
881G	4	<1		71	16	65	80	54					}
881D													0
881E	5	<1		10		2	40	60		<1			0
881F	<1					<1				2			0
881H	4	99	181	98	439	481	1 114	786	1 012	1 514	1 365	487	}
881I	26	149	376	246	345	131	628	613	373	557	126	633	} 1 994
881K		31	183		121		<1	737	588		61	861	}
881J	2	17	11	12			1	158	545	438	411	55	}
881L				97			12	170	84		39	3	} 354
881M													0
882A					41		11	137	17				0
882B							1						0
882E						106	362	270	318	325	333	323	353
882C													}
882D									41	22	38	29	} 214
882F									65		45	132	}
882G									1	<1			}
Total	42	297	752	650	1 370	1 907	2 552	3 484	3 389	3 443	2 838	2 932	3 267

[13] Note these catch records include minor amounts of Patagonian toothfish (*Dissostichus eleginoides*) landings also.

The catch records shown in Table 2 come from the monthly fine-scale catch and effort data recorded for each SSRU (Conservation Measure 41-01 (2009)).[14]

The main species of bycatch in the Ross Sea fishery include Whitson's rattail and skates.

Figure 5. HMNZS Te Kaha inspecting a Ukranian toothfish vessel (photo courtesy of the Ministry of Foreign Affairs and Trade website).

[14] In the 2007/08 season, a research fishing exemption allowed catches of up to 10t to be extracted from SSRUs with zero catch limits.

3. Critical assessment of the toothfish fishery

3.1 Catch limits

3.1.1 Ngai Tahu tikanga

Catch limits are established by Tangata Tiaki/Kaitiaki (kaitiaki in traditional times). These catch limits are based on the tikanga that has been handed down to each guardian from previous generations and the detailed local knowledge held by the kaitiaki. This knowledge is developed through constant monitoring of the resource (mainly through the harvesting of kai).

Traditionally, the tribal area was divided up amongst hapu (and amongst whanau within the hapu) to provide small areas that were micro-managed by the kaitiaki (these management areas were known as wakawaka).

The allocation of catch limits to individual fishers is primarily focussed on sustenance fishing requirements (getting a 'feed') and any bulk harvesting is generally conducted to look after (manaaki) visitors (manuhiri) at a collective gathering (hui) – fishing is about mana not money. The limits are based on needs versus wants and the overriding consideration is always the state and health of the fishery itself. A very precautionary approach is taken (in traditional times especially as these resources were the lifeline for the local people – the true meaning behind mauri can be envisaged very easily) and rahui (temporary closures or restrictions) are still used today to assist resources to recover from a state of depletion.

The biomass at which a fishery is deemed to be 'healthy' in a Ngai Tahu tikanga context is difficult to quantify as cultural health is determined by the mauri of the resource (which obviously has a key spiritual component), however, as noted above, the mauri of a resource can be measured using tangible indicators such as the accessibility and abundance of important kai species (a measure of the ease of harvesting – a cultural 'catch per unit effort).

Tikanga-based catch limits are analogous to skimming the cream off the top or selective thinning within natural limits. As such the resource is effectively perpetuated at a stable 'virgin' biomass. The 'fishing down' of a fishery is not even contemplated under a tikanga-based regime.

3.1.2 CCAMLR conservation measures

The overall catch limits are set by CCAMLR each year (eg, Conservation Measure 41-09 (2009) and Conservation Measure 41-10 (2009) that are set in accordance with Conservation Measure 21-02 (2009) – the requirement for exploratory fisheries to be fished at a rate which allows for the acquisition of information sufficient to ensure the fisheries will be managed in accordance with

the principles in Article 2 of the Convention). The limits are set in accordance with the CCAMLR population target which allows for a long-term fish-down of the population to 50% of B_0 (virgin biomass) over 35 years. The limits are set at the SSRU level and catch spreading within SSRU is required in order to minimise local depletion of toothfish (Conservation Measure 41-01 (2009)).

The fishery is accessible by permit only (Conservation Measure 32-09 (2009)). The permits are issued to vessels by their respective flag States pursuant to the fishing limits and vessel limits set by CCAMLR each year (eg, Conservation Measure 41-09 (2009)). Each vessel that is permitted to enter the fishery is competing for the overall catch limits set by CCAMLR.

All catch must be reported to CCAMLR – specifically daily reports (vessel to flag state to CCAMLR – greenweight of target catch and by-catch – Conservation Measure 23-07 (2009)), weekly reports (vessel to CCAMLR – five day catch and effort – Conservation Measure 23-01 (2005)), monthly reports (vessel to flag state to CCAMLR – fine-scale catch, effort and biological data reporting – Conservation Measure 23-04 (2000) and Conservation Measure 23-05 (2000)) and annual reports (FAO reports to CCAMLR from flag state).

If the catch limits are reached for any SSRU, fishing must cease in that SSRU for the season (Conservation Measure 31-02 (2007)).

In accordance with their Tagging Protocol, CCAMLR require fishers to tag and release one toothfish for every tonne caught (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010). Each vessel must tag and release toothfish continuously while fishing and the tagged individuals must reflect the length frequency of the catch (Conservation Measure 41-01 (2009)). The released fish are not recorded against the catch limits.

3.1.3 Discussion

The toothfish population model developed by scientists from the National Institute of Water and Atmospheric Research (NIWA) assists CCAMLR to determine catch limits for the Ross Sea fishery. This model has been internationally peer reviewed and accepted by CCAMLR as the key stock assessment tool for the Ross Sea fishery. For stock assessment purposes all of Subarea 88.1 and SSRUs 88.2A and 88.2B are treated as a single 'Ross Sea' stock. SSRU 88.2E is treated as a separate stock. All other parts of Subarea 88.2 (SSRUs 88.2C, 88.2D, 88.2F, 88.2G) are treated as the third management unit.

In accordance with the CCAMLR Decision Rules (and Resolution 31/XXVIII – best available science) an updated estimate of biomass was provided in 2009 for the Ross Sea and SSRU 88.2E stocks. These stock assessments were based on analyses using a combination of catch per unit effort (CPUE), catch-at-age from the commercial fishery, tag-recapture data, and estimates of biological

parameters. The 2009 assessment is the fourth stock assessment of the Ross Sea stock and the second for SSRU 88.2E.

The model estimates the Ross Sea stock B_{2009} to be at 80% of B_0 and the SSRU 88.2E stock B_{2009} to be at 81% of B_0 (Ministry of Fisheries, 2009a; Ministry of Fisheries 2009c). The model is virtually certain (>99% probability) that the Ross Sea stock is above the soft limit and long term target (50% B0) and the fishery is still thought to be in the 'fish-down' phase. The stock is assessed to be well above the target biomass level and the catch limits in force are thought to be sustainable in the long term.

However, MFish then state that the CPUE and catch-at-age data are relatively short time series, and are therefore not reliable for determining current or initial stock size. Thus for these 2009 assessments, the tag-recapture data provide the best information on stock size, but the total number of fish recaptured in both areas is small and this may be introducing bias into the model (Ministry of Fisheries, 2009c). Other sources of uncertainty include estimates of natural mortality rate, stock structure and the size and variability of year classes.

MFish conclude that although the absolute stock size is uncertain, the available evidence (tag recapture data, catch rates, length frequency data)[15] suggests that the stock has been lightly exploited to date.[16] MFish state that the other sources of human-induced mortality are insignificant. These include a small quantity of toothfish that is taken for scientific research purposes in most years and a minor amount of depredation due to large squid, cetaceans, and pinnipeds.[17] No discards have been reported to date (observers monitor discards, with at least 40% of all hooks hauled being directly observed) and based on aerial surveillance and other sources of intelligence, the level of illegal, unregulated and unreported (IUU) catch is thought to be low in the Ross Sea fishery (refer to the estimates in Table 1).

Ice conditions are also an important factor in the fishery (Ministry of Fisheries, 2009c). In 2002/03, 2003/04 and 2007/08 heavy ice conditions meant little catch was taken in SSRUs 88.1J–L. It is unknown how significant this unscheduled closure of the fishery is for ensuring long-term sustainability but is certainly positive for local toothfish populations.

The catch limits imposed by CCAMLR are inconsistent with Ngai Tahu tikanga, as '<u>fishing a fishery down</u>' to B_{MSY} or even 50% of B_0 is incompatible with a tikanga approach. Notwithstanding these comments, all commercial fisheries are fished harder than the Tangata Tiaki/Kaitiaki would allow. In reality it is difficult to compare toothfish catch limits to the tikanga-based approach as this is now

[15] Although these last two data sets may result from serial depletion within SSRU.
[16] This is supported by D. Ainley (Friends of the Ross Sea Ecosystem, personal communication – public lecture, 8 November 2009.)
[17] Unlike the Patagonian toothfish fishery (Kock, Purves and Duhamel, 2006).

strictly non-commercial (managed for sustenance and mana) and the toothfish fishery is managed purely for profit.

It is therefore useful (and appropriate), when looking at catch limits, to bring international best practise into the assessment. Based on the above data that indicates the fishery has been lightly exploited to date and factoring in the target to manage the fishery above B_{MSY}, this fishery would most likely comply with the relevant best practise guidelines set by the FAO as well as the relevant provisions of the Fisheries Act 1996, UNCLOS, and the relevant principle set by the MSC.[18]

Incidentally, certain toothfish operators are currently seeking MSC certification. ASOC support MSC certification in order to further incentivise sustainable fishing practises and to encourage independent auditing of CCAMLR's performance (D. Martin, ASOC member, personal communications, 24 November 2009).

What else could be done to improve management? The Antarctic Southern Ocean Coalition suggest that much greater effort needs to be put into monitoring the impacts of climate change and that these impacts should be reflected in the precautionary approach taken by CCAMLR (Antarctic Southern Ocean Coalition, 2009f). For example, changes to the Antarctic Circumpolar Current (or the Ross Sea Gyre) may lead to significant changes to toothfish larvae distribution patterns. CCAMLR have acknowledged the need for better science in this area (Resolution 30/XXVIII), initiating programs such as *Integrating Climate and Ecosystem Dynamics* and conservation measures such as 91-01 (2004) – CCAMLR Ecosystem Monitoring Program sites (CEMP sites) (Agnew, 1997).

There have also been discussions within CCAMLR about introducing yearly individual vessel limits to improve fishing techniques (as operators do not have to rush their fishing activities with the move away from the competitive environment of the Olympic-style fishery to the certainty of set individual limits – I. Jamieson, Fisheries Advisor – Ministry of Fisheries, personal communication, 12 January 2010).

3.1.4 Findings

The catch limits set for the Ross Sea toothfish fishery by CCAMLR are inconsistent with Ngai Tahu tikanga. However, it is most likely that this fishery would comply with the best international practises advocated by fisheries management standard-setting bodies such as the FAO and the MSC and with the international obligations set by UNCLOS.

As such the long-term sustainability of the toothfish fishery, from the assessment of catch limits, is uncertain. More research is required to better determine stock

[18] Principle 1: A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations.

status (from the additional CPUE, length frequency, catch-at-age and the tag-recapture data that will be available over time), as the catch rates and length frequency data that have been used to determine the fishery has only been lightly exploited, may in fact be evidence of serial depletion within SSRU.

3.2 Size limits

3.2.1 Ngai Tahu tikanga

Size limit tikanga is species specific. Detailed tikanga regarding size limits was generally developed around nearshore species as these were more accessible and available in abundance. Specialist customs were developed to target certain-sized individuals in order to maintain the fishery in question and to provide the quality of catch that was desired. For certain species (eg, paua and crayfish) Ngai Tahu tend to harvest the smaller, more succulent juvenile individuals – avoiding the big breeding individuals, whereas for other species (eg, cockles and eels) larger individuals are targeted.

Traditionally, Ngai Tahu would generally target larger individuals of finfish (especially offshore species), during the summer months, as these fish were mostly smoked (or preserved in some other fashion) for winter consumption when open-coast fisheries were not as accessible. Over-time Ngai Tahu learnt which areas could be relied upon to provide suitable sized fish and which areas were to be avoided as these were occupied by juveniles. The traditional offshore grounds (known as tauranga ika) where middle-depth or deepwater species were targeted by Ngai Tahu were marked using prominent peaks in the Southern Alps.

The size limit tikanga for offshore, middle-depth / deepwater species is the most suitable for use in assessing the toothfish fishery.

3.2.2 CCAMLR conservation measures

No size limits are set by CCAMLR. Spatial closures used to avoid juveniles are discussed below.

3.2.3 Discussion

As stated above, the age and length at recruitment to the fishery varies between areas and between years. In some areas toothfish recruit to the fishery at a length of about 130cm at 7-10 years of age, whereas the estimates of maturity suggest the mean age and length at 50% spawning for females on the Ross Sea slope region were 16.6y and 133.2cm and 12.8y and 120.4cm for male (Ministry of Fisheries, 2009c).

This means that many fish will be taken before they have had a chance to breed. This management would not be inconsistent with Ngai Tahu tikanga if the

quantities taken were more in line with those authorised by Tangata Tiaki/Kaitiaki. However, the lack of size limit combined with the 'fish-down' of the fishery is certainly inconsistent.

Again, it is therefore useful to bring international best practise and obligations into the assessment when looking at size limits. Even though most juveniles reside in areas outside of the fishing grounds, it is uncertain whether fishing with no size limits would comply with the relevant best practise guidelines set by the FAO as well as the relevant provisions of the Fisheries Act 1996, UNCLOS, and the relevant principle set by the MSC (Principle 1).

UNCLOS requires States to actively take measures to maintain healthy populations. Setting a lower size limit for this fishery is a simple, effective measure to help protect the breeding population (spawning biomass). A minimum legal size limit could be implemented easily in this fishery (given that many individuals are already tagged and released). Such a move could improve the yield per recruit also so that fewer individuals would need to be harvested to obtain the catch limits set by CCAMLR (decreasing fuel costs and associated carbon emissions).

Setting a minimum legal size to encourage breeding success is entirely consistent with the precautionary approach advocated by CCAMLR and it is a sensible and pragmatic method to mitigate the possible impacts of climate change (ASOC, 2009c).

3.2.4 Findings

The lack of size limits for the Ross Sea toothfish fishery are inconsistent with Ngai Tahu tikanga (when combined with the catch limits set by CCAMLR), and it is uncertain whether fishing with no size limits would comply with the best international practises advocated by fisheries management standard-setting bodies such as the FAO and the MSC and with the international obligations set by UNCLOS.

To adopt a truly precautionary approach, CCAMLR should set a minimum legal size limit of at least 150cm for females and 140cm for males based on the length at maturity estimates.

3.3 Seasonal or spatial closures to protect toothfish stocks

3.3.1 Ngai Tahu tikanga

Rahui (seasonal or spatial closures) were extensively used traditionally to protect juvenile habitat and spawning grounds or to protect populations during their spawning seasons. Many of these rahui are still used today – but usually in the

form of fisheries regulations (eg, the closure of the Bluff oyster fishery during spawning season or the prohibition on harvesting berried crayfish).

3.3.2 CCAMLR conservation measures

The toothfish fishery has a distinct season (the season is scheduled to commence on 1 December each year – eg, Conservation Measure 41-09 (2009)).

CCAMLR has put in place a number of spatial closures that will contribute to the conservation of toothfish stocks, including:

- The prohibition on fishing for toothfish in depths shallower than 550m (Conservation Measure 22-08 (2009)).
- The prohibition on fishing for finfish in Subarea 48.1 (Conservation Measure 32-02 (1998)) and Subarea 48.2 (Conservation Measure 32-03 (1998)) pending stock biomass surveys;
- Prohibition on fishing for toothfish in Subarea 58.4.4 (Conservation Measure 32-10 (2002)) and Subarea 88.3 (Conservation Measure 32-16 (2003) and Subarea 88.2 north of 65^0 South pending toothfish biomass surveys;
- Prohibition on fishing for toothfish within 10 nautical miles of the Balleny Islands (Conservation Measure 41-09 (2009));
- Closure of a significant number of Subareas such as 58.4.1A, 88.1A, 88.2A, 88.2B, using Conservation Measure 32-09 (2009).

3.3.3 Discussion

The toothfish season set by CCAMLR is primarily for accessibility reasons (access to the Ross Sea polynya fishing grounds through the sea ice barrier), rather than as a sustainability measure designed to protect juvenile or breeding toothfish. The loss of ice cover with global warming may impact significantly on access to the fishery. Although this may not be a concern for the legal fleet (which is bound by the total catch limits set by CCAMLR), this could well increase IUU fishing in the Ross Sea especially.

However, CCAMLR have made extensive and effective use of spatial closures to protect toothfish stocks. The prohibition on fishing for toothfish in depths shallower than 550m is potentially the most significant of the closures, as this will contribute to the conservation of the brood stock of juveniles and young adults living in coastal waters.

Coupled with the formal closures, a voluntary closure on fishing in areas >2000m is also observed by the toothfish fleet (mostly because it is impracticable to longline beyond this depth).

These measures are consistent with the precautionary, tikanga-based approach employed by Ngai Tahu. However, they are merely the start of what a tikanga-based rahui regime would consist of. For example, further protection is required over the toothfish spawning areas on the seamounts to the north of the main fishing grounds in the Ross Sea (possibly through the establishment of MPA – this is discussed further below). These measures are also consistent with the best international practises advocated by fisheries management standard-setting bodies such as the FAO and the MSC and with the international obligations set by UNCLOS.

3.3.4 Findings

CCAMLR have made effective and extensive use of spatial closures to protect toothfish stocks. These measures are consistent with the precautionary, tikanga-based approach employed by Ngai Tahu. However, further spatial closures are required, especially over the seamounts where toothfish spawn.

3.4 Protection of important habitats

3.4.1 Ngai Tahu tikanga

Ngai Tahu believe that fisheries habitat must be protected in order to ensure that the life-supporting capability of the fishery is maintained – all fisheries habitat is important. Traditionally, Ngai Tahu extensively employed rahui (temporary spatial closures) to protect fisheries habitat (especially juvenile habitat and spawning grounds).

The rahui were constantly monitored and assessed by the kaitiaki and they would be removed once the threats or risks to the area were overcome or they had ceased. Rahui were never established permanently as there was no need given the constant management undertaken by the kaitiaki. In other words, rahui were not employed as a lock-up and walk away mechanism.

Rahui are still employed today by Tangata Tiaki/Kaitiaki, but very rarely are these rahui observed by non-tribal members. Rahui equivalents (using fisheries regulations) are employed in many parts of the Ngai Tahu tribal area (such as in the benthic protection areas established over important seamounts). Marine reserves are also established in many parts of the tribal area, however, the permanent nature of these closures means that this mechanism is not supported by the tribe in areas of importance for customary fishing.

3.4.2 CCAMLR conservation measures

General protection

CCAMLR has put in place a number of general and spatial conservation measures that will contribute to the protection of fisheries habitat, including:

- The prohibition of bottom trawling in the high seas areas of the Convention Area (Conservation Measure 22-05 (2008));
- The assessment (environmental impact assessments) of all proposed bottom fishing activities[19] by the Scientific Committee in order to protect known vulnerable marine areas (VME – which include seamounts, hydrothermal vents, cold water corals and sponge fields) (Conservation Measure 22-06 (2009));
- The compilation of a list of vessels who are authorised to undertake bottom fishing activities (Conservation Measure 22-06 (2009));
- The requirements to cease fishing, to establish a 'risk area' and to notify the CCAMLR Secretariat when evidence of new VME is encountered (through the fishing of the prescribed amount of VME indicator organisms) so that appropriate conservation measures can be adopted by CCAMLR before any fishing may recommence (Conservation Measure 22-06 (2009) and Conservation Measure 22-07 (2009));[20]
- The prohibition on fishing for toothfish in depths shallower than 550m (Conservation Measure 22-08 (2009)).
- Prohibition on fishing for toothfish within 10 nautical miles of the Balleny Islands (Conservation Measure 41-09 (2009));
- Closure of a significant number of Subareas such as 58.4.1A, 88.1A, 88.2A, 88.2B, using Conservation Measure 32-09 (2009).

Current MPA / Marine ASPA

CCAMLR has put in place a MPA over the South Orkney Islands southern shelf (Conservation Measure 91-03 (2009)).

The ATCM have also established a number of ASPA that have marine components (for example, Rookery Islands (ASPA 102), Southern Powell Islands (ASPA 111) and Northern Coronation Island (ASPA 114)) although the areas

[19] In accordance with New Zealand's obligations under UNCLOS and the Environmental Protocol.
[20] These conservation measures are consistent with Resolution 105 of the 61st Meeting of the General Assembly, which calls upon regional fisheries management organisations (such as CCAMLR) to identify vulnerable marine ecosystems (VME) and to close these areas to 'bottom fishing' (bottom trawling but possibly bottom longlining also – I. Jamieson, Fisheries Advisor – Ministry of Fisheries, personal communication, 12 January 2010) and not allow these activities to proceed unless conservation measures have been put in place to prevent significant adverse impacts (Commission for the Conservation of Antarctic Marine Living Resources, 2009; United Nations General Assembly, 2007).

covered are all coastal nearshore habitat, no open-ocean ASPA have been established.

3.4.3 Discussion

The general and spatial conservation measures that have been adopted by CCAMLR are all consistent with the precautionary, tikanga-based approach employed by Ngai Tahu. However, they are merely the start of what a tikanga-based rahui regime would consist of. For example, further protection is required over the toothfish spawning areas and MFish state that CCAMLR need to conduct research into the effects of longlining on benthic habitat to ensure compliance with the UN Resolution 61/105[21] (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010), and the NZ IPY-CAML Project identified a number of different habitat types that were vulnerable to the effects of longline fishing (Ministry of Fisheries 2009b), so despite the ban on bottom trawling, there is still a need for urgent action to further protect fisheries habitat.

The MPA and ASPA that have been established are also consistent with Ngai Tahu tikanga as they do not occur in areas important for customary fishing – many more MPA/ASPA could be established to protect fisheries habitat, while sustaining an economically viable toothfish fishery (Earle, 2005; Grant, 2005).[22]

Despite the guidance provided by the Committee for Environmental Protection, ATCM and CCAMLR (and the requirements set out in Article 3(2) of Annex V of the Protocol for Parties to use a systematic framework approach to identify and establish a network of ASPA over representative examples of major marine ecosystems), only a handful of MPA and marine ASPA are currently in place. These protected areas form the mere beginnings of a representative network of protected marine habitats and ecosystems. Far more MPA/ASPA are required to achieve the appropriate level of protection necessitated by Article 3(2).

In recent years CCAMLR has taken a number of steps to develop a systematic approach to establishing MPA. Since 2005 CCAMLR has been working on the development of a marine environmental classification system as the framework to co-ordinate the identification and establishment of MPA south of the Antarctic Convergence (Commission for the Conservation of Antarctic Marine Living Resources, 2005). A number of workshops have been held to gather and assess the best available physical and biological data on the Southern Ocean to identify

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[21] This will ensure compliance with MSC Operational Criteria 13 also.

[22] These general and spatial conservation measures (including the MPA and ASPA) are also consistent with the types of best international practises advocated by fisheries management standard-setting bodies such as the FAO and the MSC and with the international obligations set by UNCLOS but it is uncertain whether that they would be sufficient to ensure compliance (Scovazzi, 2004).

broad biogeographic regions south of the Antarctica Convergence. This work has been termed ‘bioregionalisation’.

The Bioregionalisation Workshop in 2007 agreed on a set of bioregions that were identified from an analysis of a number of Southern Ocean characteristics including depth, sea surface temperature, silicate concentration, nitrate concentration, surface chlorophyll-a and ice concentration. The highest heterogeneous areas were then identified by the Workshop as the priority regions for identifying MPA to conserve key fisheries areas in the Southern Ocean from overexploitation and to establish a comprehensive and representative network of marine protection. Two of the eleven priority areas identified are within the Ross Sea region (Commission for the Conservation of Antarctic Marine Living Resources, 2008).

The NZ IPY-CAML Project identified the biodiversity associated with a number of different habitat types in the two priority areas in the Ross Sea (Ministry of Fisheries, 2009b). New Zealand is therefore well placed to finalise the fine-scale classification of the two priority areas identified by CCAMLR in the Ross Sea region and then identify MPA proposals to be tabled with CCAMLR in the near future.[23]

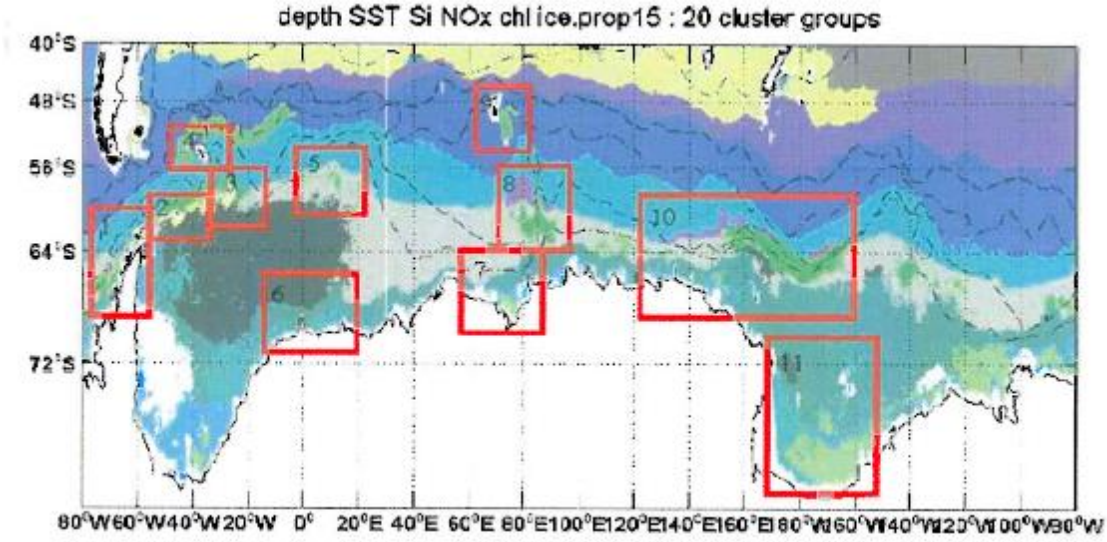

Figure 6. Southern Ocean Bioregionalisation with CCAMLR priority areas identified.

The New Zealand Ross Sea Strategy, developed in 2006, requires the Ross to be managed using a mix of CCAMLR and MPA-type principles. Sizeable MPA can be established in the Ross Sea with very limited impact on existing (or potential) fishing operations. For example, all areas in the Ross shallower than

[23] The progress to date for the Ross Sea area was tabled with CCAMLR, in November 2009, as an Information Paper. It is hoped that the MPA proposals for the Ross Sea will be tabled with CCAMLR in October 2010 (which will include protection around the Balleny Islands – Trevor Hughes, Ministry of Foreign Affairs and Trade, personal communication, 15 December 2009).

550m, areas deeper than 2000m and the marine area within 10 nautical miles of the Balleny Islands could be protected with no impact at all on fishers.

New Zealand needs to proceed immediately with establishing MPA in the Ross Sea as, in terms of human-induced impacts, this area is one of the least affected areas of the world's oceans. The scientific values of the Ross Sea are therefore immense and worthy of immediate protection (Ainley, 2009; Allsopp, Page, Johnston & Santillo, 2009; Antarctic and Southern Ocean Coalition, 2009b; Antarctic and Southern Ocean Coalition, 2009e; Halpern et al., 2008; Last Ocean Charitable Trust, 2009).

To assist further, CCAMLR should set minimum protection standards/guidelines for the protection of MPA – much like those that have been written for MPA around New Zealand (Ministry of Fisheries and Department of Conservation, 2008). For example, this could mean that some fishing may be allowed within a MPA, provided the level of fishing was appropriately restricted to meet the desired standard or level of protection.[24]

It is important too that CCAMLR follow similar network design and planning principles, for establishing their MPA network, to those developed by the Department of Conservation and ASOC outlined above in sections 2.3.3 and 2.3.5 of this paper. In addition to these principles it is important that MPA boundaries are amendable in response to new information – especially as the impacts of climate change become more evident (Lombard et al., 2007).

3.4.4 Findings

The general and spatial conservation measures (including the MPA and the marine ASPA) that have been adopted by CCAMLR to protect important fisheries habitat are all consistent with the precautionary, tikanga-based approach employed by Ngai Tahu. However, they are merely the start of what a precautionary, tikanga-based rahui regime would consist of in order to ensure the long-term sustainability of the toothfish fishery.

Therefore, CCAMLR must proceed immediately with the establishment of a network of MPA that is comprehensive and representative of the full range of habitats and ecosystems in the Convention Area. This network of MPA must include extensive areas of the Ross Sea (given its scientific value), in particular, the toothfish spawning grounds on the seamounts to the north of the main fishing grounds.

[24] This may require an increase in surveillance operations to combat IUU fishing activity. IUU fishing is already renowned for the damage it causes to fisheries habitat.

3.5 Protection of associated and dependant species

3.5.1 Ngai Tahu tikanga

Kaitiakitanga is a holistic, ecosystem-based approach to managing natural resources. Natural population and ecosystem dynamics (predator-prey relationships etc) are maintained primarily through the harvesting rates that are authorised under the tikanga-based regime employed by Tangata Tiaki/Kaitiaki (where the populations of all species in the fishery are effectively perpetuated at a stable 'virgin' biomass – B_0).

As well as protecting the full range of important mahinga kai species, Ngai Tahu believe that associated and dependant species (in particular marine mammals and seabirds) must also be protected. In many cases species of marine mammals or seabirds are thought to act as kaitiaki (guardians) over the people (especially when fishing). A good example of this are the pahu (Hector's dolphins) that are thought to keep a protective eye over the Ngai Tahu fishers of Otago. It is inconsistent with Ngai Tahu tikanga to use bulk harvesting methods that catch marine mammals and seabirds.

3.5.2 CCAMLR conservation measures

Bycatch

CCAMLR has put in place a number of measures in an attempt to avoid bycatch of non-target species, including:

- The prohibition of gillnetting (Conservation Measure 22-04 (2006));
- Resolution 7/IX on driftnet fishing;
- The prohibition of bottom trawling in the high seas areas of the Convention Area (Conservation Measure 22-05 (2008));
- Resolution 22/XXV on actions to reduce seabird mortality
- The employment of specified longline weighting to ensure sufficient sink rates to minimise seabird bycatch (Conservation Measure 24-02 (2008) and (Conservation Measure 25-02 (2009));
- Longlines are set at night (Conservation Measure 25-02 (2009));
- The dumping of offal and discards is prohibited while lines are being set (Conservation Measure 25-02 (2009));
- A streamer must be deployed during longline setting to deter birds from approaching the hookline (Conservation Measure 25-02 (2009));
- A bird exclusion device must be employed to discourage birds from accessing baits during hauling (Conservation Measure 25-02 (2009));

CCAMLR has also put in place a number of measures to minimise the bycatch of non-target species (Conservation Measure 33-03 (2009)), including:

- Catch limits are set for key bycatch species at a SSRU level proportional to the toothfish limits based on the following rules:
    - Skates and rays 5% of toothfish catch or 50t per SSRU (whichever is higher);
    - Rattails 16% of toothfish catch or 20t per SSRU (whichever is higher);
    - All other species combined 20t per SSRU;
- If these limits are reached the toothfish fishery closes in those SSRU;
- Vessels should release skates and rays alive where possible;
- A 'move-on' rule applies (and the vessel is required to move at least 5 nautical miles away and not return to that area for at least five days) if the bycatch of any species is equal to or greater than 1 tonne for any one set.

Ecosystem approach

In addition to the measures outlined above and the measures outlined in section 3.4.2 of this paper, the target reduction in biomass of 50% B_0 over 35 years (rather than B_{MSY}) is the key conservation measure employed by CCAMLR to adopt a precautionary, ecosystem approach.

3.5.3 Discussion

Bycatch

No New Zealand vessel has ever caught a seabird in this fishery and seabirds have not been caught in the toothfish fishery by any vessel in the last nine years with the exception of one Southern giant petrel (*Macronectes giganteus*) caught in 2003/04.[25]

Illegal Unregulated Unreported (IUU) fishing however is seen as a serious problem as it kills many seabirds and marine mammals through the employment of destructive, bulk harvesting methodologies that are used without bycatch mitigation measures. CCAMLR estimates that thousands of seabirds were killed the Southern Ocean in 2007/08 from IUU fishing (Kock, 2001).

The main species of fish bycatch in the Ross Sea fishery include Whitson's rattail (from 4-16% of total catch by weight from 1997/98 to 2008/09) and skates (now approximately 1% of catch). Skates once constituted approximately 10% of the total toothfish catch by weight but this was reduced with the initiation of a tag and release programme (Conservation Measure 41-01 (2009)) and the release of untagged skate that are likely to survive since the beginning of the 2000/01

[25] There is a high degree of certainty in this estimate given the high level of observer coverage (100% of vessels are covered by two observers and greater than 40% of all hooks hauled are directly observed).

season.[26] Icefish and various species of cod make a further 1% of total catch (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010).

The rattail bycatch limits for 2008/09 were derived from the rattail population estimates conducted within the NZ IPY-CAML Project trawl survey.

The bycatch (both fish and non-fish) from the permitted fleet is consistent with Ngai Tahu tikanga and this level of bycatch would most likely comply with the relevant best practise guidelines set by the FAO as well as the relevant provisions of the Fisheries Act 1996, UNCLOS, and the relevant principle set by the MSC.[27]

Ecosystem impacts

Toothfish are both predator and prey so reducing their numbers could affect Ross Sea food webs in both directions (DeVries, Ainley & Ballard, 2008). The ecosystem effects of toothfish fishing on associated and dependant species is not well understood at this time as this ecosystem itself (and therefore the impacts on it) is not well understood.

CCAMLR have acknowledged the need for better science (Resolution 30/XXVIII), initiating programs such as *Integrating Climate and Ecosystem Dynamics* and conservation measures such as 91-01 (2004) – CCAMLR Ecosystem Monitoring Program sites (CEMP sites) (Constable, 2002).

Developing a better understanding of the Ross Sea ecosystem was a key driver for the NZ IPY-CAML Project. This project highlighted the biodiversity across three major habitat zones in the Ross Sea:

(a) Ross Sea Shelf – shallow coastal waters;

(b) Ross Sea continental slope – the outer edge of the Ross Sea Shelf where the toothfish fishery operates; and

(c) Seamounts and abyssal plains north of the Ross Sea – near Scott Island and the Admiralty Seamounts.

The Project was able to estimate the abundance of several bycatch species (rattails and skates) for the first time and the abundance of Antarctic silverfish was also estimated from acoustic data. The project looked at the role of certain

[26] A proportion of the tagged skate have been recaptured demonstrating survivability of released individuals (Ministry of Fisheries, 2009c).

[27] Principle 2: Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

organisms in the Ross Sea ecosystem as well. This data is being used within the trophic model of the Ross Sea, which is being developed by NIWA, to determine the role of Antarctic toothfish in this ecosystem and what the impacts will be on this ecosystem with the reduction in toothfish numbers (La Mesa, Eastman & Vacchi, 2004; Ministry of Fisheries, 2009b; Ministry of Fisheries, 2009c). These impacts may be:

(a) Direct (first-order – one trophic level away from the target species) such as reducing the food available to its predators (Weddell seals etc). Many shore-based studies have been carried out on Weddell seals but the potential impacts of reducing toothfish numbers are still not well understood. There has been very little work done regarding the potential impacts on Orca and Sperm whales. Based on observations from field scientists in McMurdo Sound, stomach contents, vomit and scats analysis and stable isotopes of carbon and nitrogen, NIWA believe it unlikely that toothfish would make up a significant component of the diet of these marine mammals (Ministry of Fisheries, 2009c) but they may be important to certain populations in particular locations at certain times of the year as noted in Ainley and Siniff (2009); DeVries, Ainley and Ballard (2008) and Ponganis and Stockard (2007).[28] These impacts remain to be explored (Pinkerton, Hanchet & Bradford-Grieve, 2007); or

(b) Indirect (second-order), such as trophic cascades[29] and keystone predator effect. A trophic cascade occurs when a decrease in predator numbers leads to an increase in its prey which in turn then places increased pressure on the species they prey upon.[30] A keystone predator maintains the biodiversity of an ecosystem by preferentially preying upon certain species which, if allowed to increase with a reduction in predation, would completely exclude their subordinate competitors (Pinkerton, Hanchet & Bradford-Grieve, 2007).

The indirect impacts in particular, are extremely difficult to predict and/or detect (Ainley, Ballard & Dugger, 2006; Ainley, Ballard & Olmastroni, 2009; Baum & Worm, 2009; Fenwick & Bradford-Grieve, 2002; Heithaus, Frid, Wirsing & Worm, 2008). However, it is known that any flow-on impact on silverfish could adversely affect the entire Antarctic ecosystem[31] given the importance of this species as a 'bottomfeeder' on primary producers and as a food source to so many predators (including penguins, seals, whales and demersal fish) – thus linking the two

[28] NIWA note that it may be the juvenile or young adult toothfish (>95% of toothfish <100cm have not recruited into the fishery) that are key prey in these feeding relationships.
[29] N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010.
[30] The NIWA trophic model has suggested that toothfish may consume 70% of the production of demersal species so the reduction in the toothfish population may have a very significant impact on the survival of these species (which may be partly offset by the increase in fishing mortality as bycatch).
[31] Similar to the impacts of krill fishing (Antarctic Southern Ocean Coalition, 2009g; Falk-Petersen, Hagen, Kattner, Clarke & Sargent, 2000).

opposite ends of the food web (La Mesa, Eastman & Vacchi, 2004). However, it has been demonstrated in other parts of the Southern Ocean that heavy fishing has led to declines in seabird and marine mammal populations (Ainley & Blight, 2008).

In the latest stock assessment report for toothfish in the Ross Sea, MFish concludes: *"at present the effects of the toothfish fishery on ecosystem relationships in the Ross Sea region cannot be predicted. There is a need to establish appropriate monitoring in the Ross Sea to ascertain how species and ecological relationships are affected by the fishery. Monitoring should focus on species most likely to be affected by the toothfish fishery in the first instance."*

NIWA and MFish state that more research is needed on the populations of silverfish and key (small and medium) demersal fish before we can begin to better understand the ecosystems effects of toothfish fishing and reduce the potential for trophic cascades (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010).

Therefore the CCAMLR approach cannot be said to be a truly 'precautionary' if the impacts of toothfish fishing on the Antarctic marine ecosystem are not known with any degree of certainty. This is certainly inconsistent with the precautionary, tikanga-based approach employed by Ngai Tahu (as there is virtually no potential for trophic cascades under customary management) and it is uncertain whether such a regime would comply with the relevant best practise guidelines set by the FAO as well as the relevant provisions of UNCLOS, or the relevant principle set by the MSC.[32]

3.5.4 Findings

The bycatch from the permitted fleet is consistent with Ngai Tahu tikanga and so this component of the fishery in well managed in a precautionary, long-term manner. However, at present the effects of the toothfish fishery on ecosystem relationships in the Ross Sea region are not well known and thus the effectiveness of CCAMLR management is uncertain.

Therefore the CCAMLR approach cannot be said to be a truly 'precautionary'. It is certainly inconsistent with the precautionary, tikanga-based approach employed by Ngai Tahu and it is uncertain whether such a regime would comply with the relevant best practise guidelines set by the FAO as well as the relevant provisions of UNCLOS, or the relevant principle set by the MSC.

As such the long-term sustainability of the toothfish fishery, from the assessment ecosystem effects, is uncertain. More research is needed on the populations of

[32] Principle 2: Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

silverfish and small and medium demersal fish before CCAMLR can begin to better understand the ecosystems effects of toothfish fishing and reduce the potential for trophic cascades.

3.6 Compliance and enforcement

3.6.1 Ngai Tahu tikanga

The primary role of kaitiaki in traditional times was to establishment sustainability measures. The secondary role was to enforce these rules (often rahui) as compliance was seen as an essential part of sustainable fisheries management. The penalties for breaching the rules in traditional times were severe (including the confiscation of possessions or the death penalty) so compliance tended to be good.

Today many Tangata Tiaki/Kaitiaki (who establishment the customary fishing measures) also hold warrants as Honorary Fishery Officers (enforcing fisheries regulations). Compliance in the contemporary setting tends to be good also as generally most tribal members have a strong environmental ethic (which flows from their knowledge of whakapapa to the resource) and it is still seen as an essential component of long-term sustainability.

3.6.2 CCAMLR conservation measures

CCAMLR has put in place a number of compliance measures, including:

- Permitted access into the fishery[33] (Conservation Measure 32-09 (2009));
- Licensing and inspection obligations (Conservation Measure 10-02 (2008));
- Port inspections of vessels carrying toothfish (Conservation Measure 10-03 (2009));
- Automated satellite-linked Vessel Monitoring System (VMS) (Conservation Measure 10-04 (2007)). The VMS automatically transmits the vessels position, via satellite, every four hours.
- Reporting requirements (as outlined in section 3.1.2 of this paper);
- In accordance with Article XXI of the Convention (and Conservation Measure 10-06 (2008)), each Contracting Party is to take appropriate measures to ensure their fishers comply with the objective of the Convention and with conservation measures and each Party is to notify CCAMLR of the measures taken (including any enforcement measures for non-compliance);
- The CCAMLR Catch Documentation Scheme (CDS)[34] (Conservation Measure 10-05 (2009) and Resolution 14/XIX) is compulsory. This scheme is an origin certification system designed to track landings and trade flows of

[33] Through the Antarctic Marine Living Resources Act 1981 for New Zealand vessels.
[34] Implemented in New Zealand through the Fisheries (Toothfish Catch Documentation Scheme) Regulations 2000 and Customs Export and Import Orders.

toothfish that have been caught in the CCAMLR area. Each catch of toothfish must be accompanied by a valid catch document that indicates compliance with CCAMLR conservation measures. All landings, imports and exports of toothfish to and from New Zealand must be accompanied by a valid catch document;

- Resolution 15/XXII on the use of ports not implementing the CDS;
- Resolution 16/XIX on the application of VMS in the CDS;
- Each Contracting Party to the Convention is required to carry out surveillance against illegal, unreported and unregulated (IUU) fishing in the CCAMLR area and to monitor licensed vessels' compliance with CCAMLR conservation measures. Under the CCAMLR System of observation and inspection (Article VVIV and Conservation Measure 10-02 (2008)), New Zealand designates inspectors and carries out Southern Ocean and Ross Sea surveillance under "Operation Mawsoni" (refer to Figure 5 above).
- New Zealand fishing vessels are required to carry both New Zealand and international observers (eg, Conservation Measure 41-01 (2009) and Conservation Measure 41-09 (2009)). MFish believes that this may be the most observed fishery in the world (I. Jamieson, Fisheries Advisor – Ministry of Fisheries, personal communication, 12 January 2010). Observers also monitor and record sightings of other fishing vessels.
- Resolution 19/XXI on flags non-compliance;
- Resolution 25/XXV on combating IUU in the Convention Area;
- CCAMLR compiles a list of IUU vessels that are then prohibited from participating in any CCAMLR fishing in future (Conservation Measure 10-07 (2009));
- Article X of CCAMLR, requires the Commission to draw the attention of any State which is not a Party (Conservation Measure 10-06 (2008)) or a Contracting Party (Conservation Measure 10-07 (2009)) to any activity undertaken by its nationals which affect the implementation of the Convention.

3.6.3 Discussion

Illegal unregulated unreported fishing is broadly defined as any fishing activity that contravenes CCAMLR's conservation and management rules. This IUU fishing is seen as a serious problem in the Southern Ocean (nearly 50% of the toothfish vessels listed on the COLTO website are 'pirate' IUU vessels – Coalition of Legal Toothfish Operators, 2009) as it impacts on targeted fishstock populations, it damages fisheries habitat and kills many seabirds and marine mammals through the employment of destructive, bulk harvesting methodologies that are used without bycatch mitigation measures[35] (T. Hughes, Antarctic Policy

[35] An example is the recent discovery of a 130km gillnet that had 30t of toothfish and 30t of bycatch in it (D. Ainley, Friends of the Ross Sea Ecosystem, personal communication – public lecture, 8 November 2009).

Unit – Ministry of Foreign Affairs and Trade, personal communication, 15 December 2009; Kock, 2001).

CCAMLR estimates that more than 1750 tonne of toothfish was illegally taken from the Southern Ocean in 2007/08 whereas others believe this figure is far higher – perhaps five times the legal catch limit (Agnew, 2000; D. Martin, ASOC member personal communication, 24 November 2009. This is occurring mainly in the South Atlantic (McKinlay, Welsford, Constable & Nowara, 2008) and IUU fishing in the Ross Sea is thought (based on aerial surveillance and other sources of intelligence) to be light at this stage (approximately 5% of legal catch levels – refer to Table 1 above) due to the weather constraints and the legitimate operators assisting with compliance. However, this is predicted to increase as toothfish stocks in other areas of the Southern Ocean decline in response to IUU fishing pressure and due to the predicted loss of ice cover allowing greater access to the Ross Sea polynya (Halpern et al., 2008; I. Jamieson, Fisheries Advisor – Ministry of Fisheries, personal communication, 12 January 2010).

Toothfish are often marketed as Mero, Chilean Sea Bass and Black Hake – in some cases by IUU operators to avoid detection (Coalition of Legal Toothfish Operators, 2009). The worst States for facilitating and/or accepting IUU fish are generally non-parties to CCAMLR, such as Indonesia, Malaysia, Hong Kong and Singapore, or vessels operating under flags of convenience.

This is the main form of recourse used by Party States and CCAMLR is to put diplomatic pressure (in accordance with Article X) on States that support IUU operations. ASOC state that stronger compliance and diplomatic efforts are required to combat IUU fishing (Antarctic Southern Ocean Coalition, 2009a; Antarctic Southern Ocean Coalition, 2009c)

There have been discussions within CCAMLR about introducing yearly individual vessel limits. This may incentivise compliance as the greater certainty that comes with individual entitlements may spur the legal fleet to assist the flag States with their compliance and enforcement operations in the fishery. COLTO advocates for greater industry involvement to limit IUU fishing activity (Coalition of Legal Toothfish Operators, 2009). A. Russ stated that tourism operators were also willing to assist with compliance observations (Heritage Expeditions, personal communication, 19 November 2009).

Some believe that reducing IUU fishing is best done through ports (preventing the fish from being landed) or markets (preventing black market products from being sold) (N. Smith, Fisheries Scientist – Ministry of Fisheries, personal communication, 12 January 2010; Sovacool & Siman-Sovacool, 2007).

The compliance measures established by CCAMLR are consistent with the tikanga-based approach employed by Ngai Tahu and it is most likely that these measures would comply with the relevant best practise guidelines set by the

FAO, the principles set by the MSC as well as the relevant provisions of UNCLOS. However, the level of compliance generally (by non-permitted vessels) for the Southern Ocean (including the Ross Sea) is not. The impacts on targeted fishstock populations, fisheries habitat and the bycatch of seabirds and marine mammals from IUU operations need to be addressed.

Compliance levels for permitted vessels are generally acceptable so any increased compliance efforts should focus on surveillance and inspection operations targeted at IUU vessels.

3.6.4 Findings

The level of IUU fishing currently occurring in the Southern Ocean (including the Ross Sea) is inconsistent with Ngai Tahu tikanga due to the impacts on targeted fishstock populations, fisheries habitat and the bycatch of seabirds and marine mammals. This level of IUU fishing needs to be addressed if the toothfish fishery is to have a long-term future.

IUU fishing is likely to increase in future (especially in the Ross Sea as other parts of the Southern Ocean are depleted).

Increased surveillance and inspection efforts are therefore required, especially with the new conservation measures proposed in this paper (minimum size limits, the increased use of spatial closures and the establishment of a representative network of MPA).

3.7 Environmental health

3.7.1 Ngai Tahu tikanga

For the purpose of this paper, this section will focus on Ngai Tahu tikanga relating to pollution and biosecurity issues. As stated in section 2.1.3 of this paper, kaitiakitanga is essentially aimed at the protection of mauri and mauri may be represented by qualities of health, the unpolluted and the presence of indigenous flora and fauna.

The Tangata Whenua must do all in their power to restore the mauri of the resource that has been adversely affected. Rahui are often used to restore the health of resources or the environment.

The discharge of human effluent, the dumping of rubbish and debris (eg, plastics) and the discharge of dead marine life from ships into the marine environment is strictly forbidden in accordance with Ngai Tahu tikanga as too is the release of foreign organisms (and genetically modified organisms – GMO).

3.7.2 CCAMLR provisions

CCAMLR put in place Conservation Measure 26-01 (2009) to addressed environmental protection during fishing. This conservation measure includes:

- The prohibition on dumping plastics in the Convention Area;
- Vessels south of Latitude 60^0 South are prohibited from dumping or discharging:
    - Offal;
    - Discards;
    - Oil or fuel products;
    - Garbage;
    - Food waste;
    - Poultry or parts (including egg shells);
    - Sewage within 12 nautical miles of land or an ice shelf or when the ship is travelling at less than 4 knots;

Resolution 3(2006) adopted by the ATCM, and Resolution MEPC.163(56) adopted by the International Maritime Organisation (IMO), adopted the *Guidelines for Ballast Water Exchange in the Antarctic Treaty Area.* Resolution 28/XXVII adopted by CCAMLR urges all Parties fishing in the Convention Area to apply these ballast water guidelines. These guidelines encourage vessels not to discharge ballast water inside the Convention Area and those that do are encouraged to exchange ballast water first before they reach the Convention Area, at least 200 nautical miles from the nearest land in water at least 200m deep. The guidelines also state that for vessels that have spent significant time in the Arctic[36], ballast water sediment should preferably be discharged and tanks cleaned before entering the Convention Area.

The permit issued by the Minister of Fisheries for New Zealand fishing vessels also sets strict requirements regarding the storage of rubbish (consistent with UNCLOS requirements). Observers monitor compliance with this provision of the permit.

3.7.3 Discussion

The measures established by CCAMLR are consistent with the tikanga-based approach employed by Ngai Tahu and it is most likely that these measures would comply with the relevant provisions of UNCLOS. The level of compliance (by permitted vessels) is not known, although some research suggests that the compliance is poor (Walker, Reid, Arnould & Croxall, 1997).[37]

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[36] These vessels are seen as one of the greatest biosecurity risks to the Antarctic (M. De Poorter, IUCN, personal communication, 24 November 2009).

[37] It is assumed that the level of compliance by IUU vessels is virtually nil.

However, the measures adopted by CCAMLR make no mention of what is to be done to support the eradication of any foreign organisms (including GMO) that are detected or what is to be done to address the clean-up of oil or chemical spills should they occur.

3.7.4 Findings

The measures established by CCAMLR to address the pollution and biosecurity risks posed to the marine environment in the Convention Area from the toothfish fleet are consistent with Ngai Tahu tikanga. However, further measures are required to guide the eradication of any foreign organisms (including GMO) that are detected and the clean-up of oil or chemical spills should they occur.

3.8 Integrated management

3.8.1 Ngai Tahu tikanga

As already stated, kaitiakitanga is a holistic, ecosystem-based approach to managing natural resources. Customary management is an integrated regime as all things are connected by whakapapa.

Today, the obligations associated with the exercise of kaitiakitanga have become difficult for the Tangata Whenua to uphold given due to the complexity and the number of central and local government entities now involved in managing natural resources. Constructive relationships with key natural resource management agencies are therefore required in order to effectively manage fisheries of importance to Ngai Tahu.

3.8.2 CCAMLR measures

Article XI of the Convention states that the Commission will seek to co-operate with Contracting Parties which exercise jurisdiction in marine areas adjacent to the Convention Area, to conserve any stock or stocks of associated species which may occur in both areas.

In addition, Article XXIII of the Convention compels CCAMLR to work with the ATCP as well as the FAO when appropriate.

3.8.3 Discussion

The analysis conducted in this paper indicates that CCAMLR adopts more of an individual species focus than a truly integrated, holistic, ecosystem-based approach. The management regime adopted by CCAMLR is therefore inconsistent with Ngai Tahu tikanga.

ATCM and CCAMLR must therefore develop a truly integrated management regime – one that integrates the management of the marine environment south of the Antarctic Convergence with the management of the Antarctic Continent.

The ATCM is taking steps to encourage the integrated management of the Antarctic[38], including the adoption of a resolution to extend the "Antarctic Area" north beyond Latitude 60^0 South to encompass the entire marine area south of the Antarctic Convergence (Resolution 1, 17 April 2009, ATCM XXXII).

3.8.4 Findings

The lack of integration of the management regime adopted by CCAMLR is inconsistent with Ngai Tahu tikanga. CCAMLR and ATCM must develop a truly integrated management regime – one that integrates the management of the marine environment south of the Antarctic Convergence with the management of the Antarctic Continent.

3.9 Reviewing performance

3.9.1 Ngai Tahu tikanga

Maori culture revolves around the acquisition of mana. As such the work of practitioners such as Tangata Tiaki/Kaitiaki is constantly monitored and reviewed by other tribal members. The positive aspect of this constant feedback loop is the encouragement of excellence and the immediate identification of poor performance.

3.9.2 CCAMLR provisions

Resolution 31/XXVIII urges all Parties to work with the best available science. As stated in section 3.1.3 of this paper, the toothfish population model, developed by NIWA, to determine catch limits for the Ross Sea fishery has been internationally peer reviewed.

CCAMLR recently undertook a review of its operations through a Panel of 'Experts'.

3.9.3 Discussion

The international peer review of the NIWA population model is a valuable component of CCAMLR management. It is important that the management tools employed by CCAMLR and the conservation measures adopted by CCAMLR undergo constant analysis and review.

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[38] Such as adopting a resolution to encourage increased cooperation with CCAMLR (Resolution 1, 23 June 2006, ATCM XXIX).

ASOC too are an important entity for the CCAMLR management regime (Antarctic Southern Ocean Coalition, 2009d). The constant analysis and feedback on CCAMLR performance provided by ASOC is consistent with Ngai Tahu tikanga. ASOC have also encouraged further external, independent analysis of the CCAMLR management regime (such as through the MSC certification process).

3.9.4 Findings

The peer review and external review processes on the management tools operated by CCAMLR and the conservation measures adopted by CCAMLR are consistent with Ngai Tahu tikanga. However, further external, independent assessments of the CCAMLR management regime should be encouraged.

4. Conclusions

The long-term sustainability of the Antarctic toothfish fishery is uncertain when assessed against key Ngai Tahu 'best practice' fishing customs.

The management of bycatch levels from the legal fleet is consistent with Ngai Tahu tikanga, and other management measures employed in the toothfish fishery are consistent also, but they were not comprehensive enough. These measures are:

- The spatial closures for the protection of toothfish stocks;
- The general and spatial conservation measures (including the MPA and the marine ASPA) that have been adopted by CCAMLR to protect important fisheries habitat;
- The environmental protection measures; and
- The performance review processes;

However, many of the key conservation measures are inconsistent with Ngai Tahu tikanga which leads to the conclusion that the long-term future for this fishery is at best uncertain. These key conservation measures are:

- The catch limits set for the Ross Sea and 88.2E toothfish fisheries (set to 'fish-down' the populations to a target biomass of 50% of B_0);
- The lack of minimum size limits for toothfish that may be retained from fishing;
- The awareness of (and therefore management of) the effects of the toothfish fishery on ecosystem relationships;
- The lack of compliance with the CCAMLR conservation measures (the nature and extent of IUU fishing in the Convention Area); and
- The lack of an integrated management regime;

Therefore, CCAMLR must adopt a range of new conservation measures to embrace a truly precautionary, ecosystem-based approach, in order to improve the sustainability of this fishery in the long-term. The key measures required are:

- Further research to better determine toothfish stock biomass with more certainty;
- Minimum legal size limits of at least 150cm for females and 140cm for males;
- Further spatial closures to protect stocks (especially over the seamounts where toothfish spawn);
- The establishment of a network of MPA that is comprehensive and representative of the full range of habitats and ecosystems in the Convention Area. This network of MPA must include extensive areas of the Ross Sea (given its scientific value), in particular, the toothfish spawning grounds on the seamounts to the north of the main fishing grounds.

- More research into the ecosystem impacts of toothfish fishing (especially on the abundance and distribution of silverfish and small and medium-sized demersal fish species so that CCAMLR can start to develop an understanding of the ecosystems effects of toothfish fishing in order to reduce the potential for trophic cascades);
- Increased surveillance and inspection efforts (especially with the new conservation measures proposed in this paper – minimum size limits, the increased use of spatial closures and the establishment of a representative network of MPA);
- Guidance for the eradication of any foreign organisms (including GMO) that are detected and the clean-up of oil or chemical spills should they occur;
- The develop of a truly integrated management regime by CCAMLR and ATCM – one that integrates the management of the marine environment south of the Antarctic Convergence with the management of the Antarctic Continent; and
- Further external, independent assessments of the CCAMLR management regime.

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