Aquaculture Round Table

Report 2: synthesis of issues and options

October 2014

Hauraki Gulf Marine Park
Ko te Pataka kai o Tikapa Moana
Te Moananui a Toi

In partnership with mana whenua and the following agencies:

Hauraki Gulf Forum
Tikapa Moana
Te Moananui a Toi

Ministry for Primary Industries
Manatū Ahu Matua

Department of Conservation
Te Papa Atawhai

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Tai Timu Tai Pari
Sea Change
Hauraki Gulf Marine Spatial Plan

V0.1	G Silver	14/5/14	Outline
V0.2	G Silver	30/5/14	Partial draft
V0.3	G Silver	10/6/14	Early draft for staff circulation
V0.4	G Silver	5/8/14	Formatted with cover
V0.7	G Silver	28/10/14	Modified to new structure
V0.8	S Baguley	31/10/14	Re-drafting, as circulated to RT
v1.0	G Silver	25/11/14	Amended following RT comments

Contents

Aquaculture Round Table Synthesis of issues and options

1 Overview

The Hauraki Gulf is second only to the Marlborough Sounds in terms of the amount of space used for aquaculture and the volumes produced. Farms in the Gulf grow nearly half of the oysters and over a quarter of the mussels produced in New Zealand, from 1689 hectares of water space, mostly within the Wilson Bay zone (1106 hectares) in the Firth of Thames.

The Gulf's aquaculture industry generates $97 million in revenue, adds $36 million to the Gross Domestic Product (GDP) of the two regions and directly employs 638 full-time equivalents (FTEs). Indirect and induced economic impacts increase all these figures by about 50%.

The industry has significant growth potential, resulting from productivity gains within the existing farmed space, allocation of new space and diversification of the range of species being farmed. There is potential to farm fish, such as kingfish and hapuku, and species such as seaweeds, sea cucumbers and geoducks (pronounced gooey-duck, a type of clam).

Marine farms require clean water, relatively calm conditions and access to landing facilities. Shellfish farms benefit from abundant phytoplankton (associated with higher nutrient levels) while fish farms needs deeper water with good flushing to avoid build up of organic waste and depletion of dissolved oxygen.

Aquaculture has the potential to modify ecosystems, affect landscapes and restrict people's use of the marine environment. To a degree these impacts can be managed by locating farms in suitable locations – away from sensitive habitats or areas of particularly high amenity, landscape or natural character values. Other effects can be prevented or reduced through careful design and operation of the farm, but like all farming it will have some degree of residual effect on the environment. The degree of impact is generally related to the type, scale and intensity of the farming.

1.1 Purpose of this report

This report draws on the information received by the Aquaculture Round Table from expert presentations and in report no.1 – background information. It discusses the issues facing aquaculture in the Gulf under 6 headings:

- Ecology, including biosecurity (section 4)
- Landscapes and natural character (section 5)
- Interactions with other marine activities (section 6)
- Benefits of aquaculture (section 7)
- Allocation processes (section 8)
- Effects associated with fish fed (section 9)

- Iwi aquaculture and Matauranga Māori (section 10)

Each section describes the issue and how it can be managed. This report is a work in progress that can be updated based on input by the members of the Aquaculture Round Table (ART).

It is intended that the ART members use the description of the issue and how it can be managed to help them complete Part 1 of the report that the ART delivers to the SWG. It is intended that the descriptions in this report, help the members to identify 'goals' or 'objectives' and the 'solutions' or 'actions' that will be recommended to SWG for each individual issue.

Once the objectives and solutions have been identified by the ART, this report may be updated to include preliminary information which will help the discussion on the locations of different types of aquaculture, when the objectives and solutions are applied.

1.2 Terminology

Aquaculture is a broad term that covers any activity involving the raising of aquatic plants and animals. This includes fish (also called finfish), shellfish, crustaceans (such as crayfish), eels, seaweed and sponges. Marine farming is any aquaculture that takes place in the marine environment as opposed to freshwater aquaculture or farming of marine species in tanks or ponds on land. It is also known as mariculture in some overseas literature.

Most aquaculture can be broadly divided to two main types – fed and non-fed:

1. **Fed aquaculture**:

   The organisms being farmed are dependent on the supply of food provided by the farmer. This is mainly the farming of carnivorous fish such as salmon, trout, kingfish and tuna, but does include some others species such as crayfish and paua. This type of farming is commonly referred to as fish farming or finfish farming (to distinguish it from shellfish), and is also known as additive farming.

2. **Non-fed aquaculture**:

   The organisms being farmed can obtain their food from the environment and do not require any additional feed inputs from the farmer. This type of farming is sometimes referred to as extractive farming. This is dominated by shellfish farming and includes seaweeds, sponges, sea cucumbers and some fish. Mussels and oysters, for example, are filter-feeders, collecting phytoplankton from the water flowing past them. They consume the palatable food they collect and expel the non-palatable particles, such as sediment, as pseudo faeces.

In New Zealand, most aquaculture fits neatly into one of these categories – oyster and mussel farming is non-fed, while the farming of king salmon is fed aquaculture.

In some places aquaculture may be a combination of the two types. For example, some omnivorous fish, such as the carp farmed in Asia, may feed mainly on the available algae in the water but have additional food provided to boost their growth.

2 The history of aquaculture

Modern commercial aquaculture is a relatively young industry but the farming of aquatic and marine organisms dates back thousands of years. Fish, seaweed, and eels were farmed in ancient China (about 2500BC), Japan and Australia (possibly as long ago as 6000BC).

Aquaculture as we currently know it developed in the mid-twentieth century and has grown so rapidly that, according to the United Nations Food and Agriculture Organisation (UNFAO), it now provides nearly half the seafood consumed by people.

2.1 The global context of aquaculture

Global aquaculture production in 2011 was 66.6 million tonnes with an estimated value of US$138 billion[1]. By comparison, New Zealand's aquaculture production was 117,000 tonnes in the same year. The UNFAO estimate that production is currently growing by 6.3% per annum and that an additional 23 million tonnes will be required by 2020 to maintain the current per capita consumption.

In contrast to aquaculture's growth, production from global fisheries has been static since the mid-1990s at about 90 million tonnes. About 70 million tonnes of this is consumed by people and the remaining 20 million tonnes used for non-food purposes such as livestock feed (fed to fish, pigs and poultry), fertiliser, pharmaceuticals, and glue.

The majority of aquaculture occurs in Asia with China accounting for 66% of world production and the rest of Asia 23%. Asian aquaculture is primarily freshwater fish (carp and related species), coastal shrimp farms and some marine fish farming. European and Canadian aquaculture is mainly salmon farming while catfish dominate in the United States. Other significant aquaculture species are oysters, seaweeds, mullet and tilapia.

There are currently over 300 species being farmed with new species constantly being studied for their farming potential. By quantity, fish make up just over half of global aquaculture production, shellfish nearly a quarter, and shrimp and seaweeds make up most of the remainder.

2.2 Traditional Maori aquaculture

Kaimoana has always been an important protein source for coastal Maori, and provides cultural, spiritual, and physical sustenance. Being able to provide food to manuhiri (visitors) maintains the standing and mana of a hapu. The importance of the cultural role of kaimoana has grown as the availability of the other main traditional protein source, birds, has been restricted by law and scarcity.

[1] FAO Fisheries and Aquaculture Department, 2014. **The State of World Fisheries and Aquaculture, 2014**. Food and Agriculture Organization of the United Nations.

Maori traditionally carried out several aquaculture activities. They involved active husbandry of aquatic organisms with the available technology of the time. Examples include:

- Placing rocks in suitable locations in the inter-tidal zone to encourage oyster growth for later harvest.
- Transferring shellfish from places where they were abundant to areas of lower abundance or where they had been over-harvested.
- Rahui were used to restrict harvesting when stocks required time to recover.
- Holding excess fish from large catches in pens made up of nets in the near-shore area.
- Constructing artificial rock pools in inter-tidal areas and stocking them with young mussels.

On the basis of these traditional activities, the Waitangi Tribunal found that Maori have a customary interest in aquaculture. This formed the basis for the 20% allocation of new marine farming space to Maori in the 2004 settlement (Commercial Aquaculture Claims Settlement Act 2004).

Maori are significant players in modern commercial aquaculture. It is estimated that about 40% of the marine farming industry is owned by Maori.

2.3 Marine farming in New Zealand and the Gulf

Aquaculture in New Zealand began in the mid-1960s with marine farming of oysters, then mussels in the 1970s and king salmon in the 1980s. Mussel farming grew very rapidly in the late 1980s and 1990s (averaging 12% per annum) and makes up the larger part of the sector with production of about 100,000 tonnes (2011) compared to 14,000 tonnes of king salmon and 1800 tonnes of oysters.

The main farming areas are Northland, Auckland, Coromandel, Marlborough, Canterbury and Stewart Island. Oysters are mainly grown in the warmer northern waters (Northland, Auckland and Coromandel) while king salmon requires the cooler waters of Marlborough, Canterbury and Stewart Island. Mussels are farmed in all these areas.

Within the Gulf farms (see figure 1) are found in:

- Mahurangi Harbour (108 ha of oysters).
- Great Barrier Island (32 ha of mussels).
- Waiheke Island (20 ha of oysters and 14 ha of mussels).
- Clevedon (14 ha of oysters).
- Waimungu Point on the western side of the Firth of Thames (55 ha of mussels).
- Coromandel Peninsula (67 ha of oysters and 270 of mussels).
- Wilson Bay in the Firth of Thames (1106 ha of mussels).

The main concentration of marine farming is the Wilson Bay zone in the Firth of Thames. This provides space for 1210 hectares of shellfish farming (of which 1106 has been consented) and 90 hectares for fish farming (currently not consented). Due to the requirement for a minimum 75 metre separation between farm blocks within the zone, the total foot print of the zone is 2472 hectares.

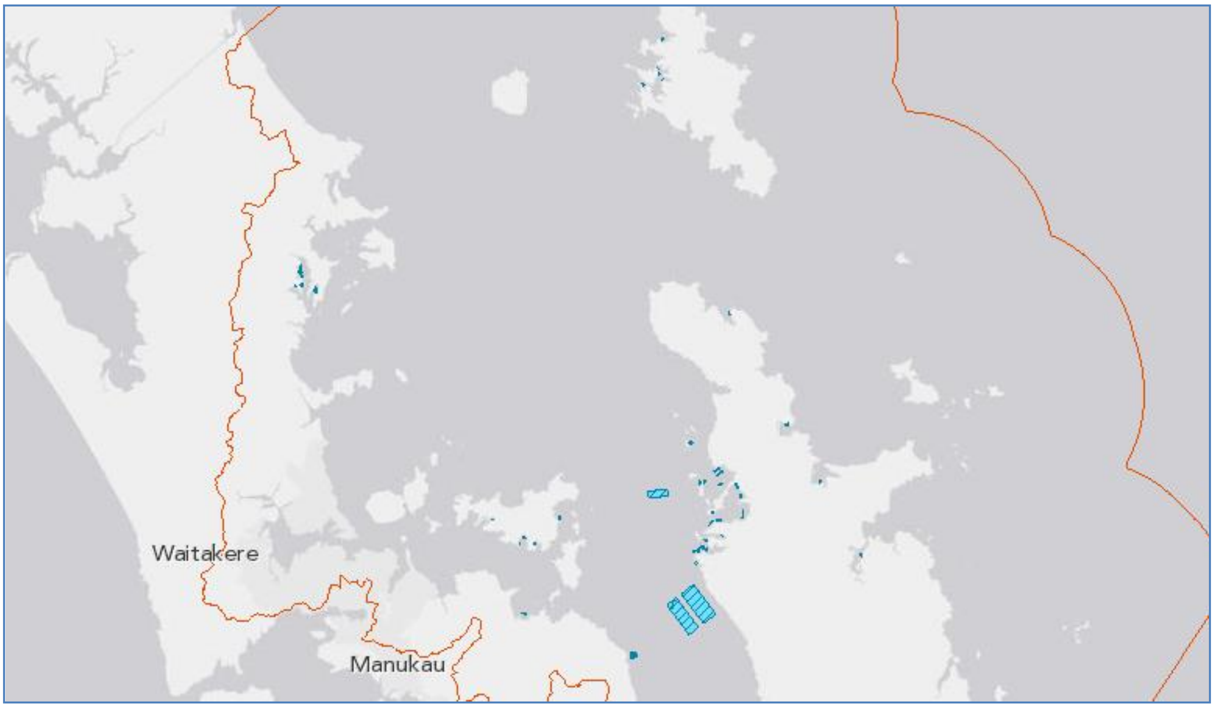

Figure 1: Existing marine farms and zones within the Gulf.

2.4 Types of marine farming structures

There are three main types of marine farm structures currently used in New Zealand: wooden inter-tidal racks for oyster farming, long-line farms for mussels, and net pens for salmon. As farming technology develops new types of structures will appear.

Inter-tidal racks

Oyster spat is collected on wooden battens which are then nailed to the racks. As they grow they may be placed into wire baskets (see figures 2 and 3). Recently post and line systems with plastic baskets have been used on some farms.

Figure 2: Oyster farms at Coromandel Harbour.

Figure 3: Close up of oyster farm.

Long-line farms

Mussels are typically grown in water depths of 10 to 20 metres on a long-line system adapted from shellfish farms in Japan (see figures 4 and 5). The long-line system replaced earlier raft-based farming. The mussels are held on a dropper line suspended under a surface backbone line. A significant innovation was the use of a single continuous dropper line on each backbone, rather than many separate dropper lines on the same backbone.

There is potential to farm other species that can attach to lines or be suspended from them. In some areas, oysters that are ready for harvesting are transferred from inter-tidal racks to long-line farms where they are suspended in baskets. This provides the oysters with clean water, allowing them to flush out any sediment or bacteria they may have ingested while in the inter-tidal zone.

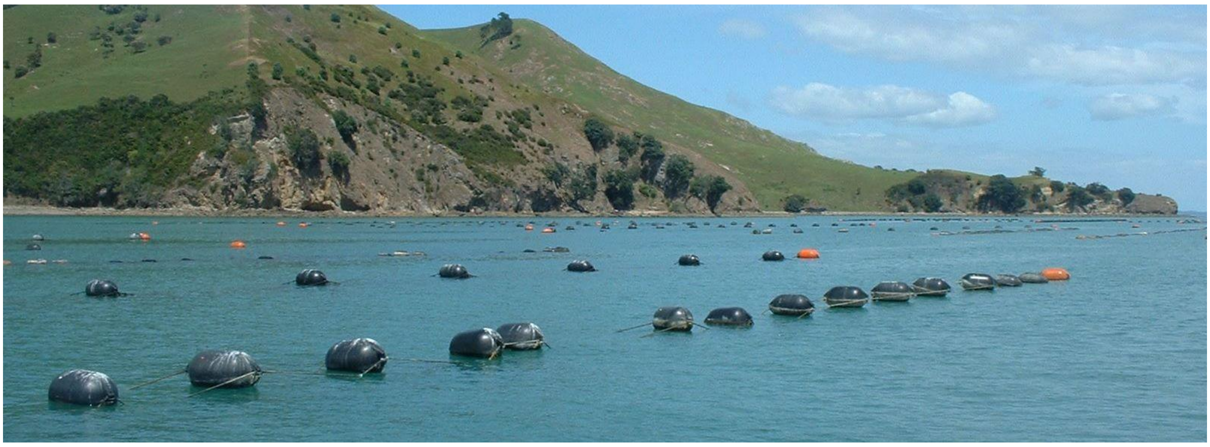

Figure 4: Mussel farms at Coromandel Harbour.

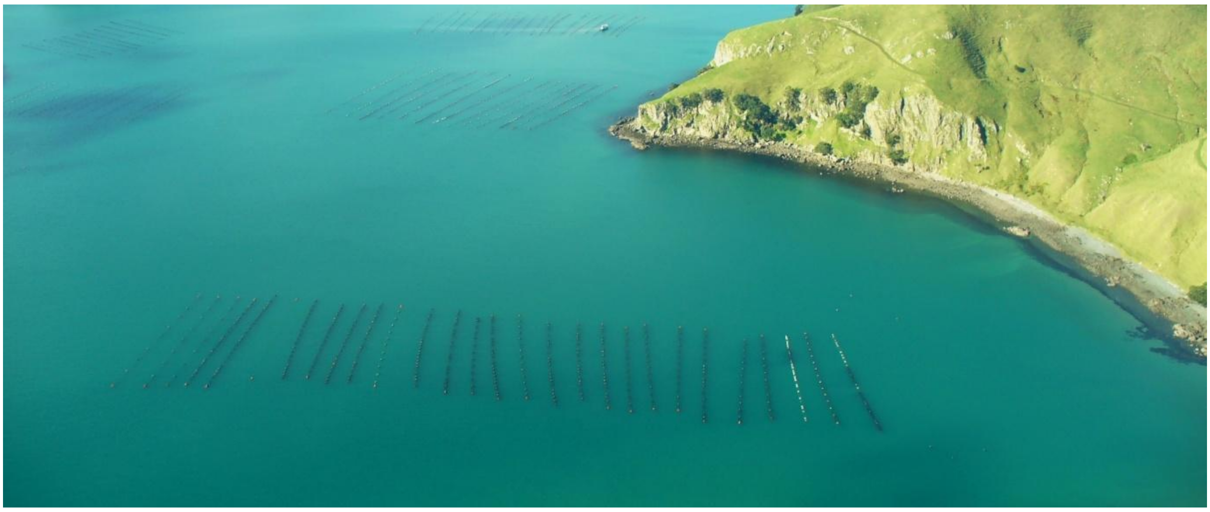

Figure 5: Mussel farms at Manaia Harbour.

Net pen farms

Fish are held in nets suspended under a surface structure. In sheltered waters the nets are positioned side-by-side suspended under a single surface structure. In the Marlborough Sounds the farms include worker accommodation due to the distance from landing facilities (see figure 6). In more exposed waters the nets are separated and suspended under circular plastic rings (see figure 7). These structures can flex with the sea conditions and have the added advantage of increasing the dispersal of wastes.

Figure 6: King salmon farm at Marlborough Sounds.

Figure 7: Kingfish farm at Port Lincoln, South Australia.

3 The ideal state for aquaculture in the Gulf

In its first meeting the Aquaculture Round Table discussed different perspectives of the 'ideals' for aquaculture in the Gulf.

Informed by these ideals and subsequent discussions at the ART meetings, we have proposed an over-arching 'goal' for aquaculture and high level 'outcomes' which the ART members appear to be supportive of.

ART members with suggested changes to the goals or outcomes should provide these, as tracked changes, to Graeme Silver or Paul Creswell.

Ideals (as originally brain-stormed)

Aquaculture makes a positive contribution to the Gulf

Improves economic wellbeing of communities

Improves local infrastructure

Value is added by the community

Benefits of aquaculture to other areas are maximised including recreational fishing, commercial fishing, tourism, education

Restoration opportunities are realised

Aquaculture provides for opportunities for stewardship of the Gulf

The needs of the industry are met (certainty, security, flexibility, can adapt)

Cultural vision aspiration for aquaculture is provided for

Aquaculture supports a healthy ecosystem (negative effects are managed): impacts are managed, enhances the value of the ecosystem, monitoring

Fewer barriers for small operators

Aquaculture co-habitats with other users: recreational, other commercial, cultural values, environmental values, safe navigation

Aquaculture is an indicator of a healthy marine environment

Management of aquaculture provides for: industry, innovation, small users, restorative potential, cultural commitments

The industry is innovative in terms of: addressing environmental impacts and benefits, maximising value of product, process used, species involved, opportunities for land based aquaculture

Goal *(what do we want to achieve at a high level)*

A prosperous aquaculture sector contributes to the health and wellbeing of the people and the environment of the Gulf by minimising adverse environment effects and maximising benefits.

Outcomes *(detail on what we want to achieve)*

A thriving aquaculture industry supports local communities including tangata whenua.

Significant ecological effects are avoided and other ecological effects are minimised.

Marine farms are sentinels for a healthy environment and contribute to the restoration of the Gulf's mauri.

Conflicts over the use of space are minimised.

Monitoring of aquaculture is carried out an appropriate level and is integrated with state of the environment monitoring.

Marine farm operators have adequate certainty for investment and business planning.

The community has certainty regarding the effects of aquaculture while the industry has flexibility to innovate, diversify and adapt to changes in the business environment.

Barriers for small operators are reduced.

4 Ecological effects

The ecological impacts of marine farming have been thoroughly studied, both in NZ and overseas. However, some uncertainty remains due to the highly variable nature of the marine environment, the difficulty of studying it in detail, and the site-specific nature of some effects.

In general, fed aquaculture is more intensive and has the potential for greater impacts, particularly with regard to the release of organic matter and nutrients into the environment, but has a smaller footprint of occupation so most effects are more localised. Non-fed aquaculture is more extensive (that is, requires a larger area to be economically viable) and so may potentially affect a greater area but its ecological effects are generally considered less significant.

Farming of filter-feeding shellfish can improve water quality by filtering out particulate matter and removing nutrients (in the form of phytoplankton). Farming of seaweeds removes dissolved nutrients from the water column.

4.1 Biosecurity

Issue

Biosecurity risks have the potential to adversely affect NZ's natural, cultural, recreational, amenity and economic values. Once established in marine environments, pests and diseases are typically difficult and costly to manage and the ongoing effects are often permanent.

Aquaculture can be a source or stepping stone for biosecurity risks but is unlikely to be the cause of a new incursion into NZ. Marine farms can be adversely affected by biosecurity incursions due to loss of production, increased costs to manage pests and increased drag on farming structures.

Marine farms structures provide potential habitat for pest organisms to colonise and may become a reservoir for further spread. Movement of marine farming equipment, vessels and stock is a potential vector for the movement of pests.

The prevalence of pests and disease occurring in NZ's aquaculture industry is low. The health of farmed species and the aquatic environment is paramount to the sustainable growth of NZ's aquaculture industry. One of the key risks is losses in production and potential impacts to trade caused by the introduction or exacerbation of pests and diseases.

How it can be managed

- Maintain good surveillance practices on farms to identify pest organisms.
- Prepare response plans to manage incursions.
- Regular cleaning of vessels and equipment carried out on land or with adequate containment.

- Washing and sorting of seed shellfish prior to transfer between regions.
- Raising awareness of the importance for other potential vectors in the marine environment to undertake similar responsible practices.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the ‘goals’ or ‘objectives’ that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc (‘solutions’) need to take place to work towards meeting the goal or objective?

4.2 Water column effects (pelagic)

Shellfish and other non-fed aquaculture

Issue

Filter-feeding shellfish extract phytoplankton from the water that flows past. Phytoplankton form the base of many food chains within the marine environment and a significant reduction in phytoplankton has the potential to impact on many other species.

The removal of phytoplankton by a shellfish farm creates a zone of depleted water that will extend some distance down-current. The size of this zone depends on the intensity of the farming but usually only extends a relatively short distance beyond the boundary of the farm.

The shape, location and duration of the depletion plume depends on the hydrology of the area. Very sheltered and poorly mixed locations will experience more severe and prolonged depletion, while well-flushed areas will recover quickly.

When the Wilson Bay zone was established it was the largest concentration of mussel farms in one location. Strict monitoring requirements were imposed and the potential phytoplankton depletion was modelled. From 12 years of monitoring data, NIWA has concluded that no significant depletion of phytoplankton has occurred as a result of mussel farming in the Firth[2].

Further modelling was carried out when Area B of the zone was approved by the Ministry of Fisheries in 2009. Some of the results of that modelling are shown in figure 8. These show the predicted impact of the full development of Area A and the predicted combined impact for Areas A and B under a range of seasonal and weather conditions. The maximum depletion predicted is up to 20% over an area about two to three times the size of the Wilson Bay zone. This occurred under winter conditions with no wind. Under winter conditions with a ENE wind the area of depletion is predicted to be much larger but the

[2] Stenton-Dozey, J., Zeldis, J., 2012. **Wilson Bay Marine Farming Zone Area A water quality monitoring biennial report for May 2010 to March 2012**, NIWA client report CHC2012-062 prepared for Wilson Bay Group A Consortium.

degree of depletion would be just 5% to 10%. The extent and intensity of depletion was predicted to be lower in all summer scenarios.

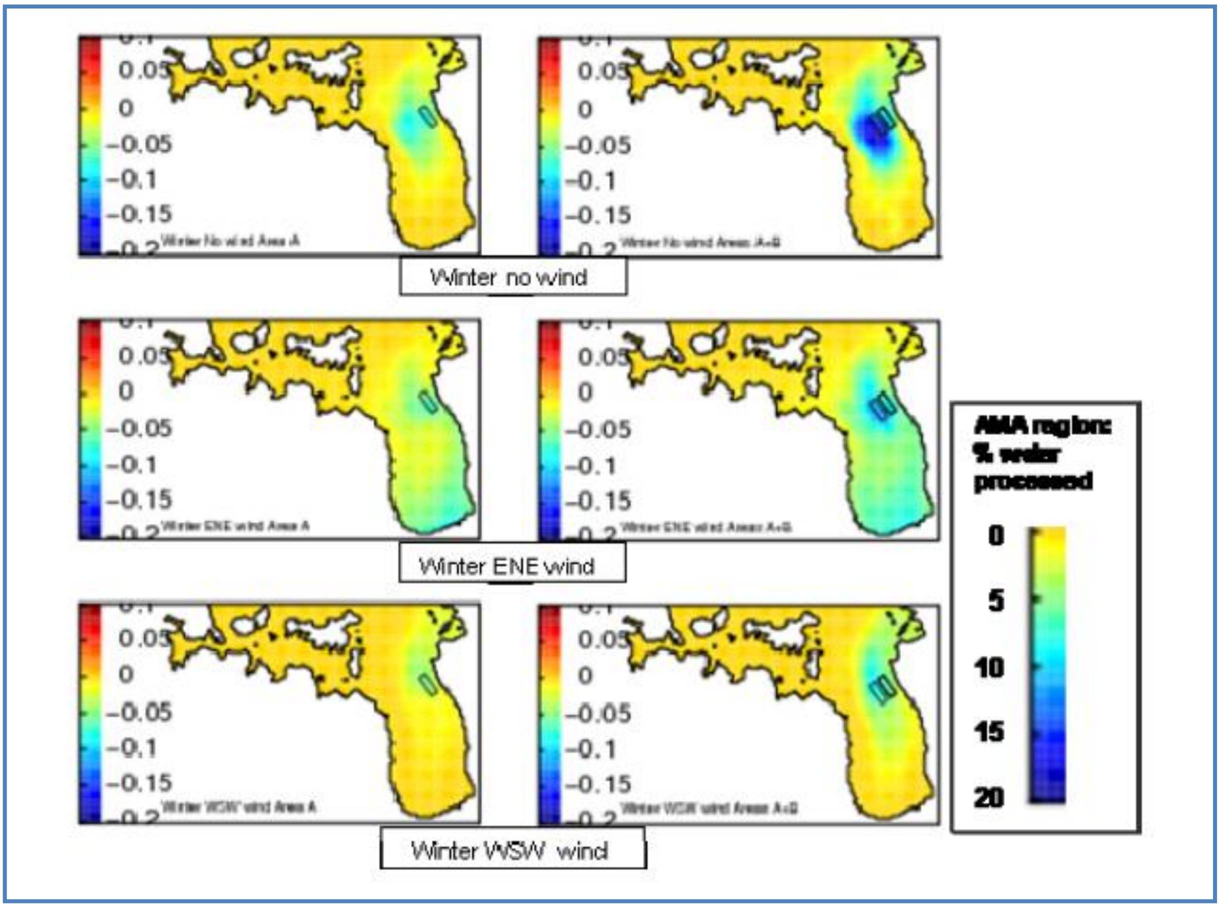

Figure 8: Modelled phytoplankton depletion for the Wilson Bay zone, as a percentage of seawater processed by the mussels (source: Stenton-Dozey, *et.al.*, 2008).

How it can be managed

- Model phytoplankton depletion as part of the assessment of environmental effects for large scale shellfish farming proposals.
- Require monitoring to confirm the results of the modelling. The intensity of monitoring can be scaled down over time if it confirms that no significant adverse effects are occurring.
- **Locate** farms in areas with reasonable flushing and/or relatively higher levels of phytoplankton (usually resulting from higher nutrient levels from land based discharges or upwelling of nutrient rich oceanic waters).

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the ‘goals’ or ‘objectives’ that the group want to see in relation to this issue?
3. What sort of activity, action or initiatives etc (‘solutions’) need to take place so that the goal or objective will be met?

Fish farms and other fed-aquaculture

Issue

Fish farms release dissolved nutrients to the water column due to the decomposition of fish faeces and uneaten food. Nutrients, especially nitrogen, in seawater encourage the growth of phytoplankton, potentially resulting in algal blooms. As large blooms die off the decomposition of such vast amounts of organic matter can deplete the water of oxygen, affecting fish and other organisms.

Blooms can occur as a natural phenomenon but the nutrient enrichment of seawater by human activity increases the likelihood and potential severity of them. This is mainly a problem in enclosed waters with little flushing.

Of particular concern is the risk of harmful algal blooms that include species that produce toxins. These can be directly toxic to fish and may accumulate in shellfish. No harmful algal blooms have been linked to fish farms in New Zealand[3].

Harmful algal blooms have occurred in the Hauraki Gulf in the summer of 1992-93 and the spring of 2002. The 1992-93 bloom contaminated shellfish and resulted in a number of people becoming sick. A national monitoring programme was established in response. The 2002 bloom caused mass mortalities of fish in the Gulf[4].

The level of dissolved oxygen in the water may be reduced by fish farms, due to the respiration of the fish in the farm and the decomposition of organic wastes on the seafloor. This quickly becomes a problem for the farm operator as the farm stock are directly affected and may suffocate in extreme cases. Wild fish are able to move away from localised areas of depleted oxygen and avoid any harmful effects.

Some of the early salmon farms established in New Zealand were placed in relatively shallow water in sheltered bays. Due to the poor flushing of these sites and inefficient feeding practices at the time, several of these farms suffered from low oxygen levels. As a result they closed down or were moved into deeper waters.

Due to the cost of fish feed, farmers now have systems to manage feed input rates very carefully in order to minimise wastage and the loss of uneaten feed into the environment.

how it can be managed

- **Locate** farms in areas with very good flushing (deeper waters with high water turnover due to tides and/or currents).
- Nutrient discharge limits (in terms of tonnes of nitrogen) and feed limits can be imposed to limit the extent of the effect.

[3] Ministry for Primary Industries, 2013. **Overview of Ecological Effects of Aquaculture**
[4] MacKenzie, A.L, 2012. Statement of evidence in relation to water column effects: harmful algal blooms. Prepared for the New Zealand King Salmon Company Limited.

- Model the discharge of nutrients to determine the likely extent and effect on the ecosystem.
- Apply a staged development approach with adaptive management and performance standards to be applied in conjunction with monitoring to respond to the actual effects.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.3 Seafloor (benthic)

Issue

Both fed and non-fed aquaculture result in deposition of organic matter on the seafloor. Levels of deposition are greatest under fish farms. This organic matter may consist of:

1. faeces (from fish) and pseudo-faeces (from shellfish);
2. both live and dead shellfish dislodged from the lines;
3. uneaten food pellets under fish farms and other fed aquaculture systems; and
4. deposition of biofouling dislodged from lines and nets.

Accumulation of organic matter on the seafloor modifies the benthic community by attracting predators (eg. starfish), scavengers (eg. sea cucumbers) and decomposing organisms (eg. worms and bacteria).

In extreme cases the seafloor can become anoxic (lacking oxygen) as all the available oxygen is consumed in the decomposition of the organic matter. This eliminates all life except mats of bacteria. These conditions have been seen under salmon farms in NZ, but never under shellfish farms.

Consent conditions on salmon farms in NZ do not allow anoxic conditions to appear under the farms. Better management of feed and stocking densities has enabled farmers to avoid these conditions. Feed is the single biggest expense for a fish farm so avoiding wastage is a high priority for farmers.

Under shellfish farms, dead and live shellfish will accumulate as a result of stormy conditions dislodging them from the lines. These provide hard substrate for other organisms to grow on. This "artificial reef" effect will attract other organisms and increases the biodiversity.

During the harvesting of shellfish and the maintenance of fish cages, accumulated biofouling is dislodged and sinks to the seafloor. Some of these organisms will survive and add to the biodiversity of the seafloor, while others, especially those dependent on higher light levels

will die and add to the deposition of dead organic matter. Biofouling can include unwanted pest organisms.

How it can be managed

- **Locate** marine farms over seafloor that does not consist of rocky reefs or other significant habitat.
- **Locate** farms over muddy seafloor that is better able to assimilate the fine particulate deposition and organic matter from the farm.
- **Locate** fed aquaculture farms in areas of adequate water depth (20 to 40 metres or more) and good flushing to reduce seafloor accumulation.
- Maximise the efficiency of feeding to avoid wastage and deposition of uneaten fed on the seafloor (use feeding calculations to determine optimal feeding rates and underwater video cameras to determine when feeding is complete).
- Monitor the level of organic enrichment occurring under a farm. Manage stocking densities and feed inputs to prevent enrichment reaching an unacceptable level.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.4 Effects on wildlife

Issue

Marine farms may affect wildlife, such as marine mammals, birds and sharks, in three ways:

- exclusion from habitat
- entanglement in lines and nets
- attraction and aggregation

Exclusion effects are important when the farms prevent wildlife from using areas that are important for feeding or as a nursery habitat, or when the combined effect of farms and other human activities has a significant cumulative impact on their habitat.

Entanglement occurs when wildlife, in particular marine mammals and birds, get caught in lines or nets. There have been a few documented cases of dolphins being caught in nets around salmon farms and a Brydes whale being entangled in a mussel spat-catching line.

Marine farms can attract wildlife due to the increased availability of food. Fish, particularly snapper, are attracted to mussel farms to prey on the mussels and will be attracted to fish farms due to the availability of fish feed escaping through the nets. Other wildlife is attracted as the structures provide shelter and places to hide from predators (the artificial reef effect).

This aggregation may reflect an enhancement of the population of the species concerned but may also result in an increased risk to them. For example, birds attracted to a fish farm by the feed may be at greater risk of entanglement. Snapper attracted to mussel farms are at greater risk of being caught by recreational fishers.

How it can be managed

- **Locate** farms in areas that are not ecologically significant.
- Limit the cumulative effects of excluding wildlife from other areas.
- Avoid the use of floating feeds as this will attract birds.
- Predator nets used at fish farms must be fully enclosed (that is, not open at the bottom) and maintained in good condition to reduce the risk of entanglement.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.5 Genetic effects and escapees

Issue

Farmed organisms may be genetically distinct from the wild population. If they are able to inter-breed with them it could affect the genetic make-up of the wild population. Shellfish for example are broadcast spawners, releasing eggs and sperm into the water. Fish may escape from fish farms and interact with the wild population.

Farmed organisms are often selectively bred to improve growth rates and disease resistance. If they interbreed with the wild population those traits may reduce its general fitness.

The likelihood of escapee effects in New Zealand is low, based on the current small size of the finfish farming industry, limited overlap of wild and farmed populations (in terms of salmon) and the broad home range and likelihood of high genetic diversity in these indigenous species (in terms of kingfish and hāpuku).[5]

Genetically modified organisms are not used in New Zealand aquaculture and would require the approval of the Environmental Protection Authority.

How it can be managed

- Minimise the interaction of farmed organisms with the wild population by: (1) harvesting the crop before sexual maturity; (2) minimising the escape of farmed fish; and/or (3) minimising the use of selectively breed stock if there is a risk of genetic mingling to the wild population.

[5] Ministry for Primary Industries, 2013. **Overview of Ecological Effects of Aquaculture**

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.6 Additives and chemicals

Issue

Chemicals associated with marine farming may include feed additives, antifoulants, and treatments for bacteria diseases or parasites. Currently no chemicals are used in the shellfish farming industry in NZ, apart from treated timber for inter-tidal oyster farm racks. The only chemicals used in king salmon farming in the South Island are copper in antifoulants and zinc in feed and antifoulants.

Farming indigenous species such as kingfish and hapuku is likely to require management of pests and diseases, and this may involve the use of antibiotics, disinfectants and parasiticides.

How it can be managed

- Monitor sediment for accumulation of copper, zinc and CCA (timber treatment).
- Minimise the use of chemicals to control pests and diseases by applying best practice farming techniques such as managing stocking densities, regular cleaning of structures and fallowing of farm sites.
- Minimise the use of antifoulants by using net cleaning systems.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.7 Hydrodynamics

Issue

Structures in the water have an impact on currents and waves. This has the potential to reduce currents and wave energy. This may be positive by reducing the wave energy reaching the coast, and hence reduce shoreline erosion, or could negatively affect surf breaks.

Modelling of the hydrodynamic effects of marine farms has indicated that farms have a small effect on waves and currents at the densities currently used in NZ

How it can be managed

- **Locate** farms in areas that are not a significant part of the swell corridor for popular surf breaks.
- Model the hydrodynamic effects, including cumulative effects, of any proposed large scale aquaculture development as part of the assessment of environmental effects.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

4.8 Cumulative effects

Issue

Individual marine farms may be judged to have an acceptable ecological effect but they need to be considered in the context of both other marine farms and other human activities that are stressing the same ecosystem. This becomes particularly important as additional farms are proposed, other activities increase in intensity and new activities appear

How it can be managed

- Monitoring should be comprehensive and address the requirement for baseline data, monitoring of individual farms and broader state of the environment monitoring.
- Consenting processes should consider the effects of an activity in the context of other environmental stresses.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

5 Landscape and natural character

issue

Introducing artificial structures into the environment has an impact on its visual landscape and natural character values. The degree of impact will depend on the size, type and number of structures, and the pre-existing values of the location. These effects are the most common reason for a resource consent application to be declined[6].

[6] Banta, W., Gibbs, M., 2006. **Factors Controlling the Development of the Aquaculture Industry in New Zealand: Legislative Reform and Social Carrying Capacity**, Cawthron Report No.1208

Natural character is a function of how natural an environment is and is made up of natural sights, sounds and processes. The introduction of any artificial elements (boats, houses, fences, roads, wharves) or processes (dredging, sedimentation, fishing, farming) into it degrades the natural character but does not necessarily remove it entirely. All but the most extremely modified environments retain some degree of natural character.

Landscapes and seascapes are made up of the visual elements of a view, including natural and artificial elements, and their scenic, historic, cultural and spiritual values. Many outstanding natural landscapes are also working rural landscapes.

Amenity is a combination of factors that contribute to people's appreciation of an environment. This can include facilities and structures that create or support opportunities for people to use and enjoy the marine environment, such as boat ramps allowing access for trailer boats, wharves allowing people to fish off them and board walks that allow people to explore the coastline.

Areas that have been identified as having outstanding natural character, outstanding natural features or outstanding natural landscapes are highly protected by the New Zealand Coastal Policy Statement. All adverse effects on these values must be avoided.

how it can be managed

- **Locate** farms so that they do not have adverse effects on areas of outstanding natural features, outstanding natural landscapes or have outstanding natural character (minimum requirement of the NZCPS).

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

6 Interaction with other marine activities

Issue

Marine farms occur in public space in the coastal marine area. They can affect the ability of other people to use that space. For example yachts will give marine farms a wide berth to avoid any risk of entangling on the farms anchor lines, and commercial fishing is effectively excluded. Other structures, such as moorings and marinas, could not be located in the same space.

Some other activities are able to co-exist with marine farms. Recreational fishing and fishing tourism in particular are enhanced by shellfish farms due to the fish aggregation effect of the farms.

How it can be managed

- **Locate** farms in areas that are not subject to high levels of incompatible uses, not on popular cruising routes, not popular or important anchorages.
- Where marine farms may impact on other commercial uses, have regard to the relative values of those uses in terms of their socioeconomic benefits.
- Ensure Maritime New Zealand navigation and lighting requirements are implemented.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

7 Benefits of aquaculture

Issue

Aquaculture is a significant primary industry in the Hauraki Gulf. Currently, 27% and 45% of NZ's total Greenshell mussel and Pacific oyster production is grown in the Auckland and Waikato regions, respectively. This production is worth (export revenue) about $52 m for mussels and $7.3 m for oysters. It contributes about $31 m to Waikato's GDP and employs about 423 FTEs, and $28 m to Auckland's GDP and employs about 507 FTEs.

Maori owned farms in the Gulf have directly supported Maori development in Hauraki. Returns from farms owned by the Hauraki Maori Trust Board have funded health and social services and supported the evolution of the Manaia Primary School (26 students and 2.5 staff) to a Kura a Iwi with a role of 130 students and 13 teachers.

Aquaculture production in the Gulf will increase in the future through increased productivity, consented farms become productive and as new farms are created to satisfy the growing demand for seafood, both domestically and internationally. Farming of new fish and other shellfish and seaweed species will also occur. To date, there are 1480 ha and 210 ha of consented space of mussel and intertidal oyster farms, respectively. National forecast analysis suggests that the industry will require an additional 270 ha and 80 ha for mussels and oysters in the Auckland region, and 652.2 ha and 65 ha for mussels and oysters in the Waikato region by 2035. This new space will comprise of approved and new extensions, and new space.

How it can be managed

- Maximise the socioeconomic benefits of aquaculture to the communities of the Gulf.
- Provide a supportive regulatory environment for the growth of sustainable aquaculture (security of tenure, certainty for investment, and flexibility for diversification).

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?

2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

8 Allocation process

Issue

The majority of the coastal marine area is public space (the "commons"). Rights to occupy this space are managed by the Resource Management Act 1991, but usually in a passive "effects-based" way. The right to occupy space is allocated on a first-come first served basis.

Consent to occupy space may be granted or declined based on the potential environment effects of an activity. This can include the effects on other people's use of the space, such as the exclusion of recreational activity. The decision to grant or decline consent cannot consider alternative uses of the space or other users applying to carry out the same activity.

This first-in first served approach is adequate when there is little demand for space and a plentiful supply of it. However if water space that is suitable for a particular activity is restricted, it is likely to generate a rush of applications where competing applicants attempt to secure the rights to use the space before it is taken up by someone else.

This is most obvious with regard to the rush for marine farming space in the late 1990s/early 2000s but has also occurred with moorings and may occur in the future as marine energy technology develops.

The rights to extract minerals form the coastal marine area are subject to a licencing system under the Crown Mineral Act 1991, which prevents a similar rush of applications. No equivalent system applies to other activities requiring a consent in the coastal marine area.

Changes to the RMA in 2004 and 2011 provided additional tools for managing demand for public space in the coastal marine area. The main tool is the ability for regional councils to include allocation methods in their regional coastal plans. These tools have not yet been applied and so have not been tested in practice.

How it can be managed

- Regional coastal plans can include rules to manage competition for space and specify allocation methods.
- Regional councils may request that the Minister of Conservation allocate public space in the coastal marine area.
- Regional councils may request the Minister of Aquaculture to suspend consent applications for aquaculture consents for up to 12 months.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?

2. What are the 'goals' or 'objectives' that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc ('solutions') need to take place to work towards meeting the goal or objective?

9 Fish feed

Farming predatory fish, such as salmon, kingfish, hapuku and trout requires the supply of fish meal and fish oil in their feed. In a few cases, whole fish are used as feed. For example Southern Bluefin Tuna ranching in South Australia uses frozen baitfish for feed. In most cases manufactured feeds in a pellet form are used. These contain a mixture of fishmeal, fish oil, vegetable protein and vegetable oils.

In the past some feeding practices were wasteful and inefficient with the focus being on maximising growth by overfeeding. It was estimated that up to 7.5 kilograms of wild fish were consumed to produce 1 kilogram of farmed salmon in 1995. By 2006 this had been reduced to 4.9 kilograms[7].

The worst performing fish farms are the Bluefin Tuna ranches in the Mediterranean and South Australia. In this type of aquaculture wild Bluefin Tuna are caught, brought back to farms and fattened up on whole baitfish before being harvested for market. It is estimated that between 10 and 20 kilograms of wild fish are consumed to produce 1 kilogram of tuna[8].

Current feeding practice is to calculate the correct amount of feed to use to avoid wastage. Underwater video cameras are often used to confirm when fish have stopped feeding. Feed is the single largest operating cost for fish farmers – they have a strong economic incentive to avoid wastage.

Manufactured feeds initially had very high levels of fishmeal and oil (45% in salmon feeds)[9]. Considerable research has gone into replacing these with vegetable proteins and oils. As a result the fishmeal and fish oil content of modern feeds is much lower. Current feeds used by New Zealand King Salmon contain 10% fishmeal and 7% fish oil[10].

The fishmeal and oil used in feeds comes from two sources: 75% is from the reduction fisheries and 25% from off-cuts, trimmings and other wastes from the

---

[7] Tacon, A.G.J., Metian, M., 2008, **Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects**, Aquaculture 285: 146–158
[8] Ottolenghi, F. 2008. **Capture-based aquaculture of bluefin tuna**. In A. Lovatelli and P.F. Holthus (eds). Capture-based aquaculture. Global overview. FAO Fisheries Technical Paper. No. 508. Rome, FAO
[9] UNFAO Fisheries and Aquaculture Department, 2012. **The State of World Fisheries and Aquaculture, 2012**. Food and Agriculture Organization of the United Nations
http://www.fao.org/docrep/016/i2727e/i2727e00.htm
[10] Wybourne, B.A., 2012. **Statement of evidence in relation to feed discharges for the New Zealand King Salmon Company Limited**.

processing of fish[11]. Reduction fisheries are those that are targeted specifically for conversion to fish meal, such as the Peruvian anchoveta fishery. Peru stored top in a ranking of the sustainability of global fisheries[12] (New Zealand came in 12th place).

The total catch from reduction fisheries has been static since 1970 but varies from year to year, ranging between 20 and 30 million tonnes per year. In the same period fish farming has grown dramatically by diverting fishmeal from pig and poultry farming. Fish farming now consumes about 75% of the fishmeal supply. It is expected that this will be a constraint on the future growth of fed aquaculture.

While research on substituting plant proteins and oils in fish feed continues it is unclear whether complete substitution will be possible due of the difficulty of providing suitable omega-3 oils from plant sources. Many of the health benefits of eating fish result from its omega-3 oil content.

Questions for the ART members to answer as they develop their report to the SWG:

1. Is the nature of the issue framed correctly? If not, how should it be changed?
2. What are the ‘goals’ or ‘objectives’ that the group want to see in relation to this issue?
3. What sort of activity, action, initiatives etc (‘solutions’) need to take place to work towards meeting the goal or objective?

[11] International Fishmeal and Fish Oil Association
[12] Mondoux, S., Pitcher, T., Pauly, D., 2008, **Ranking maritime countries by the sustainability of their fisheries**, pg 13-27. In: Alder, J. and Pauly, D. (eds) *A comparative assessment of biodiversity, fisheries and aquaculture in 53 countries’ Exclusive Economic Zones*, Fisheries Centre Research Reports 16(7), University of British Columbia.

10 References

Banta, W., Gibbs, M., 2006. **Factors Controlling the Development of the Aquaculture Industry in New Zealand: Legislative Reform and Social Carrying Capacity**, Cawthron Report No.1208

MacKenzie, A.L, 2012. **Statement of evidence in relation to water column effects: harmful algal blooms for the New Zealand King Salmon Company Limited**.

Ministry for Primary Industries, 2013. **Overview of Ecological Effects of Aquaculture**

Mondoux, S., Pitcher, T., Pauly, D., 2008, **Ranking maritime countries by the sustainability of their fisheries**, pg 13-27. In: Alder, J. and Pauly, D. (eds) *A comparative assessment of biodiversity, fisheries and aquaculture in 53 countries' Exclusive Economic Zones*, Fisheries Centre Research Reports 16(7), University of British Columbia.

Ottolenghi, F. 2008. **Capture-based aquaculture of bluefin tuna**. In A. Lovatelli and P.F. Holthus (eds). *Capture-based aquaculture. Global overview*. FAO Fisheries Technical Paper. No. 508. Rome, FAO

Stenton-Dozey, J., Morrisey, D., Broekhuizen, N., Oldman, J., 2008. **Fisheries Resource Impact Assessment (Wilson Bay Area B, Interim AMA)**, NIWA client report CHC2008-145 prepared for the Ministry of Fisheries.

Stenton-Dozey, J., Zeldis, J., 2012. **Wilson Bay Marine Farming Zone Area A water quality monitoring biennial report for May 2010 to March 2012**, NIWA client report CHC2012-062 prepared for Wilson Bay Group A Consortium.

Tacon, A.G.J., Metian, M., 2008. **Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects**. Aquaculture 285: 146–158

Tacon, A.G.J.; Hasan, M.R.; Metian, M., 2011. **Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects**. FAO Fisheries and Aquaculture Technical Paper No. 564.

UNFAO Fisheries and Aquaculture Department, 2012. **The State of World Fisheries and Aquaculture**, 2012. Food and Agriculture Organization of the United Nations

UNFAO Fisheries and Aquaculture Department, 2014. **The State of World Fisheries and Aquaculture, 2014: Opportunities and challenges**. Food and Agriculture Organization of the United Nations.

Wybourne, B.A., 2012. **Statement of evidence in relation to feed discharges for the New Zealand King Salmon Company Limited**