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Aquaculture Quadruple Bottom Line Assessment

Multi Criteria Analysis for the Auckland Region

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Multi Criteria Analysis for the Auckland Region

Enveco

Prepared for
Auckland Regional Council

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Executive Summary

Enveco has been commissioned by the Auckland Regional Council (ARC) to provide additional comparative information on aquaculture effects. The aim of the report was to consider the potential social, economic, environmental and cultural effects (the "quadruple bottom line") of three indicative aquaculture scenarios in the Auckland Region.

- Scenario 1 A baseline scenario reflecting currently operating oyster and mussel marine farms.
- Scenario 2 An expansion of current farming practices to 2025 mainly focused on oyster and mussel farms, but also allows 18 hectares for experimental species and finfish. The biggest expansion lies in mussel farming with over 1,000 hectares of additional space envisaged (primarily in the western Firth of Thames).
- Scenario 3 An expansion of scenario 2 with the addition of four indicative co-culture areas in mid to deep waters. It involves an additional 1,839 ha of mussels and oysters, and 300 hectares of new experimental species, scallop spat catching and finfish.

A qualitative Multi Criteria Analysis (MCA) can reliably compare impacts upon quadruple bottom line (QBL) categories but applies expert knowledge and professional judgement rather than numerical data. ARC and Enveco developed a set of indicators and definitions reflecting QBL effects. Indicator development took several months to allow for a robust ranking of effects during a workshop.

At the workshop, attendants assigned qualitative rankings to the indicators. In addition, low, medium and high levels of confidence were attached to the rankings. Where participants either did not agree on the intensity of the effect, agreed that effects might be mitigated by future technical advances, or agreed that effects were uncertain due to a lack of knowledge, a low level of confidence was attached to the ranking. A sensitivity analysis was then conducted on any indicators that were ranked with a low level of confidence during the workshop. Positive and negative variations were applied to test the sensitivity of the MCA results to alternative decisions that could have been made on the low confidence rankings.

After the workshop was held, the qualitative rankings were assigned numerical values and subsequently indicators were "normalised". This process enabled an equal comparison of the rankings between each of the four indicator categories even where the number of indicators varied within categories.

The findings of the MCA have to be interpreted within the context of this report and within the scope of what was considered as part of the MCA analysis. There are limitations to the results such as the qualitative nature of the MCA and the fact that the indicators were not individually weighted.

Applying the qualitative MCA approach, all three scenarios show negative environmental effects overall, intensifying as development increases. However, they contribute positively to the economy. When taking into consideration the scope of the social indicators, excluding the economic aspects of social effects, none of the scenarios exhibit positive outcomes. Scenarios 2 & 3 perform well with regard to cultural (Maori) economic opportunities, whereas scenario 1 does not create any real opportunity for Maori to advance economically.

Before application of the sensitivity analysis, the MCA revealed scenario 2 to be the preferred option, followed very closely by scenario 1. Given the considerable expansion in shellfish and the trialling of small-scale finfish farming and experimental species for

scenario 2, the ranked difference in effects between scenario 1 and 2 is minimal. Scenario 3 however indicated a more pronounced difference when compared with scenarios 1 and 2.

The strengths of scenario 1 lie in the fact that all effects are known with relative certainty and that there would be minimal expansion and development. Workshop participants were most confident about the assessment of this scenario in all ranking categories. Consequently because there is minimal development under scenario 1, the only overall positive effect this scenario demonstrates is on the economy, but it is not significant. The MCA indicates that scenario 1 is 'as good as it gets' within the current policy framework.

Scenario 2 exhibits positive outcomes for both economic and cultural well-beings. Effects on the social and environmental categories are negative. A low level of confidence was attached to the indicators "birds", "marine mammals" and "competition for space and public use". Further research on these indicators could improve accuracy and confidence in the ranking process and determine whether scenario 2 could improve its overall score.

Scenario 3 has the most uncertainty predominantly in the environmental category. Participants as a group could not reach a consensus with high confidence on some of the effects from the farming of finfish and experimental species at the scale proposed in this scenario. This could be due to the fact that at present comparisons can only be drawn with commercial salmon farming, research trials involving hapuku and kingfish at Bream Bay and the farming of some experimental species such as sponges, seacucumber (i.e. holothurians), seaweeds and kina. This type of applied development is still in its infancy in New Zealand. Despite the assumptions, some participants still had doubts about how adverse effects would be managed, and therefore scored scenario 3 accordingly.

Sensitivity analyses tested the rankings assigned to each of the indicators – it identified if the MCA was sensitive to any changes in rank where there was a low level of confidence. The negative variation of the sensitivity analysis magnified the adverse impacts of rankings with low levels of confidence largely associated with environmental indicators in scenarios 2 and 3, while the positive variation amplified favourable effects for economic indicators and reduced adverse effects of environmental and social indicators.

Having performed two variations, a number of conclusions can be drawn. Low confidence or uncertainty concerning indicators does have a profound effect on the outcomes for each of the scenarios. Scenario 1 remains the same regardless of the variations as it has no uncertain indicators. However its place in the ranking moves due to changes in the other two scenarios (i.e. from second place to first place under the negative variation, and to third place under the positive variation). The sensitivity of the MCA results to the confidence with which rankings can be assigned to indicators is graphically shown by scenario 3 which alternates between being the most and the least preferred overall outcome, depending on which variation is applied.

Future knowledge on environmental effects or technological improvement is unlikely to improve scenario 1, whereas it is likely to affect scenarios 2 and 3. Scenarios 2 and 3 are comparable when certain conditions are 'right': when low confidence levels are shifted positively.

Scenario 3 could be a viable option as it carries the greatest potential economic opportunities, but it is also associated with the greatest potential environmental and social costs. Sensitivity analysis indicates that realising sustainable economic gains may be dependent on the development of new innovative technology and improved management of adverse social and environmental effects. It has to be noted that future research, innovation, and an improved understanding of probable effects on those indicators currently ranked with low confidence would support more certain and definitive MCA conclusions.

In addition to refining rankings by improving certainty over likely effects on various (e.g. environmental and cultural) indicators, there would also be benefit in quantifying the economic effects (such as transaction and opportunity costs, effects on the local economy) and assigning relative weighting to particular indicators to reassess the overall ranking of scenarios. Applying weighting to some of the indicators to reflect individual or group preferences between indicators would provide further clarity on how scenarios are ranked.

1 Introduction

1.1 Project scope and objectives

Enveco has been commissioned by the Auckland Regional Council (ARC) to provide additional comparative information on aquaculture effects. The aim of the report is to assess the potential social, economic, environmental and cultural effects of three indicative aquaculture scenarios in the Auckland Region. The assessment will provide a comparison of positive and negative effects of a base-line scenario of existing farms in the Auckland Region as well as two possible scenarios at different levels of development intensity.

The objectives of the project were to:

- Identify the relative Social, Cultural, Environmental and Economic costs and benefits (i.e. "the Quadruple Bottom Line") of existing aquaculture activities in the Auckland Region and, if practicable, to also evaluate identified potential future development scenarios.
- Produce a Quadruple Bottom Line (QBL) Multi Criteria Analysis (MCA) output of sufficient rigour to provide robust and defensible guidance to help ARC determine its regional aquaculture policy framework.

The objective of the QBL MCA was to provide an overview to the ARC of the relative impacts of the three proposed aquaculture scenarios. The outcome of the QBL MCA will help inform ARC's decision-making process in terms of an optimal policy and regulatory approach.

1.1.1 Environmental economics analysis

Environmental economics provides a framework to analyse the impacts of aquaculture activities on the economy, the environment and local communities. Economic analyses measure overall "well-being" impacts and use monetary and/or qualitative values to rank people's preferences for different scenarios. For the purposes of this study environmental economic analysis, whether quantitative or qualitative, provides additional information to feed into:

- the assessment of effects of a particular aquaculture scenario;
- the quantitative and/or qualitative valuation of non-market effects;
- rational decision-making over a range of public intervention strategies;
- the choice of most efficient allocation of resources given environmental, cultural and socio-economic constraints;
- achieving the objectives of the decision-maker; and
- aquaculture policy making for the ARC.

2 Proposed reforms to aquaculture legislation

This Prior to the 2008 general elections, the former Labour Government introduced two aquaculture amendment bills. Bill No.1, now the Resource Management Amendment Act (RMA) 2008, clarified that applications for the occupation of the Coastal Marine Area (CMA) for aquaculture activities cannot be made unless they relate to Aquaculture Management Areas (AMAs) in operative regional coastal plans. Bill No.2 was introduced to the House in February 2009 and includes technical amendments that address issues such as the timeframes for the review of deemed consents and detail on allocation of space to the trustee under the Maori Commercial Aquaculture Claims Settlement Act. At the time of writing this Bill, has not progressed any further due to the new National Government's RMA review process.

Shortly after the 2008 General Elections, the National Government announced that it would be reviewing the Resource Management Act through two phases.

Phase 1 of the amendments to the RMA was introduced into the House in February 2009 under The Resource Management Amendment Bill (Simplify & Streamline), and was passed into law in September 2009.

Phase 2 of the RMA amendment process will address more specific areas including aquaculture. In July 2009 the Minister for the Environment and the Minister of Fisheries appointed a Technical Advisory Group (TAG) to provide the government with a report on recommendations "to enable the development of sustainable aquaculture in New Zealand". This report forms part of the Phase Two review of the RMA.

The TAG released its report in November 2009, "Restarting Aquaculture" and presented it to Ministers. The Government sought submissions from interested parties by 16 December 2009. Briefly the overarching principles of the recommendations made in the report are:

- A greater role for central government in the industry.
- Ministerial powers to insert provisions into regional coastal plans.
- An aquaculture portfolio assigned to a Minister.
- A more flexible approach to planning through zones.
- A central register of aquaculture consents provided for in legislation cross linked to the Personal Property Security Register.
- Regional coastal plans specifying that an aquaculture consent term should run for at least 20 years.
- The removal of statutory prohibitions on aquaculture outside of aquaculture management areas.

It is not certain whether the Government will adopt the TAG recommendations, or favour an alternative approach, but it is clear that there will be fundamental changes to the current aquaculture legislation.

3 Preferred choice of methodology

Common forms of scenario analysis used in government include financial analysis, cost effectiveness analysis and cost benefit analysis, all of which rely entirely or largely on monetary valuations. In practice, particularly for aquaculture where economic valuation studies are rare, it can be costly, time-consuming and often difficult to value all the costs and benefits of scenarios in monetary terms. Economic impact assessment is a common methodology used in government to estimate impacts on the economy of one particular sector. However, it does not tend to cover environmental, cultural and social impacts.

The following analysis of assessment methods illustrates how an appropriate methodology for this project was selected, taking into consideration the shortage of quantitative data for many aspects of the project.

3.1 Economic Impact Assessment

T Economic Impact Assessment (EIA) generates an estimate of the economic consequences of a particular scenario by tracing the spending on aquaculture through the economy. The EIA measures the cumulative effects of that spending and provides an understanding of the potential economic benefits of various forms of aquaculture development. Unlike a cost benefit analysis (CBA), it estimates the likely order of magnitude of economic impacts rather than relative costs and benefits of scenarios. ARC is currently undertaking a comprehensive EIA of aquaculture activities in the region, but at the time of writing this report is still obtaining the economic details required for the comparative assessment of aquaculture scenarios.

EIA provides only one piece of the puzzle in a broader evaluation or decision-making process. For example, in addition to the economic consequences there may be social, environmental and cultural consequences that need to be taken into account, which would require a different methodology. In some cases a CBA would be a better methodology to attempt to place a monetary value on such a broad range of effects.

3.2 Cost benefit analysis

A cost benefit analysis (CBA) seeks to value the expected impacts of a scenario on society as a whole in monetary terms. These valuations are based on the well-developed economic theory of valuation using willingness-to-pay or to-accept concepts. In principle, a project is desirable if benefits exceed costs, suitably discounted over time (Communities and Local Government 2009). A CBA essentially:

- is a formal discipline used to help appraise projects;
- is used by governments to evaluate the desirability of a given intervention;
- benefits and costs are expressed in money terms and adjusted for the time value of money with results being expressed as Net Present Values; and;
- inputs are measured in terms of opportunity costs - the value of their best next alternative use.

Most CBAs can accommodate qualitative impacts which either cannot be valued, or for which it is uneconomic to do so. However, qualitative impacts sit alongside the CBA in a

narrative form and are included in the decision process qualitatively. Such analysis is only effective if the most important costs and benefits have been valued. However, this is not the case for this project, where monetary values of aquaculture social, environmental and cultural effects are not available but could be significant.

3.3 Economic valuation methodologies

A particular aquaculture scenario may have impacts on factors for which no market exists to provide an economic consequence, for example: environmental impacts on amenity values, water quality, biodiversity and natural character. Such impacts can be valued using a range of economic valuation methodologies. Procedures such as contingent valuation, choice modelling or travel cost analysis provide ways to monetise non-market aquaculture impacts (PwC 2006). However, the relevant data is not currently available and is too expensive to collect for this project. It was decided at the project scoping meeting with ARC that valuation techniques were too resource-intensive. Consequently key impacts for aquaculture were not directly quantified in monetary terms, but could be considered as future areas of investigation.

A more cost-effective way to monetise impacts is the benefit transfer method (BTM), which extrapolates values of previous studies to estimate the economic value of changes resulting from current scenarios or policies. A major challenge to conducting economic valuations using BTM is finding the most appropriate studies to use (PwC 2006). There is extensive, although by no means always conclusive, overseas literature on the monetary valuation of non-market impacts, but relevant studies focus on fisheries rather than aquaculture (PwC 2006). In New Zealand there is a real dearth of studies relating to aquaculture impacts. In light of this lack of suitable reference material the BMT would provide inconclusive results.

3.4 Multi criteria analysis

A quantitative CBA works best when high standard economic data are available. This is not the case for the analysis concerning the impacts of aquaculture on environmental, social and cultural categories. On the other hand, a qualitative Multi Criteria analysis (MCA) can reliably compare impacts upon the quadruple bottom line (QBL) categories even when quantitative data is not available for all categories (including economic). The MCA was therefore chosen as the preferred methodology for this project.

In circumstances such as this evaluation of aquaculture effects, where time and monetary resources are limited or where quantification is impractical, the Multi Criteria Analysis (MCA) is a more appropriate and cost-effective methodology to use. MCA can provide a simple decision support framework for the ARC to consider, assess and weigh complex multi-pronged issues such as the choice of aquaculture scenarios.

The MCA offers a number of ways of aggregating data on individual criteria to provide an indication of the overall performance of scenarios (Communities and Local Government 2009). It also provides more flexibility than a CBA, and is more comprehensive in its coverage, but it relies on professional judgement rather than the gathering, assessment and application of numerical data. This influences the appropriate end use of the results, which are to be taken as indicative and the main findings should be applied with caution.

The MCA can assist future policy development taking into consideration the issues and concerns that are held by policy makers and capturing these within a set of indicators. Much of the value of the MCA lies in the thought and preparation that goes into the early steps of the analysis such as the development of indicators.

The MCA provides a way to review and assess QBL impacts for aquaculture. It is an analytical tool that can be used to assist in policy development, but is by no means the only valid analysis that can be undertaken. The MCA has the ability to shed light on the many complex interfaces of aquaculture, and essentially provides a comparative analysis between scenarios, rather than a comprehensive understanding of the magnitude of individual effects.

The MCA process involves qualitative ranking of indicators by a number of stakeholders according to their preferences and belief systems. The ranking in this report represents the views of a selected multi-disciplinary group analysing issues at a regional level. The outcomes of an MCA reflect the knowledge of the group who carry out the analysis and changes in who assigns the rankings could change the MCA result.

Research has shown that better judgements are produced by a group than individuals working separately (Regan-Cirincione 1994). Elements such as impartial facilitation, a structured ranking process and a multi-disciplinary approach lead to improved outcomes over traditional problem solving (Communities and Local Government 2009). The preferred approach for a MCA is to use facilitated workshops (Communities and Local Government 2009). In this particular case, participants had different areas of expert knowledge about aquaculture impacts and represented a diverse mix of interest groups, disciplines and areas of interest. The robustness of the MCA is increased when focus groups are used to deliberate in workshops with the help of a facilitator, rather than via phone calls or emails.

By working as a collective, participants often discover interconnections between areas of apparently separate expertise (Communities and Local Government 2009). Each participant sees the larger picture within which the MCA is set. This affects individual contributions as each person's own area of expertise is put into perspective. The role of the facilitator is to focus on the process and to maintain a task orientation to the work. She/he ensures that all participants are heard, understands the dynamics of the group, is sensitive to the effects of group processes and intervenes to progress the work of the group.

The MCA does not label a particular scenario as "good" or "bad". All forms of economic development prove complex when realised and generate a number of effects, both positive and negative. The analysis provides an understanding of the performance of each scenario in terms of the four well-beings (QBL) categories.

The limitations of a MCA include the reliance on the opinions of experts based on their knowledge, and the qualitative nature of the rankings and their further analysis. The limited available data on the scale, intensity, duration and the likely future ability to mitigate environmental effects in particular was a constraint. This difficulty was to some extent mitigated by the use of a sensitivity analysis. Also any form of analysis is limited when it attempts to forecast effects over extensive timeframes such as 25 years, which adds a degree of uncertainty to the analysis. Although there are some assumptions and potential caveats in methodology and assessment, useful conclusions can be drawn around the scenarios. These conclusions have to be considered in the context of the indicators chosen as well as the process and analysis of this particular MCA.

3.5 Preferred methodology

Discussions with the ARC on the above points led to the MCA becoming the preferred methodology. It was felt that a CBA would only deliver a simpler summary of the more detailed economic aspects provided by the EIA and was not adequate to address the QBL effects of aquaculture. This is not contradictory to the recommendations by the proposed Economic Analysis Framework (EAF) for aquaculture: "where possible, economic benefits and costs should be quantified using a variety of techniques as recommended...where economic costs and benefits cannot be quantified, it should be documented and clearly

explained and an alternative technique, Multi Criteria Analysis, can supplement the EAF in helping decision-making where the non-quantifiable and quantifiable benefits and costs are considered alongside" (PwC 2006 p.35).

4 Building of the Multi Criteria Analysis

4.1 Introduction

Prior to this report, the ARC had developed three aquaculture scenarios for the Auckland Region in conjunction with research institutes and the local aquaculture industry (Appendix One). The Multi Criteria Analysis (MCA) was used to analyse the scenarios and provide a broad level of understanding concerning the social, economic, cultural, and environmental effects of each scenario. The objective was to assess the relative magnitude of the effects of a number of indicators providing an overall ordering of scenarios, from the most preferred to the least preferred scenario.

4.2 Structure

Since a MCA is qualitative in nature and potentially open to criticism, a specific structure has been followed during this project to increase its robustness and credibility including:[1]

1. three aquaculture development scenarios that broadly bracket possible future development trajectories and existing development;
2. the development of a range of environmental, social, cultural and economic indicators appropriate for the impacts likely to be generated by each of the aquaculture scenarios;
3. a description of the ranking process for the indicators applied to the scenarios;
4. ranking of indicators by a multi-disciplinary group through a facilitated workshop;
5. fully briefed workshop participants who were provided with maps, instructions, assumptions associated with methodology, and an opportunity to pre-rank scenarios;
6. presentation of the outcomes of the analysis using different methods such as graphic representations and tables;
7. a discussion of the results in this report;
8. a sensitivity analysis conducted on the scenario and indicator rankings; and
9. a presentation of conclusions.

The structure of the MCA followed here is typical of what has been used in overseas projects (Communities and Local Government 2009).

4.3 Scenarios

For the purposes of this analysis, the MCA compared three scenarios: the status quo or Scenario 1 represents the "do nothing" or "business as usual" scenario, and two other scenarios (2 & 3) which represent additional levels of aquaculture development. In summary the scenarios are:

- Scenario 1 Existing Marine Farms: These are the currently operating oyster and mussel marine farms in the Auckland Region.

[1] Communities and Local Government (2009): Multi-criteria analysis manual.

- Scenario 2 Existing Farms plus Industry Medium Term Expansion Aspirations until 2025: This scenario was developed in consultation with the industry and involves an expansion of current farming practices to 2025 mainly including oyster and mussel farms, but also allowing for a small area for experimental species and finfish. The biggest expansion lies in mussel farming with over 1,000 hectares of additional space envisaged primarily in the western Firth of Thames.
- Scenario 3 Realistic Value Adding Innovation until 2050: This scenario was developed in association with Cawthron and NIWA and is a further expansion of scenario 2 with the addition of four indicative co-culture areas in mid to deep waters. It involves an additional 1,839 ha of mussels and oysters, 40 hectares of finfish (including fallow), 10 hectares of scallops and 250 hectares of experimental species mixed in with polyculture.

Table 1 provides an overview of the three scenarios in terms of size, location and type of species farmed. A detailed description of the scenarios can be found in Appendix One.

Table 1 Geographic location, type and size of existing and indicative aquaculture scenarios

Summary of the three Aquaculture Scenarios

Scenario 1 Existing Farms		Scenario 2 Existing Farms plus Industry Medium Term Expansion				Scenario 3 Realistic Value Added Innovation (Scenario1 existing +Modified Scenario2 + added innovation)			
General	*70*	Type	Existing ha	Existing + proposed new area	Indicative new area	Type	Existing ha	Added Innovation	Area (ha)
Number of farms	*70*					Mussels	91.5	Spat catching (scallop)	10
Average farm size ha	*3.7*	Mix mussel /finfish		18	18	Oysters	250.00	Finfish (excluding fallow area)	40
		Mussel	91.5	1,206	1,114			Experimental mixed species	250
Oyster total size area	250	Oyster	250	387	137			Mussels (new)	1,408
								Oysters (new)	431
Mussel total size area	91.5	Totals	341.50	1,611	1269	Total Area	341.50	Total new	2,139
Total area Scenario 1	**341.50**	**Total area Scenario 2 (exist + indicative new)**			**1,610.50**	**Total Area Scenario 3 (existing + amended scenario 2+ indicative innovation)**			**2,480.50**

Details of the three Aquaculture Scenarios

Scenario 1			Scenario 2				Scenario 3			
Geographic location	Existing ha	Type	Existing	New ha	Type	Proposed change	Existing ha	New ha	Type	Indicative change from scenario 2
Firth of Thames				1,000	Mussels			616	Bivalves (mussel 80% of 770 ha)	Resiting the indicative 1000 ha further north in deeper water.
								154	Bivalves (oyster 20% of 770 ha)	
								16	Kingfish/Hapuka. 130 ha space, 8 economic units 2ha each	
Geographic location	Existing ha	Type	Existing	New ha	Type	Indicative change	Existing ha	New ha	Type	Indicative change from scenario 2

								100	Experimental species eg seaweeds & sponges	
Waimungu Point	45	Mussel	45				45		Mussel	
Pakihi Island				10	Oysters	New		10	Oyster	
Wairoa Bay	14	Oysters	14	21	Oysters	Increase to 35ha	14	21	Oyster	
West of GB	32.5	Mussel	32.5	18	Mussels or finfish	Finfish trial within existing applications	32.5	18	Mussels	
								18	Kingfish/Hapuku. 3 sites, 37.5 ha space per site, 3 economic units per site at 2ha/unit. 40-45m water depth	Fish farming /co-culture at three 250 ha indicative sites. Replace Port Fitzroy site with deeper sites west & north of GB
								420	Bivalves (mussel 80% of 175 ha space, 3 sites)	
								105	Bivalves (oysters 20% 175 ha of space, 3 sites)	
								112.5	Experimental species (37.5ha, 3 sites)	
North of GB								6	Kingfish/Hapuku. 1 site, 37.5 ha space per site, 3 economic units per site at 2ha per unit. 70-75m water depth.	1 deeper water 250 ha Fish farming / co-culture trial site
								140	Bivalves (mussel 80% of 175 ha)	
								35	Bivalves (oysters 20% of 175 ha)	
								37.5	Experimental species (37.5ha)	
Waiheke Island	20.00	Oysters	20	2	Oysters	Increase from 20ha to 22ha	20	2	Oysters	
								10	Spat catching (scallop)	East of Waiheke Island
	14	Mussel	14	10	Mussels	Increase from 14 to 24 ha	14	10	Mussels	
South Kaipara	94	Oysters	94	104	Oysters	Previously indicative AMA's 408 ha	94	104	Oysters	
	19.81	Oyster								
Mahurangi	122	Oysters	122			None	122			

4.4 Assumptions

Key assumptions were developed for the three scenarios and four well-being categories. This was to ensure that, when assessing the scenarios, participants focused on assessing "residual risks" of impacts beyond matters that can be expected to be dealt with under the Resource Management Act 1991 (RMA) planning and consenting process. The assumptions establish a "realistic" environment in which to assess rankings for the indicators for all three scenarios.

4.4.1 Assumptions applying to all scenarios

- All identified areas in all scenarios are fully farmed at "design" capacity.
- All necessary statutory approvals have been obtained for all the farmed areas:
    - Potential adverse effects of a "catastrophic" nature for any of the aspects of the four well-beings are not anticipated to occur – since this would be contrary to the RMA test of sustainable management of natural and physical resources, necessary to pass and to get resource consent.
    - Prospective large scale developments would likely require staged development subject to a responsive adaptive management regime and comprehensive monitoring of effects.
    - Consequently, differences between scenarios will be for the scale and duration of "residual risk" of adverse effects.
    - Current best practice for marine farm design, construction and operation will be employed at all new development locations.
    - Over time technological change will improve the efficiency of farm operations and management of detrimental and potential effects. However, it was considered inappropriate to simply assume that all potential adverse effects would be resolved by yet to be developed technological advancements. Consequently, rankings were assessed based on current technology and only minor allowances for improvement were permitted over time.

4.4.2 Assumptions for the individual scenarios

Scenario 1: Based on available evidence, existing marine farms have comparatively low impact on community uses/values.

Scenario 2: The locations of the localized expansions of existing farms are not intended to be exact, but do provide a reasonably accurate indication of the size and location of medium term industry expansion interest. The location of the ~1000ha block in the Firth is only approximate but the size was guided by detailed numeric modeling of potential phytoplankton effects and the location was selected to reduce potential impacts upon navigation and safety, and visual amenity.

Scenario 3: The more northward location (than in scenario 2) of the Firth ~1000ha blocks is indicative. The indicative split between different species occupying the "co-culture" areas will not compromise each other and there may be some positive interactions. The location of the 3 mid-water and 1 deeper water co-culture farm blocks should be taken as broadly indicative only.

4.4.3 Assumptions for the four indicator categories

Environmental:

- Farms as far as practicable would be located as to not compromise identified areas of particularly high environmental value. This might be feeding or spawning grounds for rare, endangered or threatened species.
- Farms would have been assessed to ensure that as far as can be predicted they would not lead to the catastrophic collapse of surrounding ecosystems through direct or indirect effects.
- Approval for new farms would be based on a reasonable certainty about a range of direct effects, but more limited understanding of the potential for indirect, e.g. flow-on, food chain and trophic cascade effects.
- Industry best practice for reducing Biosecurity and other environmental risks would be followed.

Social:

Indicator on Amenity values and open space

- Areas of high value (natural heritage, environmental significance etc) are protected: these will be identified and will be prohibited areas for aquaculture development.
- Strategic planning will ensure that the location of future marine farms will not unduly compromise the amenity value of private property.

Indicator on Community participation

- Consultation, public awareness of proposals etc. is provided. The community at large will be provided with the opportunity to be involved. The scenarios may therefore differ in terms of what level of skill, or resourcing might be demanded of a community to effectively participate.

Economic:

- There is a market for farmed fish produce, including a premium for "New Zealand Inc." products in export markets.
- Stability in the money markets prevails, with a relative low NZ dollar, making exports internationally competitive.
- There is a return on investment and invested capital for aquaculture farmers – hence it is assumed that space will be utilised and cost is not a prohibitive barrier for industry access.
- The cost of innovation such as capital costs for new/improved methods and techniques is internalized by industry and is not prohibitive to industry.
- There is a supply of skilled labour for the industry.
- Aquaculture produce continues to find a niche in high quality domestic markets, and is used to leverage tourism expenditure in the region (consolidation of the industry, Auckland place based marketing, strong links with processing and food and beverage sector).
- The time frame of the scenarios starts at 2010 and extends to 2025.

Cultural:

Planning and consultation take into consideration:

- An agreed on process with iwi to determine/identify sites or passages (waka ama) of cultural significance.
- An agreed process, developed through consultation, to identify traditional fishing sites – assume agreement is reached between iwi.
- An agreed process through consultation, to identify mana-moana – as opposed to "sites of cultural significance". Mana moana are areas in the sea which iwi have "authority" and where specific iwi "lore" has been developed.
- Recognition of the special significance iwi has with the sea – folk-lore, historical attachments, protocols for conservation.
- Where marine farms have a negative impact on the cultural activities of iwi and opportunities to advance iwi aspirations - these occur at a regional level. It is acknowledged that there are differences in competing uses where iwi applications for marine farms are not seen to impinge on the cultural activities of iwi, because they would be in control of the application process. For the purposes of this regional MCA it is assumed that the general planning processes are sufficient to take into account matters that would affect all cultural activities or interests held by iwi.
- Treaty of Waitangi matters are considered in relation to the allocation of space. While there is no obligation on a regional council to create space specifically for iwi, when it is created the regional council will fulfil its statutory obligations. Economic opportunities for iwi increase in scenarios 2 & 3. As economic opportunities increase, social benefits increase as well (development of skills, management opportunities, employment etc).
- Depending on the policy platform, iwi would have access to their traditional fishing sites.

4.5 Indicator development

Based on existing literature and expertise, a first draft list of indicators and definitions was prepared. Officers from the ARC contributed significantly to the development of these indicators. The process started with the consultants drafting a series of environmental, social, economic and cultural indicators based on existing aquaculture literature overseas and within New Zealand (Bartley et al. 2007; Banta et al. 2006). These were then reviewed and expanded by ARC experts on environmental, social, cultural and economic aquaculture matters.

After several drafts, the indicators were further refined in a meeting between ARC and Enveco. Subsequently, not only were the definitions of the indicators refined, but also specific ranking examples for each indicator were developed to provide further clarification for the workshop. The project team also agreed on the ranking system to be applied.

Although it was recognised that the four well-being categories typically overlap, e.g. economic effects often are inter-linked to social outcomes, and cultural effects are linked to the economy and communities, an agreement was reached on the use of four separate categories to reflect environmental, social, economic and cultural values. The scope, definition and allocation of the indicators into the four well-being categories determined by Enveco and the ARC therefore set the parameters of the MCA.
The development of the indicators took several months, which is typical for the MCA process as most of the effort lies in developing and defining the effects of scenarios to allow for a robust ranking during the workshop.

The indicators that have been identified encompass a range of different issues concerning environmental, social, cultural and economic effects that future and existing development of aquaculture may have on Auckland's coastal marine area. These effects were to be considered and ranked for the three aquaculture scenarios. Associated definitions and ranking examples were developed to assist workshop participants in assessing the scenarios. Any obvious omissions, duplications or misinterpretations were also able to be highlighted and corrected during the course of the workshop.

A finalised list of indicators, definitions and rankings used during the workshop can be found in Table 2.

Table 2 Definition and ranking examples of MCA indicators

		Scenario 1	Scenario 2	Scenario 3
Social Impacts				
1	**Competition for space and public use**			
	Relates to the competing demands for water space between marine farming and people's recreational activities such as fishing, boating, swimming and diving. Includes the degree to which the marine environment remains freely accessible to the public.			
	Ranking example: Marine farms located in areas of high recreational use/value may score a "-H", and those in areas of low recreational use/value score an "-L"			
2	**Community participation**			
	The degree to which communities have the opportunity to be involved in decision-making. Includes the extent to which industry groupings provide opportunities for community participation. Aquaculture may be divisive in communities, but also may lead to protest groups, which can be effective in building social capital, and have better outcomes in giving people a voice when governance or the regulatory system fails, i.e. it might reduce transaction costs of individuals having to protest, or not getting optimal outcome due to lack of voice.			
	Ranking example: the community has been involved marginally in decision-making and the process has been costly to them in terms of time and resources, which may score a "-H".			
3	**Amenity values and open space**			
	Those natural and physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, harmony, inspiration and aesthetic coherence. Includes visual impacts and noise of the marine farm and servicing craft.			
	Ranking example (visual): marine farms located in areas of high visual amenity value (such as close to popular coastlines where seaward views are currently of a natural undeveloped environment) may contribute to a "-H" ranking for a scenario.			

Environmental Impacts				
4	Physico-chemical "Habitat"			
	Includes both direct and indirect mechanisms of habitat change in the water, on the seabed or adjacent foreshore. Includes such potential water column effects as changes in; suspended solids and turbidity (eg from such sources as faeces or excess fish food), nutrients, soluble therapeutants, water movement, wave and light attenuation, increased habitat complexity from farm structures, etc. Potential benthic effects include shell drop, organic nutrient enrichment, and change in redo potential. Potential foreshore effects could include change in wave climate or erosion potential. *Ranking example: mussel farms that increase localised water column habitat complexity and reduce turbidity and nutrients through seston removal, but also slow water movement and locally degrade seabed physical and chemical habitat quality for the original biological community may be considered to contribute a neutral or only a small negative influence upon the overall scenario ranking. Co-culture of fish, algae, and filter feeding bivalves may reduce the potential for otherwise more negative physico-chemical effects of say fish farming alone.*			
5	Marine mammals			
	Addresses the likelihood of marine mammals being indirectly or directly adversely affected by marine farming (e.g. through entanglement, habitat exclusion and vessel disturbance). *Ranking example: marine farming methods with high inherent risks to marine mammals (eg entanglement), or where their location is likely to exclude them from important habitat eg feeding and breeding area would contribute to a -ve ranking. Methods & locations that improved conditions would contribute to a +ve rating.*			
6	Birds			
	Marine farms can provide additional roosts and new feeding areas and prey, but also can lead to habitat exclusion, entanglement, and indirect effects on birds such as phytoplankton depletion induced reduction in macro invertebrate food for wading birds. *Ranking example: marine farms threatening feeding and roosting grounds may score a "-H"*			
7	Plankton			
	Refers to potential direct and indirect impacts of marine farming on small organisms in the water column, including phytoplankton, zooplankton, and includes their depletion (eg by filter feeders), enhancement (eg in response to added nutrients), or change in community structure. *Ranking example: marine farming methods with greater inherent risks of significant plankton depletion would contribute to a more -ve ranking for a scenario than those with a smaller risk.*			

8	**Benthic ecology**			
	Refers to potential direct or indirect impacts of marine farming on animals and plants living on or in the seabed or adjacent foreshore. This potentially includes such effects as reduced benthic community diversity in response to organic enrichment and other habitat shifts, increased predators responding to shell drop, introduced invasive species, contaminant effects, sea grass and algal response to shading, etc *Ranking example: marine farming methods with greater inherent risks of significantly reducing previously existing benthic ecological value would contribute to a more -ve ranking for a scenario than those with a smaller risk.*			
9	**Fish**			
	Refers to the potential direct or indirect impacts of marine farming on fish. This includes risks of genetic dilution and pathogen transmission via escape of selectively bred fish, and their interactions with wild fish and other species. Includes competition for resources with wild fish and related ecosystem effects such as predation. *Ranking example: marine farming methods with greater inherent risks of causing significant adverse effects upon natural fish populations would contribute to a more -ve ranking for a scenario than those with a smaller risk.*			
10	**Natural character**			
	Natural character relates to the degree of modification away from the "pre-human occupation" condition. Includes natural processes, elements and patterns. The degree to which the natural character of the coastal environment is preserved is a matter of national importance under s6 RMA. *Ranking example: marine farms located in areas of significant natural character would contribute to a negative scenario ranking since they reduce natural character value. Larger farms may have a more negative impact. Farms located in areas of lesser natural character value may have a lesser negative impact.*			
11	**Resource use footprint**			
	The rate of resource and energy use per output of the marine farming activity. *Ranking example: an energy intensive fish feeding system or an inefficient food conversion rate may score a "-H"*			
12	**Biosecurity risk**			
	Ecological risks as the result of infested farm or other structures by fouling pests. Marine farms can be vectors for the spread of invasive species and disease and act as a "reservoir" for the further spread of pests. *Ranking examples: adequate management practices in place to minimise the establishment and spread of fouling pest may score a "-L"*			
Economic Impacts				
13	**Opportunity cost of aquaculture**			
	Relates to the competing demands for water space between marine farming and commercial activities such as shipping, charter fishing boats and tourism activities.			

	Ranking example: no interference with commercial tourism activities and marine farms may score a "no impact or negligible effect"			
14	**Transaction costs**			
	Refers to costs incurred other than production costs, e.g. research, information, monitoring and regulatory costs, legal fees. The numerous regulatory requirements for aquaculture activities and the on-going uncertainty around future legislation incur substantial outlay as well as ongoing cost in terms of time commitment and money.			
	Ranking example: Shellfish culture may be managed by small scale units and with a small scale of investment and may score a "+H". At the other end, intensive fish culture represents a large amount of initial investment and may score a "-M".			
15	**Effects on local economy**			
	The direct and indirect benefits to the local economy in terms of employment, supply chain products and increased spending as a result of the marine farm activity. Includes the ability for the activity to foster spin-off industry such as aquaculture directed tourism, restaurant links, food processing etc.			
	Ranking example: support of the local economy through employment and purchase of supply chain products may score a "+H"			
16	**Industry performance**			
	Degree of support provided to the vision of the Aquaculture Industry to achieve $1 billion in sales by 2020/25.			
	Ranking example: the level to which financial contribution to the $1 billion target by industry is enabled.			
Cultural Impacts				
17	**Competing uses**			
	Relates to the competing demands for water between marine farming and cultural activities. Competing uses and values looks at marine farms that impinge or prevent iwi related activities from occurring. By cultural activities this also implies those aspects of kaitiakitanga or guardianship of natural and physical resources by Maori: e.g. of customary fishing areas, waahi tapu, and other sites of cultural significance.			
	Ranking example: affecting wake ama or use of traditional navigation craft through marine farms			
18	**Maori economic opportunities**			
	Includes aspects such as, employment and economic independence, leadership development, better access to education and development of skills, and employment. Consideration is also given to Treaty of Waitangi regarding economic opportunities created through new space.			
	Ranking example: Participating in marine farm development scores an "H+".			

4.6 Workshop preparation

The logistics of the workshop, such as the choice of candidates and ranking method, were discussed with the ARC. Participants were given the opportunity to pre-rank criteria to allow for an independent assessment prior to the discussion at the workshop. To ease the understanding of the multiple location scenarios, a hard copy of each scenario in the form of a map was provided to workshop participants (see Appendix Two). The maps were used as visual tools to help participants understand the context of each scenario and to support decision making in the ranking process. Participants were also provided with instructions and assumptions behind each of the scenarios and indicators.

4.7 Workshop participants

Participants were chosen from various organisations for their expertise in fields covering the major issues concerning potential effects of aquaculture on the four well-being categories. This was to maximise the outcome of the workshop by creating lively sessions with a high exchange of information between participants whose areas of expertise differ. Workshop participants and their specific areas of focus were:

- Jim Dollimore (Biomarine, industry), Dominic McCarthy (ARC, regional council), Barb Haydon (NIWA, research institute) and Nigel Keely (Cawthron, research institute) assessed the **environmental indicators**.
- Jim Dollimore, Dominic McCarthy, Anaru Vercoe (ARC), Barb Haydon and Chris Batstone (Cawthron) assessed the **social indicators**.
- Jim Dollimore, Catherine Murray (ARC), Chris Batstone and Annabelle Giorgetti (Enveco, consultant) assessed the **economic indicators**.
- Anaru Vercoe and Kristy Hill (ARC) assessed the **cultural indicators**.

Participants were not limited to comment on the categories assigned to them. The process was designed to reflect the values of all attendees. Participants at the workshop were not considered to be "representative" of the wider Auckland community. The use of expertise from industry, local government, consultancies and research organisations in a focused workshop environment solely aims to provide a robust outcome.

4.8 Cultural considerations

Prior to the workshop there was discussion with the ARC's Maori Relations Team on where cultural indicators would sit best in this process. The outcome was that:

- The MCA process works by viewing the outcomes for each scenario against each other. If Maori indicators had formed only a small part of any of the three categories their significance would likely have been lost amongst the mainstream indicators. This could lead to a perception that Maori issues were not given any significance with respect to Treaty obligations and ARC policy.

- If indicators for Maori were to be omitted from the Cultural category and subsumed within the other three categories, then what would be substituted in its place? The category would then need to embrace a multi-cultural perspective (Maori, Pakeha, Chinese et al.) that would have required the development of more indicators. Policy work in the broader aquaculture project has used the term "cultural" in reference to Maori/iwi issues. It would therefore be consistent to use the same meaning for the purposes of the MCA.

Three cultural indicators (see table 2) were drafted and presented at the workshop. However, the workshop's time constraints limited focussed discussion on this category. It was also clear that there was some overlap with the proposed indicators and that these would require further analysis and clarification. It was agreed by workshop participants that ARC officers including the Maori Relations Team would undertake to:

i. Define and clarify the indicators; and,

ii. Rank the indicators.

At the post-workshop meeting ARC officers agreed that the cultural category could be collapsed into two indicators: 1) Competing Uses, and 2) Maori Economic Opportunities.

It was also agreed to retain Maori related indicators exclusively within the Cultural category and that it would be assumed that other ethnicities would be broadly captured under the other three well-beings. This approach was adopted in view of the unique relationship Maori had with the Crown by virtue of the Treaty of Waitangi.
Finally, and with respect to the Treaty of Waitangi, it was assumed that Treaty matters and related ARC policies would be implicit in the ranking considerations of the other three categories (social, economic and environment).

4.9 Assessment of scenarios

The qualitative assessment used by the participants applied a particular scale ranging from a negative high to a positive high impact. Indicators could experience different degrees of positive or negative effects for each scenario. The ranking scale used at the workshop is outlined below.

Table 3 Ranking scale used at workshop

Ranking used at the workshop	Qualitative value of ranking
"+H"	High positive effect of the particular indicator chosen on the scenario ranked
"+M"	Moderate positive effect
"+L"	Low positive effect
"0"	Negligible or no effect
"-L"	Negative low effect
"-M"	Moderate negative effect
"-H"	High negative effect

One of the aims of the workshop was to reach consensus on the ranking through discussion. Where participants either (i) did not agree on the intensity of the effect,

(ii) agreed that the current level of effects may be able to be mitigated due to technical advances in the future or, (iii) agreed that effects were uncertain due to a current lack of knowledge, a low level of confidence was attached to the ranking. Medium and high levels of confidence indicated general consensus on the likely relative scale, intensity, and duration of projected effects. The low level of confidence assigned to some of the rankings provided the basis for a subsequent sensitivity analysis (see section 4.13).

4.10 Weighting

All indicators were given the same weight during the ranking process at the workshop. Consideration was given to applying a separate weighting to specific indicators to address any important identified imbalance. It was decided not to proceed with differential weighting since decisions on the relative importance of values (e.g. environmental versus economic), normally require some form of democratic process. As a consequence the four well being categories and their indicators remained unweighted producing an equal magnitude of effect (25% weight) for each category. Differential weightings could be developed in the future if considered necessary and appropriate. As described below (section 4.11), however , retaining this equal weighting during overall evaluation involved a normalisation process that affected the individual relative contribution of some indicators since the four well-beings were represented by unequal numbers of indicators.

4.11 Normalisation process

Once indicators were ranked by workshop attendees, a process was required to combine the qualitative rankings in a meaningful way to achieve an overall evaluation of the scenarios. To achieve this, rankings were assigned numerical values as seen in table 4.

Table 4 Change of qualitative workshop rankings to numbers

Ranking used at the workshop	New numerical ranking
"H+"	3
"M+"	2
"L+"	1
"0"	0
"L-"	-1
"M-"	-2
"H-"	-3

This numerical ranking assumes that the relative effect of best (H+) and worst (H-) case rankings for any indicator assigned at the workshop differs by no more than a maximum of 6, and that the difference for example between worst (H-) and next lesser effect (M-) is only 1. Alternative numerical rankings could be applied, if justified, and would likely affect MCA results. Such alternatives are not investigated in this report.

Once all the rankings were assigned numerical values, indicators within each of the four wellbeing categories needed to be given the same combined value (see 4.10 above). This process of producing comparable outcomes between categories and scenarios is referred to as "normalisation". Some categories had more indicators

than others (e.g. "Environment" covered 9 indicators compared with "Culture" which covered only 2). Normalisation rendered the percentage value for each of the four categories at 25%, representing an equally shared weight.

Normalised rankings for indicators were used in the QBL, scenario, and sensitivity analyses.

4.12 Analysis of results

Standard methods for representing MCA results are performance matrices and charts. In a performance matrix each column represents a scenario and each row describes the performance of the scenarios against a chosen indicator. A chart depicts the overall results (in terms of individual indicators, the four categories and the three scenarios) in the form of bars. These methods have been used in this report to represent results from the MCA workshop including:

- A summary of results of all rankings in a colour coded table (table 5).
- Detailed findings of the indicators as discussed at the workshop – an extension of the summary table with observations made at the workshop (section 5.2).
- Workshop rankings summarised in a chart to provide an overview of results before the normalisation process (chart 1).
- Normalised indicators to allow for an overview of the rankings (chart 2).
- Normalised overall outcome of the QBL to allow for a comparison between the four categories (chart 3).
- Comparison between scenarios of total normalised negative, positive and overall effects allowing for an indicative ranking of the scenarios (chart 4).
- Sensitivity analysis on the normalised ranking of indicators and scenarios (charts 5 to 10).

4.13 Sensitivity analysis

A sensitivity analysis helps define the robustness of conclusions derived from a MCA (Communities and Local Government 2009). It tests the extent to which uncertainty, low levels of confidence and/or disagreements during the assessment affect the rankings of the individual indicators and therefore the overall scenario order.

A sensitivity analysis consists of varying one or more of the parameters/assumptions of the MCA to see how these variations affect the MCA outcomes. Workshop participants had limited information about some of the key inputs such as the intensity of some of the environmental effects. Sensitivity analysis is a way to deal with these uncertainties.

Participants assigned a low, medium or high level of confidence to the rank given to each indicator. In instances where extensive discussions were held and different points of views and perspectives outlined, a low level of confidence indicated that workshop participants had different views and did not agree on the likely scale, intensity, or duration of the effect. A low level of confidence was also assigned were participants reached a consensus, but either agreed that current estimates of the level of effects might well be mitigated by future technological advances, or agreed that effects were uncertain due to a current lack of knowledge.

Where indicators were ranked with a high or medium level of confidence, the rankings were considered robust enough to not require a sensitivity analysis, i.e. where there was a high to medium level of confidence, there was no shift in the

outcome of the scenarios (scenario 1 therefore stayed the same as it had no low level of confidence indicators).

The sensitivity analysis tested the importance of not knowing for sure the intensity of effects on a particular indicator – did it matter at all, and if it mattered, by how much was the overall ranking of the scenarios affected. Some participants may have thought that the effect was not as significant as indicated, whereas other participants may have thought the opposite. Therefore a variation in two directions was tested in order to reflect both opinions.

The positive variation of the sensitivity analysis tested an optimistic version of the MCA assuming for example, that as development increases, improved technology will be introduced and environmental effects will be better managed and minimised. The negative variation tested whether the rankings of the scenarios change as a result of a pessimistic view of the workshop "low confidence" rankings, e.g. if yet to be fully understood adverse environmental effects prove to be greater than what is currently anticipated.

For example, during the workshop indicator 1 (Physico-chemical "habitat") was ranked as an "M-" for scenario 3 with a low level of confidence. In the sensitivity analysis, the negative variation changed the ranking to "H-", whereas the positive variation generated an "L-".

There are limitations to any sensitivity analysis. In this case only the low levels of confidence were tested, and all indicators were "moved at once" in one particular direction. There are endless variations to sensitivity analysis, but other approaches are beyond the scope of this report. In the longer term more resources might be used to improve accuracy and subsequently the confidence in ranking of the indicators. However, sensitivity analysis ultimately still tests what was outlined in this section.

4.14 Robustness of MCA process

The MCA process in this report is well structured and robust. While the method applied a qualitative approach, the MCA methodology involved a rigorous discussion process to arrive at a consensus (or in some cases, disagreement). A wide range of experts from different organisations and disciplines supported the process and provided advice on effects.

The sensitivity analysis tests and helps to improve the robustness of the MCA process, and highlights the limited current knowledge on some of the indicators included in the analysis. The level of uncertainty is also closely linked with the problem of making reasonable and reliable projections into the future. This was the case with aspects of scenario 2, but more particularly with scenario 3 and the possible environmental impacts it would have. The application of the assumptions outlined in this report therefore became crucial in providing workshop participants with a foundation to determine rankings and assign appropriate levels of confidence.
Experts generally made comments concerning the likely development of future technology/innovation to mitigate adverse effects, but these comments were made on the assumption that in 25 to 50 years this technology would be available.

Consequently, the effects of innovation were mixed particularly in regard to the management of environmental effects across all three scenarios. However, when the indicator "Industry performance and Innovation" (indicator 16) was assessed workshop participants assigned a positive ranking across the scenarios but it was

not reflected in the rankings for each of the environmental indicators. These outcomes could be a result of not actively assessing the effects of indicators from different categories against each other or that the environmental category was ranked first and independently of the possible effects of innovation.

In terms of the coverage or the scope and nature of the indicators, it was acknowledged by the project team that there were limitations particularly given that the three scenarios were to be viewed at a regional level and not a location specific level. Discussions in the workshop did focus on specific areas of the region's CMA, but they were later contextualised at a regional level.

The ARC acknowledges that the MCA has highlighted areas that require further investigation (e.g. the need to fill information gaps in the cultural category) and may at some future stage decide to re-apply the MCA process once more comprehensive and reliable information has been obtained.

5 MCA Results

5.1 Indicators summary results

Each workshop participant contributed to the discussion on the rankings for each of the indicators and a facilitator guided the discussion and encouraged participants to reach a consensus where possible. Table 5 shows an overview of the findings of the workshop, but it does not provide a direct comparison between categories.

Table 5 Workshop ranking of 18 indicators

	Ranking scale	L+	M+	H+
		0		
		L-	M-	H-
	Levels of Confidence	*L, M or H*	*L, M or H*	*L, M or H*
		Scenario 1	Scenario 2	Scenario 3
Environmental Impacts				
1	Physico-chemical 'Habitat'	0	L-	M-
		H	*H*	*L*
2	Marine mammals	0	0	L-
		H	*L*	*L*
3	Birds	L+	L+	L+
		H	*L*	*L*
4	Plankton	0	L-	L-
		H	*H*	*L*
5	Benthic ecology	L-	L-	M-
		H	*M*	*M*
6	Fish	0	L+	0
		H	*M*	*L*
7	Natural character	L-	M-	M-
		H	*H*	*L*
8	Resource use footprint	0	L-	M-
		H	*H*	*H*
9	Biosecurity risk	L-	M-	M-
		H	*M*	*L*
Social Impacts				
10	Competition for space & public use	0	L- M-	L- M-
		M	*L*	*L*
11	Community participation	M-	L-	L-
		H	*M*	*M*
12	Amenity values and open space	L-	M-	M-
		H	*M*	*M*
Economic Impacts				
13	Opportunity cost of aquaculture	0	L-	M-
		H	*M*	*L*
14	Transaction costs	L-	M-	H-
		H	*M*	*M*
15	Effects on local economy	L+	M+	H+
		H	*H*	*H*
16	Industry performance	L+	M+	H+
		H	*H*	*M*
Cultural Impacts				
17	Competing uses	0	L-	M-
		H	*M*	*L*
18	Maori economic opportunities	L-	M+	H+
		H	*M*	*M*

5.2 Detailed findings of all indicators

This section sets out the detailed results of the discussion held during the workshop for each indicator in terms of:

- the scoring at the workshop;
- the level of confidence attached to the ranking;
- the definition and a ranking example given prior to the workshop; and
- a summary of the discussions and observations made during the workshop (a detailed account of observations made by participants can be found in Appendix Three).

This section can be used to understand the rationale behind the ranking assigned to each indicator at the workshop.

5.2.1 Environmental Indicators

The environmental indicators comprise nine areas of possible environmental effects:

1. Physico-chemical "habitat"
2. Marine mammals
3. Birds
4. Plankton
5. Benthic ecology
6. Fish
7. Natural character
8. Resource footprint
9. Biosecurity risk

Environmental indicator 1	Scenario 1	Scenario 2	Scenario 3
Physico-chemical "habitat"	0	L-	M-
Level of confidence in ranking:	*H*	*H*	*L*
Definition: Includes both direct and indirect mechanisms of habitat change in the water, on the seabed or adjacent foreshore. Includes such potential water column effects as changes in; suspended solids and turbidity (eg from such sources as faeces or excess fish food), nutrients, soluble therapeutants, water movement, wave and light attenuation, increased habitat complexity from farm structures, etc. Potential benthic effects include shell drop, organic nutrient enrichment, and change in redox potential. Potential foreshore effects could include change in wave climate or erosion potential.			

*Ranking example: M*ussel farms that increase localised water column habitat complexity and reduce turbidity and nutrients through seston removal, but also slow water movement and locally degrade seabed physical and chemical habitat quality for the original biological community may be considered to contribute a neutral or only a small negative influence upon the overall scenario ranking. Polyculture of fish, algae, and filter feeding bivalves may reduce the potential for otherwise more negative physico-chemical effects of say fish farming alone.
Observations: Assumptions concerning innovation should be considered in terms of reducing the environmental impacts of scenarios 2 and 3. With staged development there is greater control and a better chance of managing effects. Scenario 1 effects were known but there was potential to improve effects with future technological developments. This scenario was therefore ranked at "0" with a high level of confidence. NIWA have data to show that the possible differences in impact between the scenarios would not be significant where innovation and staged development come into play. The worst case scenario was considered with the positioning of the 1000ha block in the Firth of Thames next to the Wilson's Bay development. There is not enough reliable evidence to warrant a high level of confidence with respect to scenario 3. The Great Barrier sites do pose other considerations. NIWA's data indicates that the impacts of sites in deeper water would have less effect on the environment, but there remains a risk, due to lower water movement and exposure. These sites also have different physical environments than inshore sites. It was noted that as the size of the farmed area increases, environmental monitoring may recognise early negative effects. Also, future technological advances may better mitigate adverse effects. However rankings here and elsewhere were based on existing technology and knowledge.

Environmental indicator 2	Scenario 1	Scenario 2	Scenario 3
Marine mammals	0	0	L-
Level of confidence in ranking	*H*	*L*	*L*
Definition: Addresses the likelihood of marine mammals being indirectly or directly adversely affected by marine farming (e.g. through entanglement, habitat exclusion and vessel disturbance).			
Ranking example: Marine farming methods with high inherent risks to marine mammals (e.g. entanglement), or where their location is likely to exclude marine mammals from important habitat (e.g. feeding and breeding area) would contribute to a -ve ranking for a scenario. Methods and locations that improved conditions would contribute to a +ve rating.			

Observations: There was a general consensus that there would be minimal negative effects on marine mammals as marine farms developed. The effects of scenarios 1 & 2 would be negligible. Scenario 3 could pose potential hazards regarding the offshore sites at Great Barrier and their relative positioning with migratory pathways. NIWA has not yet encountered any problems with the Wilson's Bay site, although this is now only partially developed.

Scenario 1 has been ranked "0" with a high level of confidence; because the existing farms are located in areas that do not affect whale movements – all are inshore and generally do not provide obstruction.

For scenario 3, there is a risk for migratory whales (Brydes and Baleen) colliding or becoming entangled with structures and/or being affected by the acoustic effects of larger boats servicing farms that are positioned further offshore and closer to migratory pathways. New methods of farming could potentially reduce these problems, although this is still under development and some way off. In New Zealand, there have been two instances where Brydes whales have reportedly died after becoming entangled in mussel spat collection lines (Lloyd, 2003). There has been no evidence of any adverse effects on seals, Hectors dolphins or toothed whales, which have optimum spatial sensitivity.

The rankings for each scenario reflected the participants' confidence that there would be minimal effects on marine mammals but that further information was required before a confident level of certainty could be given. Scenario 1 was given a "0" ranking with a high level of confidence reflecting that the current existing farms posed no apparent threat/risk. Scenario 2 was given a "0" ranking but with a low level of confidence indicating that more information would be needed concerning whale movements in the Firth of Thames. Scenario 3 was given an "L-"ranking with a low level confidence indicating that both the effect of development on whale movements in the Firth of Thames and the location of sites off Great Barrier required more research.

Environmental indicator 3	Scenario 1	Scenario 2	Scenario 3
Birds	L+	L+	L+
Level of confidence in ranking	*H*	*L*	*L*

Definition: Marine farms can provide additional roosts and new feeding areas and prey, but also can lead to habitat exclusion, entanglement, and indirect effects on birds such as phytoplankton depletion and induced reduction in macro invertebrate food for wading birds.

Ranking example: Marine farms threatening feeding and roosting grounds may score an "H-".

Observations: For all scenarios, there are likely to be a number of positive effects such as additional roost sites on buoys and increased feeding opportunities. It was considered that the offshore sites provided increased roosting, localised food availability and other positive effects on sea going birds (with few, if any known risks/threats).

Scenario 1 was ranked with a high level of confidence, because anecdotal evidence and observations over time have indicated that there is a low level of effect on birds. Currently there is very little robust/quantitative information or studies on this matter, although some site specific research has been undertaken.

It is not known at present whether the new habitat created by the farms and the

increased roosting opportunities truly represent a large positive effect for scenarios 2 & 3. Also, rankings had a low level of confidence because of the unknown indirect effects on the wider environment from the larger farms, e.g. the impact on shoreline birds in the Firth of Thames.

Environmental indicator 4	Scenario 1	Scenario 2	Scenario 3
Plankton	0	L-	L-
Level of confidence in ranking	*H*	*H*	*L*
Definition: Refers to potential direct and indirect impacts of marine farming on small organisms in the water column, including phytoplankton, zooplankton, and includes their depletion (eg by filter feeders), enhancement (eg in response to added nutrients), or change in community structure.			
Ranking example: Marine farming methods with greater inherent risks of significant plankton depletion would contribute to a more -ve ranking for a scenario than those with a smaller risk.			
Observations: In considering this indicator, it was observed that there may be a possible alteration to plankton levels in semi-enclosed waters like the Firth of Thames, but modelling has indicated that this is likely to be localised. Studies to date suggest that phytoplankton depletion on the existing marine farming sites is small and mainly observed within and close to the farms. Evidence shows that there is less effect on zooplankton than phytoplankton. It was also noted that the effects on phytoplankton could be positive through promotion of growth by nutrient discharges from farms. In addition, farming operations can positively affect ecological conditions where there is an already enriched environment, e.g. by filter feeders turning phytoplankton, that use nutrients to grow, into harvested biomass. Scenarios 1 & 2 were ranked with a high level of confidence based on the above studies. Scenario 3 was considered to have a relatively low level of impact, however the consequences of this scale of development remain uncertain, and a low level of confidence was assigned.			

Environmental indicator 5	Scenario 1	Scenario 2	Scenario 3
Benthic ecology	L-	L-	M-
Level of confidence in ranking	*H*	*M*	*M*
Definition: Refers to potential direct or indirect impacts of marine farming on animals and plants living on or in the seabed or adjacent foreshore. This potentially includes such effects as reduced benthic community diversity in response to organic enrichment and other habitat shifts, increased predators responding to shell drop, introduced invasive species, contaminant effects, sea grass and algal response to shading, etc			
*Ranking example: M*arine farming methods with greater inherent risks of significantly reducing previously existing benthic ecological value would contribute to a more -ve ranking for a scenario than those with a smaller risk.			

Observations: There is greater uncertainty associated with scenario 3. Benthic effects are likely to be greater for fish farming, but at the same time can be offset by an offshore location (e.g. increased depth, currents & wave energy) and the ability to farm space less intensively.

Benthic effects are reversible in the short-to-medium term (i.e. 5-10 years). There are differences between scenarios 1 & 2, but given that these are largely bi-valves there is little concern, compared to scenario 3 with the introduction of fin-fish. Monitoring of the effects of farming in Wilson's Bay shows that effects are minimal, keeping in mind that this area is only partially developed. The current assumptions, combined with staged development, establish a basis for adaptive management.

Environmental indicator 6	Scenario 1	Scenario 2	Scenario 3
Fish	0	L+	0
Level of confidence in ranking	*H*	*M*	*L*

Definition: Refers to the potential direct or indirect impacts of marine farming on fish. This includes risks of genetic dilution and pathogen transmission via escape of selectively bred fish, and their interactions with wild fish and other species. Includes competition for resources with wild fish and related ecosystem effects such as predation.

Ranking example: Marine farming methods with greater inherent risks of causing significant adverse effects upon natural fish populations would contribute to a more -ve ranking for a scenario than those with a smaller risk.

Observations: For scenarios 2 & 3, there is always a risk of disease and genetic transfer spreading to the wild population. Escapees generally have a low chance of survival having been reared in controlled environments. The functioning of marine farms as artificial reefs is poorly understood, but there are likely to be positive benefits. The question of aggregation versus enhancement of wild fish remains undetermined for mussel and finfish farming.

There is some evidence to suggest finfish farms actually enhance wild fish populations and "commercial catches", but if the effect of a mussel farm is mostly to aggregate, then additional fishing pressure may negatively affect stocks. Consumption of fish eggs is an issue of potential importance and should be approached with caution, particularly with respect to large scale sites in close proximity to high value fish habitat such as the Firth of Thames. Depletion of fish eggs can be monitored if large scale mussel farming is contemplated in the Firth. Therefore, all scenarios have been ranked with a "0" or "L+".

Sites of aggregation wild fish populations and can be exploited by fishers, e.g. snapper around mussel farms. Again, there is no substantive evidence to suggest that this has a significant effect on populations with respect to existing farms, but with an increase in mussel farm sizes under scenarios 2 & 3 there is the potential for noticeable depopulation to occur.

Rankings for this indicator were indicative of the minimal effects on fish. Scenario 1 was ranked "0" with a high level of confidence indicating that there was neither a positive or negative effect by marine farming methods on fish. Scenario 2 was given a slightly better ranking than either scenario 1 or 3 but with a moderate level of confidence reflecting that the Firth of Thames development while promoting further aggregation of fish, did not pose a threat (despite the possible effect of

fishers on populations). Scenario 3's low level of confidence rating was indicative of the sentiments by participants for potential genetic transfer and spread of disease with the establishment of finfish farms.

Environmental indicator 7	Scenario 1	Scenario 2	Scenario 3
Natural character	L-	M-	M-
Level of confidence in ranking	*H*	*H*	*L*

Definition: Natural character relates to the degree of modification away from the "pre-human occupation" condition. Includes natural processes, elements and patterns. The degree to which the natural character of the coastal environment is preserved is a matter of national importance under s6 RMA.

Ranking example: Marine farms located in areas of significant natural character would contribute to a negative scenario ranking since they reduce natural character value. Larger farms may have a more negative impact. Farms located in areas of lesser natural character value may have a lesser negative impact.

Observations: This indicator produced disagreement over what "natural character" was (often confused with visual amenity) and some participants were of the opinion that natural character was a matter of individual perception. Natural character considers the level of change of an area from a natural (pre-human) baseline to the current state of that area. It was difficult to assess given there are no standard methods to "measure" natural character and that it constitutes a number of elements that have a paucity of information (e.g.: degree of modification of the natural marine ecosystems).

Traditional land-based animal farming was considered to have a worse impact on natural character in New Zealand than aquaculture. This perception may have been linked to the greater visibility of land–based activities than development activities that occur in the sea. It was recognised by participants that there are always going to be negative effects on natural character whether or not it is observed. Recognition of "natural character" could have an effect on planning and developing farms. Better information concerning this indicator could assist in locating future marine farms away from such areas.

Taking these factors into consideration, farms, like those in scenario 3, located further off-shore is less visible to most observers. However the natural character of the area would still be affected due to the number and size of farms, particularly for scenarios 2 & 3. These were accordingly ranked "M-". For scenario 1, the farms are smaller and to some extent have become accepted as a progression of rural development into parts of the seascape. Existing farms are not likely to greatly affect the current state of natural character (although recognition of lost natural character is taken into account). Accordingly scenario 1 was ranked "-L" with a high level of confidence. Greater risks of impact are associated with the larger developments of scenarios 2 & 3, with greatest uncertainty over the impacts of scenario 3.

Environmental indicator 8	Scenario 1	Scenario 2	Scenario 3
Resource use footprint	0	L-	M-
Level of confidence in ranking	*H*	*H*	*H*

Definition: The rate of resource and energy use per output of the marine farming activity.

Ranking example: An energy intensive fish feeding system or an inefficient food conversion rate may score a "-H" as it uses up energy and emits indirect greenhouse gas emissions through the production of energy and materials.
Observations: Shellfish aquaculture has a very small material and energy use footprint. The production processes are fairly simple. Scenario 1 only comprises shellfish and therefore was ranked "0" in terms of resource use footprint. Finfish farming requires high energy inputs from automatic feeding systems, raising fingerlings on-land, feed embodied energy (the energy it takes to produce feed) and high material usage in the form of pen cages, nets, etc. Finfish has higher inputs, probably akin to other intensive agriculture such as poultry, but this has potential to be lowered significantly with new food sources (such as feed made from non-fish products). However, the larger the farm the higher the energy input. Therefore scenario 3 was ranked "M-". Scenario 2 is less resource intensive than scenario 3, because bivalves use less equipment and energy compared to fish farming. The finfish component is minor compared to scenario 3. New species like seaweeds and sponges are likely to have smaller resource use footprints. Therefore scenario 2 was ranked "L-".

Environmental indicator 9	Scenario 1	Scenario 2	Scenario 3
Biosecurity risk	L-	M-	M-
Level of confidence in ranking	*H*	*M*	*L*
Definition: Ecological risks as the result of infested farm or other structures by fouling pests. Marine farms can be vectors for the spread of invasive species and disease and act as a "reservoir" for the further spread of pests.			
Ranking examples: Adequate management practices in place to minimise the establishment and spread of fouling pest may score a "-L".			
Observations: Bio-security risks/effects, in particular the permanence of these effects, have implications at an inter-regional level. The transmission of invasives through for example: the movement of gear; bilge; and introduction of new species, present high risks not only at a regional level but nationally as well. Scenarios 2 & 3 have a higher level of risk concerning the introduction of invasives given that expansion requires more gear and more structures. Consequently both of these scenarios were ranked "-M" with a medium level of confidence for scenario 2 and a low level of confidence for scenario 3. It was noted that there is a general lack of information about bio-invasive species making it difficult to assess the risk from new species such as finfish and future experimental species hence the low level of confidence for scenario 3.			

5.2.2 Social Indicators

The social effects have been represented below and comprise the following three indicators:

1. Competition for space and public use
2. Community participation

3. Amenity values and open space

Social indicator 10	Scenario 1	Scenario 2		Scenario 3	
Competition for space and public use	0	L-	M-	L-	M-
Level of confidence in ranking	*M*	*L*		*L*	

Definition: Relates to the competing demands for water space between marine farming and people's recreational activities such as fishing, boating, swimming and diving. Aquaculture may be divisive in communities, but also may lead to protest groups, which can be effective in building social capital, and have better outcomes in giving people a voice when governance or the regulatory system fails, i.e. it might reduce transaction costs of individuals having to protest, or not getting optimal outcome due to lack of voice.

Ranking example: Marine farms located in areas of high recreational use/value may score a "-H", and those in areas of low recreational use/value score an "-L"

Observations: Overall, it was recognised that there is always a degree of competition between general recreational use, public values and aquaculture. More marine farms in place imply that there is less access for the public to open space. For scenario 1, the interference of marine farming activities and public use was thought to be minimal and that generally people had come to accept this level of development; scenario 1 was accordingly ranked "0" with a medium level of confidence.

For scenarios 2 & 3, it was observed that generally more farms means less access. Even in the case of scenario 1 the existing farms prevent access by simply being there. The level/degree to which access is limited increases from scenario 1 through to 3. However the type of "access" changes with each scenario. Scenario 1 limits access in certain parts of the CMA close to shore. In the case of scenarios 2 & 3, along with the limited access under scenario 1, access to open space by the public is increasingly prohibited.

Workshop participants could not reach a consensus on how access was limited under scenarios 2 & 3 and that "access" was a perception that differed from one person to the next. Participants generally agreed that the effect was either minor or moderate, but not severe, therefore two rankings of "L-" and "M-" were both assigned with a low level of confidence.

Social indicator 11	Scenario 1	Scenario 2	Scenario 3
Community participation	M-	L-	L-
Level of confidence in ranking	*H*	*M*	*M*

Definition: The degree to which communities have the opportunity to be involved in decision-making. Includes the extent to which industry groupings provide opportunities for community participation. Aquaculture may be divisive in communities and may lead to protest groups, which can be effective in building social capital, and have better outcomes in giving people a voice when governance or the regulatory system fails. It may reduce transaction costs of individuals protesting, or not getting optimal outcome due to lack of voice.

Ranking example: The community has been involved marginally in decision-making and the process has been costly to them in terms of time and resources, which may score a "-H".

Observations: The public can be involved in decision-making through the plan development and resource consent processes, but once at the Environment Court appeal stage it may be too expensive for the individual or community to participate further in decision-making. This could be exacerbated by the level of expansion under scenarios 2 & 3 (ergo increased possible objections to planning and associated costs). Scenario 1 was given the rank of "-M" and a high level of confidence given that the public could not participate in the transitional process for these farms (Aquaculture Reform (Repeals and Transitional Provisions) Act 2004).

The amended RMA Simplifying and Streamlining Act 2009 provide less opportunity for community groups to participate in decision-making. RMA changes (phase 2) are also expected to specifically address aquaculture matters in more depth, particularly in regard to Aquaculture Management Areas and the identification and allocation of space, all of which would appear to further limit community participation. While the Ministry for the Environment has funds to support community participation in the planning process, it is likely that these funds would not be sufficient to cover costs once appeals to the Environment Court are considered. Accordingly both scenarios 2 & 3 were given a medium level of confidence and a rank of "-L".

Social indicator 12	Scenario 1	Scenario 2	Scenario 3
Amenity values and open space	L-	M-	M-
Level of confidence in ranking	*H*	*M*	*M*

Definition: Those natural and physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, harmony, inspiration and aesthetic coherence. Includes visual impacts and noise of the marine farm and servicing craft.

*Ranking example (visual): M*arine farms located in areas of high visual amenity value (such as close to popular coastlines where seaward views are currently of a natural undeveloped environment) may contribute to a "-H" ranking for a scenario.

Observations: It was observed that for all scenarios amenity values can be affected by aquaculture activities. For example, people at elevated points such as hills along the Coromandel coast would see the marine farms and this may adversely affect their enjoyment depending on their perceptions. It was also noted that aircraft and boat users are affected, but it was felt that these are typically a small and temporary effect.

A mussel farm resource consent application in Kaipara harbour was declined because of the effect of the activity on amenity values. Out of a selection of 62 marine farm applications declined from 1995 through to 2003, 87 % cited "significant adverse effects" on natural character, landscape, and amenity values as one of the reasons for the decision (Banta 2006). The Marlborough District Council examined the reason why marine farm consent applications were declined - 95 % were declined at least partially on social grounds: i.e. social carrying capacity is a major factor involved in approving the extent of marine farms (Banta 2006). Scenarios 2 & 3 which have larger aquaculture developments than scenario 1, are therefore more likely to have a higher impact on amenity values, and were ranked

"M-". However, it was also observed that perceptions may change over time - people get used to the visual impacts and eventually consider it as a part of the landscape. Therefore a medium level of confidence was attached to the rankings of scenarios 2 & 3. For scenario 1, despite the general public acceptance of existing farms. It was felt that marine farms will always be visible to some degree and affect people's enjoyment of the surrounding landscape. Therefore this scenario was ranked "L-".

5.2.3 Economic Indicators

The economic effects comprise the following four indicators:

1. Opportunity cost of aquaculture
2. Transaction costs
3. Effects on the local economy
4. Industry performance & innovation

Economic indicator 13	Scenario 1	Scenario 2	Scenario 3
Opportunity cost of aquaculture	0	L-	M-
Level of confidence in ranking	*H*	*M*	*L*
Definition: Relates to the competing demands for water space between marine farming and commercial activities such as shipping, charter fishing boats and tourism activities. Opportunity costs are defined as the costs of next best investment, e.g. what the money could be spent on rather than aquaculture such as a hospital or education.			
Ranking example: No interference with commercial tourism activities and marine farms may score a "no impact or negligible effect"			
Observations: Prior to the ranking, the definition of this indicator was further discussed to clarify that it relates to the money which could be used in other investments by the government for example in providing grants for research. As such it represents a cost to society. It can also be viewed as a displacement cost, e.g. what activities on the water are displaced as the result of marine farming. It has been noted that very few activities on the water such as shipping, fishing boats, or commercial activities currently interfere with existing farms (scenario1) and vice versa. Scenario 1 was accordingly ranked "0" a high level of confidence. However, as the marine farm space is increased, the potential for interference with recreational or commercial activities at sea is also increased. The area considered for aquaculture expansion under scenario 2 was considered by some participants to have very little use capable of generating an economic return. However, the Firth of Thames does present other opportunities that do come at an economic cost to the local community. Tourism may have an increased opportunity with the expansion of marine farms. The seasonal increase			

in yachting and recreational fishing has a direct effect on the local community, although this will be smaller in comparison to marine farm expansion.

However, there is a displacement cost to society in terms of what other activities would be excluded. The value which people place on recreational activities would come at such a cost if marine farms (scenarios 2 & 3) were to be established. Taking this factor into consideration, scenario 2 was ranked "L-" with a medium level of confidence. Similarly, while acknowledging the potential benefits to industries like tourism (eg visiting marine farms and processing stations) there are also potential negative effects. Introducing large scale marine farms into pristine areas of the marine environment would most likely have a detrimental effect. There was also a significant degree of uncertainty attached to scenario 3 as to the effects on other opportunities. Accordingly scenario 3 was ranked "-M" with a low level of confidence.

Economic indicator 14	Scenario 1	Scenario 2	Scenario 3
Transaction costs	L-	M-	H-
Level of confidence in ranking	*H*	*M*	*M*

Definition: Refers to costs incurred other than production costs by government and businesses, e.g. research, information, monitoring and regulatory costs, legal fees. The numerous regulatory requirements for aquaculture activities and the on-going uncertainty around future legislation incur substantial outlay as well as ongoing cost in terms of time commitment and money.

Ranking example: Shellfish culture may be managed by small scale units and with a small scale of investment and may score a "+H". At the other end, intensive fish culture represents a large amount of initial investment and may score a "-M".

Observations: For all scenarios, it was observed that the costs of resource consents and monitoring to fulfil consent conditions are high regardless of the species farmed. Current legislative procedures are resource intensive; considerable funds have been spent on research, legal disputes, consent processes & legislation. This led to scenario 2 being ranked "M-". Scenario 1 has no proposed fish farms or experimental species, and therefore transaction costs are assumed to be lower than for the other two scenarios. Therefore scenario 1 ranked "L-".

It was also noted that in order to realise the potential of scenario 3, substantial research money is being (and will be) invested by governments, investors, marine farmers and research institutes. Therefore scenario 3 was ranked "H-".

On the other hand there will be a learning curve over the years where industry and local government will improve the management of marine farming; therefore there may be a reduction in transaction costs over time. The feedback loop of lessons learnt is expected to reduce costs in the future. This led to a medium level of confidence being assigned to the rankings of scenarios 2 & 3.

Economic indicator 15	Scenario 1	Scenario 2	Scenario 3
Effects on local economy	L+	M+	H+
Level of confidence in ranking	*H*	*H*	*H*

Definition: The direct and indirect benefits to the local economy in terms of employment, supply chain products and increased spending as a result of the farming activity. Includes the ability for the activity to foster spin-off industry such as aquaculture directed tourism, restaurant links, food processing etc.
Ranking example: Support of the local economy through employment and purchase of supply chain products may score an "H+".
Observations: Prior to the ranking, the idea of GPI (Genuine Progress Indicator) as an alternative economic measure to GDP was raised. GDP only records money earned to the economy but does not distinguish between local, regional or national earnings. GDP excludes environmental and other social impacts as the result of economic activity whereas GPI does not. However GPI is an indicator of how the scenarios perform in a whole range of areas such as those highlighted within this report. Therefore this raised concerns about double-counting within this MCA and GDP was chosen as the preferred measure. All scenarios benefit the local economy: aquaculture is labour intensive and is largely a regional activity, therefore enhancing the regional economy. Increasing production and farming higher value species will have the most positive outcome on GDP. Therefore scenario 3 was ranked "H+", because it encompasses high value finfish species and the largest production outputs (out of all three scenarios). Scenario 2 was ranked "M+", because it also has finfish species, although at a smaller scale. The effects of scenario 1 on the local economic are also positive, although these are at a much smaller scale, and do not allow for high value experimental and finfish species. Therefore scenario 1 was scored "L+".

Economic indicator 16	Scenario 1	Scenario 2	Scenario 3
Industry performance & innovation	L+	M+	H+
Level of confidence in ranking	*H*	*H*	*M*
Definition: The ability to adapt (e.g. to new technology), generate profits and stay in business, and maintain skilled workforce. Degree of support provided to the vision of the Aquaculture Industry to achieve $1 billion in sales by 2020/25.			
Ranking example: The level to which the scenarios enables financial contribution to the $1 billion target by industry. A highly adaptable and skilled industry scores a "+H".			
Observations: Prior to the ranking it was observed that as innovation improves, other efficiencies (not only in production) are also achieved. Innovation affects time and production costs, particularly as the industry expands. Any site expansion or further development over the long-term affects economies of scale, e.g. more effective management of farms, increased production at lower costs. The industry will incorporate new technology, not necessarily linked to increasing farm size or the introduction of new species. Scenario 3 is likely to contribute most to the industry's $1 billion vision due to the higher returns from finfish and possibly from other experimental species. Therefore this was ranked "H+". Scenario 2 will also contribute positively to the industry's vision, although the scale is smaller than scenario 3. Therefore scenario 2 was ranked "M+". Scenario 1 does not enjoy the high return from finfish and experimental species, but still contributes to the $1 billion vision, and therefore was ranked "L+".			

5.2.4 Cultural Indicators

The cultural effects have been represented below and comprise the following two indicators:

1. Competing uses
2. Maori economic opportunities

Cultural indicator 17	Scenario 1	Scenario 2	Scenario 3
Competing uses	0	L-	M-
Level of confidence in ranking	*H*	*M*	*L*

Definition: Relates to the competing demands for water between marine farming and cultural activities. Competing uses and values looks at marine farms that impinge or prevent iwi related activities from occurring. By cultural activities this also implies those aspects of kaitiakitanga or guardianship of natural and physical resources by Maori: e.g. of customary fishing areas, waahi tapu, and other sites of cultural significance.

Ranking example: Affecting waka-ama or use of traditional navigation craft through marine farms

Observations: While there is a viable argument supporting differences in terms of positives and negatives to iwi in relation to who the marine farm applicant is (i.e. if iwi are applying then there is less of a problem and probably no issue), this level of analysis would be better addressed in a more focussed MCA for cultural indicators. Kaitiakitanga (conservation, guardianship of natural and physical resources etc) raises the importance of Maori cultural well-being and the importance of protecting it in the region.

There tends to be a lack of Treaty engagement in these processes - while it is "part" of the RMA process, there seems to be little opportunity for Maori to actively participate

Cultural values and uses could be negatively affected by increased aquaculture development, although this would be offset by the level of participation iwi had in marine farm development. Where iwi had control or partial control over the establishment of farms, it is likely that activities such as waka-ama and sites of cultural significance would be taken into consideration. Accordingly scenario 1 was considered to have little positive of negative effect on competing uses and was ranked "0" with a high level of confidence. Scenario 2 was considered more intrusive (given the Firth of Thames marine farm) but not significantly and was ranked "L-"with a medium level of confidence. While scenario 3 presented as the most negative scenario there was a moderate level of uncertainty as to the scale of effects. Accordingly it was ranked "M-"with a low level of confidence. .

Cultural indicator 18	Scenario 1	Scenario 2	Scenario 3
Maori economic opportunities	L-	M+	H+
Level of confidence in ranking	*H*	*M*	*M*

Definition: Includes aspects such as employment and economic independence, leadership development, better access to education and development of skills, and employment. Consideration is also given to Treaty of Waitangi regarding economic opportunities created through new space.
Ranking example: Participating in marine farm development scores an "H+".
Observations: Allocation of space under the legislative provisions determines economic opportunities. The Treaty component whilst providing a clear opportunity for Maori to participate in aquaculture development would not preclude independent private development (as on Great Barrier). While there is an obligation on the Crown to settle with iwi there is no obligation on Regional Councils to create space specifically to fulfil Treaty obligations. However where new space was created the Regional Council is bound to identify representative space. There would be an increase in economic opportunity for Maori particularly in regards to scenario 2 & 3 – more space converts into more economic opportunities and greater access to resources, having a high positive economic impact. Accordingly scenario 2 was ranked "M+" with a medium level of confidence, and scenario 3 was ranked "H+" with the same level of confidence.

5.3 Numerical rankings of indicators

Table 6 below outlines the numerical values assigned to the qualitative indicator rankings.

Table 6 Numerical values of indicator ranking

	Scenario 1	Scenario 2	Scenario 3
1 Physico-chemical	0.0	-1.0	-2.0
2 Marine mammals	0.0	0.0	-1.0
3 Birds	1.0	1.0	1.0
4 Plankton	0.0	-1.0	-1.0
5 Benthic ecology	-1.0	-1.0	-2.0
6 Fish	0.0	1.0	0.0
7 Natural character	-1.0	-2.0	-2.0
8 Resource use footprint	0.0	-1.0	-2.0
9 Biosecurity risk	-1.0	-2.0	-2.0
10 Competition for space and	0.0	-1.5	-1.5
11 Community participation	-2.0	-1.0	-1.0
12 Amenity vales and open	-1.0	-2.0	-2.0
13 Opportunity cost of	0.0	-1.0	-2.0
14 Transaction cost	-1.0	-2.0	-3.0
15 Effects on local economy	1.0	2.0	3.0
16 Industry performance	1.0	2.0	3.0
17 Competing uses	0.0	-1.0	-2.0
18 Maori economic	-1.0	2.0	3.0

Chart 1 represents the above 18 indicators as they were ranked during the workshop for each scenario. The numerical scale was used to present indicators (Y axis). At this stage, indicators have not been normalised.

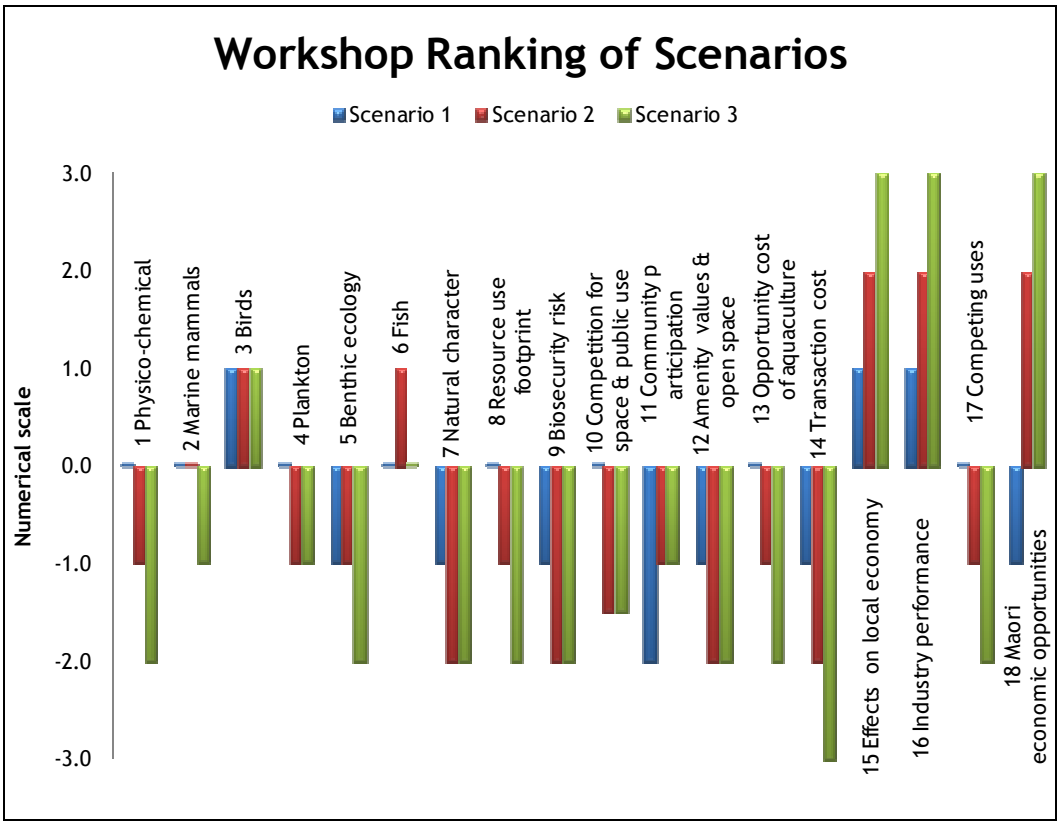

Chart 1 Pre-normalisation of workshop rankings of all four indicator categories

As with the matrix representation, this chart cannot be used to compare total rankings between categories, but only to evaluate the rankings of each individual indicator between the 3 scenarios.

Many indicators exhibit different degrees of negative impact on the scenarios. The exceptions are birds, fish, effects on the local economy, industry performance and Maori economic opportunities, where scenarios have a positive effect. All of the three scenarios exhibit negative effects on society, the environment and part of the economy, e.g. indicators 1-14 (with the exception of indicators 3 and 6). Positive effects are also illustrated by some of the cultural and economic indicators.

6 Discussion

6.1 Comparison between all indicators

To compare scenarios, numerical indicators from Chart 1 were normalised. Chart 2 illustrates how well each scenario is performing in terms of environmental, social, economic and cultural indicators.

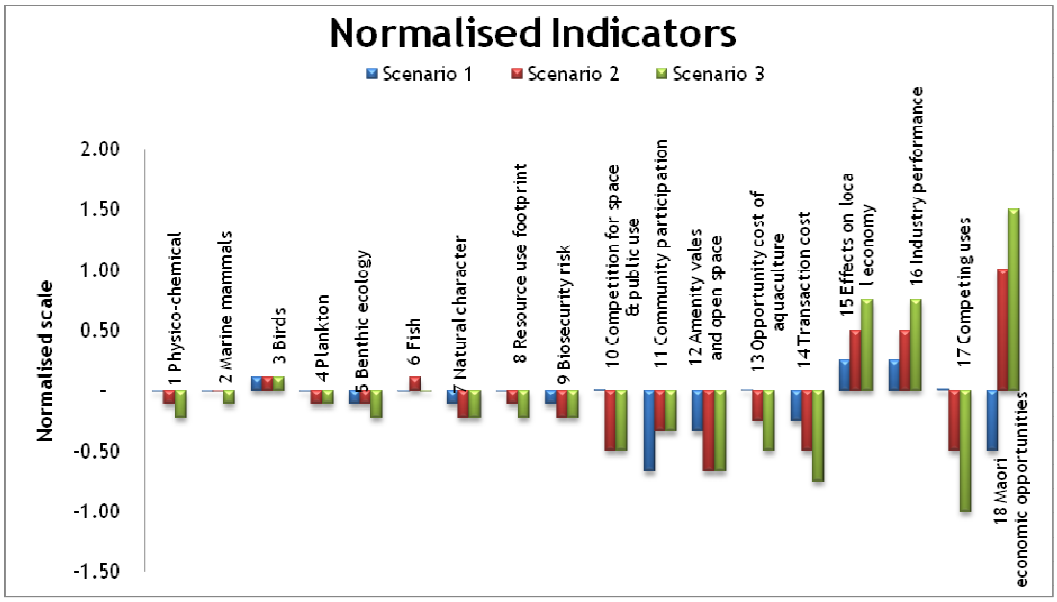

Chart 2 Normalisation of workshop rankings of all four indicator categories

The normalisation process effectively compressed the contribution of the individual environmental indicators more so than those in the other three categories. The small numbers of indicators in the social, economic and cultural categories carry individually more weight than those of the environmental category.

For scenario 1, negative environmental effects are minimal. Scenario 2 experiences some environmental effects although less severe than for scenario 3. All three scenarios impact adversely on social indicators. For scenario 3, contribution to local economic and industry performance show high positive economic effects, whereas opportunity and transactions costs are most severe. For the cultural indicators, scenario 2 & 3 show negative effects in terms of competing uses, whereas scenario 1 impacts negatively on Maori economic opportunities.

6.2 Comparison between the QBL categories

The following graph shows the normalisation process across the QBL categories. It provides a comparison applying an equal weighting of 25% for each of the four QBL categories across the three scenarios.

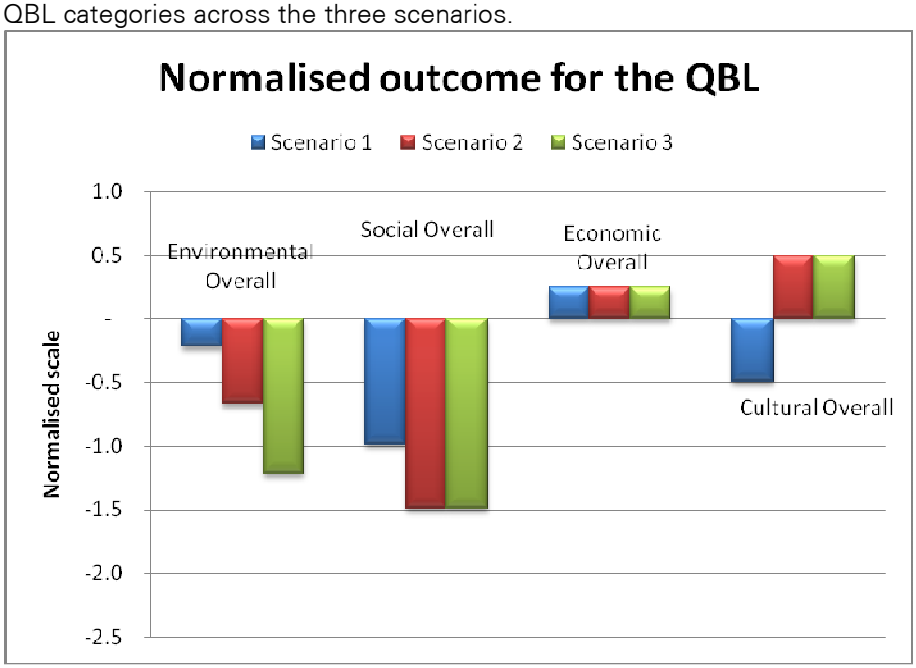

Chart 3 Normalisation of the QBL categories for all scenarios

Environmental and economic categories

Graph 3 illustrates that all three scenarios have overall negative effects in the environmental category – these increase from scenario 1 to 3. This is expected as often economic activities engender negative environmental effects rather than positive ones. Adverse environmental effects are expected to intensify as development increases.

All three scenarios have similar overall positive economic effects, and these are relatively minor when compared to the magnitude of social and environmental effects. The positive effects of some of the economic indicators were mostly offset by negative effects within the category. This is likely to have been affected by the decision to not differentially weight individual indictors within any of the four QBL wellbeings. For example, it is likely that transaction costs (indicator 14) to establish new forms and areas of aquaculture might well cost millions to 10's of millions of dollars. However, it is also likely that the returns from such developments could generate 10's to possibly 100's of millions of dollars for the regional economy (indicator 15).

The relative ranking of both of these indicators is of an opposite sign but of the same magnitude for both scenarios 2 & 3 (transaction costs: M-, and H-, and effects of local economy: M+ and H+ for scenario 2 & 3 respectively). This means the two economic indicators effectively cancel each other out despite there potentially being 1-2 orders of magnitude between their economic values.

Applying defensible differential weightings to indicators within each wellbeing category to overcome such concerns would further improve the value of the MCA process.

Intuitively scenario 3 would generate more substantial positive effects on the economy due to the introduction of larger and more high-value farms such as finfish and experimental species.

However, some of these gains are offset by the need to spend considerable investment funds to bring those new species to a point where they are commercially viable – some of these funds come from the public purse. Legislative procedures, research and consent processes are resource intensive. Finfish farming can be profitable though as has been demonstrated by the established King Salmon industry in the South Island. Unless these effects are quantified, it will be difficult to reach a conclusion.

Further research or consultation on the indicator "opportunity costs of aquaculture" would refine the outcome for the economic category.

Social category

Although the analysis shows none of the scenarios exhibit positive effects on the community, one of the reasons could be the way the way indicators were constructed during the MCA. For example, employment and education could be regarded as social indicators as well as economic. Although society and the economy are often inter-linked, it was decided at the beginning of the analysis to keep these two indicator categories separate.

Further research or consultation on the indicator "competition for space and public use" would refine the outcome for the social category.

Cultural category

For the cultural effects, scenarios 2 & 3 show overall positive effects and these are larger than those on the economy. Economic opportunities for Maori were found to be highest for scenario 3, followed closely by scenario 2. However, the current aquaculture environment represented by scenario 1 presents little economic opportunities for Maori. Some of the positive effects for scenarios 2 & 3 were offset by the fact that competition for space when considering cultural values and uses could be negatively affected by future aquaculture development.

This could change where Maori have an interest in aquaculture development. If this is the case, then the negative impacts on Maori "competition for space" would be reduced. Again, this is subject to the assumption that all indicators carry the same weight. Future weighting application of these indicators would provide further insights.

Further research or consultation on "competing uses" would refine the outcome for the cultural economic category.

6.3 Comparison between scenarios

A further agglomeration of the normalised rankings can be seen in Chart 4, which shows total negative, positive and overall effects across the three scenarios.

Overall effects represent the difference between the total negative and positive effects of all indicators for each scenario.

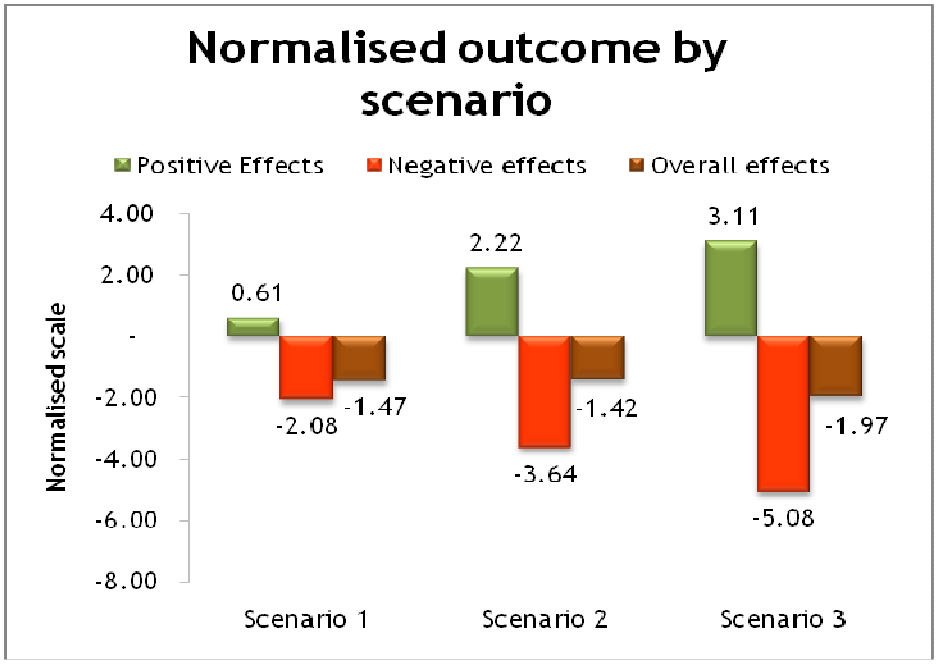

Chart 4 Total rankings (post normalisation) of the three scenarios

Given all indicators carry the same weight, scenario 3 generates the highest combined positive effects, but it also causes the largest negative effects. Positive and negative effects increase in magnitude from scenario 1 to 3. Overall effects of all three scenarios are relatively similar.

All three scenarios have negative effects outweighing positive effects. When looking at the overall effects, *ceteris paribus*[2], scenario 2 scores the lowest net negative effect, followed closely by scenario 1, with scenario 3 having the higher overall negative effect.

At this level of analysis, it could be concluded that scenario 2 is the preferred option, followed closely by scenario 1, and then by scenario 3. The overall negative effect of scenarios 1 & 2 is similar, but given the additional level of marine farm development in scenario 2 the difference between two scenarios is negligible. However, there is a clearer apparent difference in terms of absolute negative effects between scenarios 1 and 2, and scenario 3. Given this small difference between scenarios 1 & 2 and the low level of confidence attached to most environmental indicators affecting scenario 3, a sensitivity analysis was used to test the effect of shifting rankings up or down as a result of changes in those indicators with a low level of confidence.

6.4 Sensitivity Analysis

6.4.1 Sensitivity testing on indicator rankings

Chart 5 & 6 show the results of the sensitivity analysis, where changes in the indicators with a low level of confidence were made by "one degree worse"(i.e. negative variation) and "one degree better" (i.e. positive variation) respectively **(indicators highlighted in bold)**.

[2] When using ceteris paribus in economics, it is assumed all other variables except those under immediate consideration are held constant.

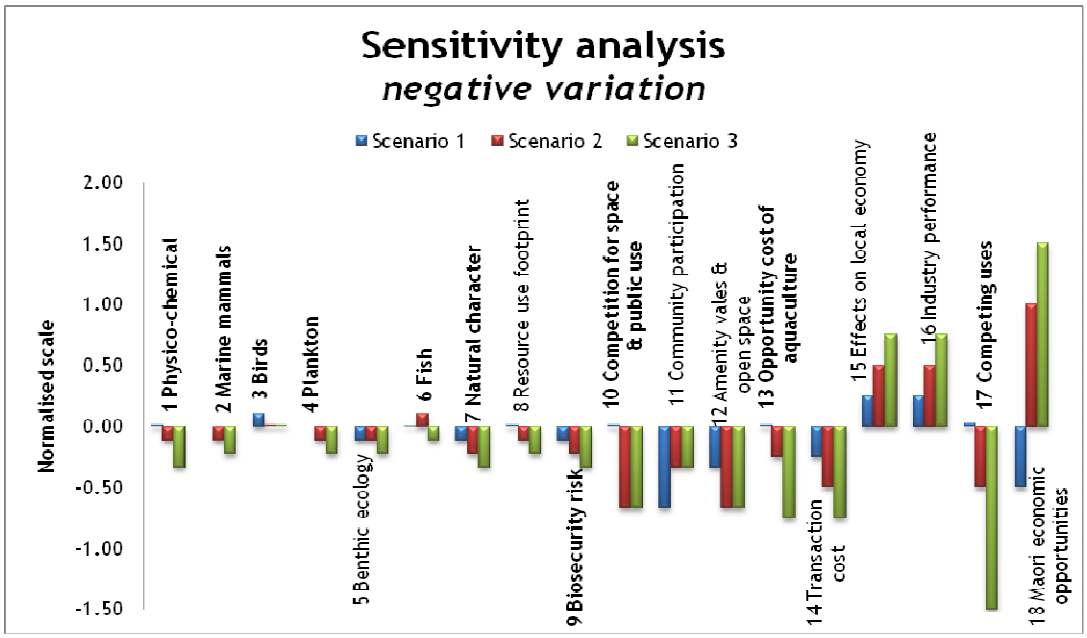

Chart 5 Sensitivity Analysis on low level of confidence rankings – negative variation

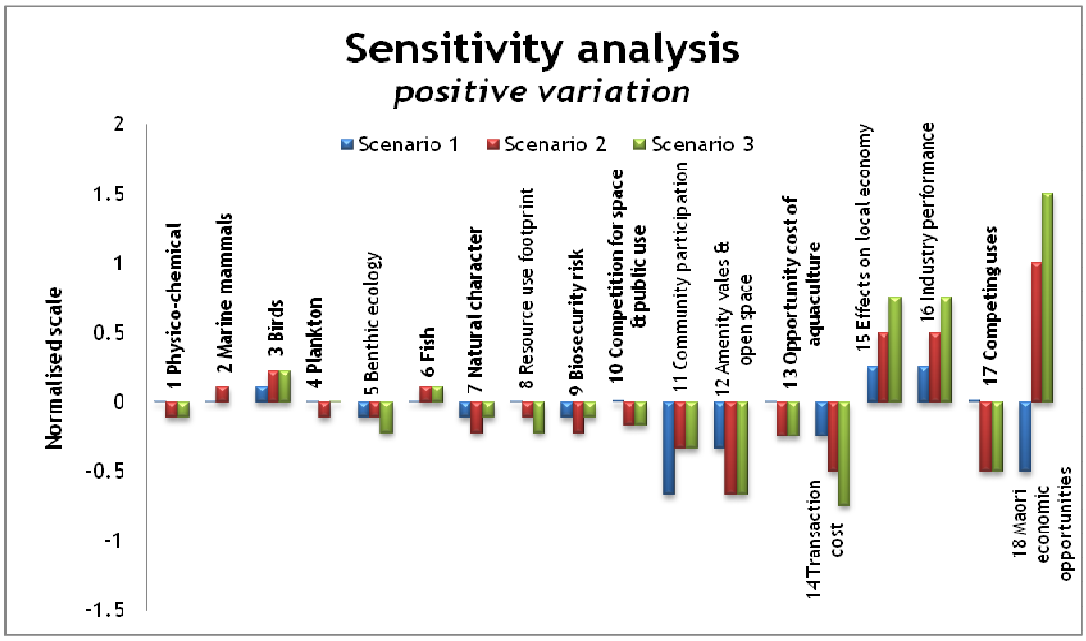

Chart 6 Sensitivity Analysis on low level of confidence rankings – positive variation

The indicators that were subject to the sensitivity analysis were:

- The indicator "Physico-chemical" had a low level of confidence for scenario 3; therefore the ranking for that scenario was changed by one degree.
- The ranking for marine mammals had a low level of confidence attached to scenarios 2 & 3; therefore the ranking was changed by one degree. At the workshop it was felt that there was a significant lack of research on the effects of marine farms and associated vessel operations on marine mammals.
- The indicator concerning birds, was given a low level of confidence in scenarios 2 & 3, principally because of the unknown indirect effects on the wider environment from the larger farms, e.g. potential flow-on effects of

expanded marine farming activities within the Firth of Thames upon shoreline wading birds at Miranda.

Similar discussions on uncertainty about the degree of adverse effects led to the inclusion of indicators 3, 6, 7, 9, 10, 13 and 17 in the sensitivity analysis (refer to section 5.2). There were no low levels of uncertainty attached to scenario 1 and all of the positive rankings. It has to be noted that some indicators, i.e. most of the environmental indicators will always be scored negatively with respect to any level of aquaculture development in the CMA.

6.4.2 Sensitivity testing on QBL categories

Negative variation

Sensitivity analysis was undertaken on the four well-being categories to further test the sensitivity of the rankings across the four well-being categories. Chart 7 provides the overall ranking results for the environmental, social, economic and cultural pillars for each of the three scenarios.

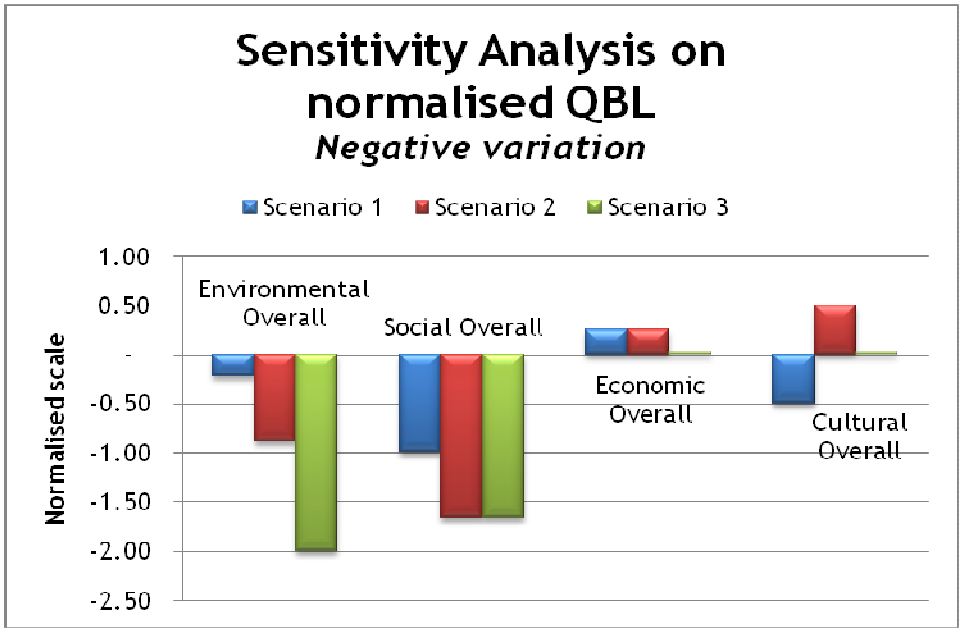

Chart 7 Sensitivity Analysis of the QBL - negative variation

The negative variation of the sensitivity analysis amplifies negative and reduces positive effects. As a consequence, the original positive overall effects for scenario 3 in the economic and cultural categories dropped to "zero" effects. Although only one indicator in each of those categories for this scenario had low confidence assigned, the overall outcome changed substantially.

The overall environmental rankings for scenarios 2 & 3 have worsened, with scenario 3 having the largest increase in adverse environmental effects. This was expected as most uncertainty is associated with the scoring of environmental impacts for scenarios 2 & 3.

The social well-being category has only changed marginally for scenarios 2 & 3. Workshop participants were fairly confident about the ranking of social indicators and therefore only one indicator was tested. Scenario 1 remained the same as no low level of confidence was attached to the indicators.

Positive variation

Positive variation sensitivity analysis amplified positive and reduced negative effects. Chart 8 provides the overall ranking results for the environmental, social, economic and cultural pillars for each of the three scenarios.

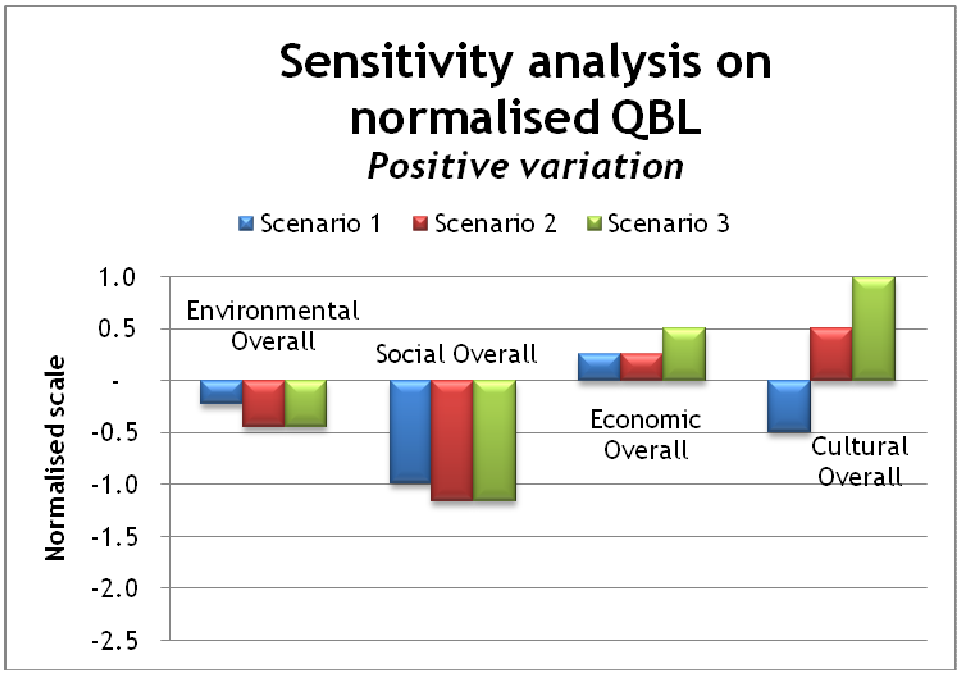

Chart 8 Sensitivity Analysis of the QBL – positive variation

Ceteris paribus, *s*cenario 3 looks more favourable, with higher positive economic and cultural overall effects than scenarios 1 & 2. Negative environmental effects have been significantly reduced, so that scenarios 2 & 3 hold the same magnitude of effects. Overall social effects for scenarios 2 & 3 have also reduced to the point where they are very similar to scenario 1. Again, scenario 1 has not changed.

6.4.3 Sensitivity testing on scenario rankings

Negative variation

The negative variation tested the effect of negative shifts on low levels of confidence indicators in order to see the extent to which uncertainty affects the outcome for each of the scenarios (chart 9). Positive and negative effects were added together to generate an overall effect to allow for the comparison between scenarios.

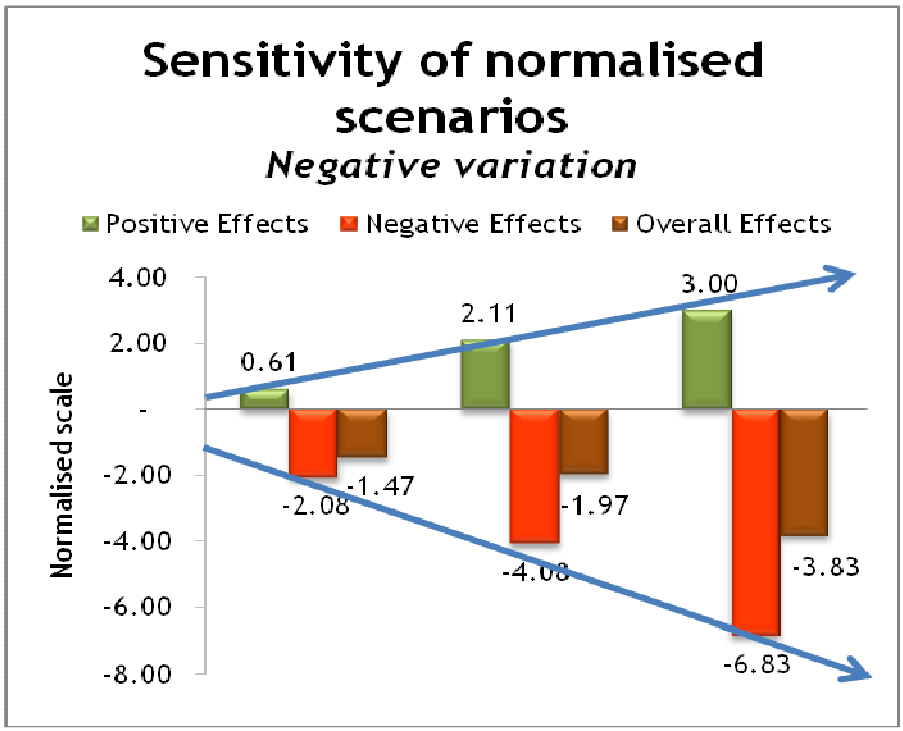

Chart 9 Comparison of normalised scenarios – negative variation

Changing low confidence indicators by one degree worse accentuates the negative effects for scenario 2 & 3. Ceteris paribus, the overall ranking of the scenarios has changed. There is now a bigger overall gap between scenario 1 & 2, therefore making scenario 2 less favourable than scenario 1 (the scenario 1 not having changed). This has mainly been caused by the uncertainty in environmental effects, despite the assumptions, and relegating these effects by one degree. The largest impact lies in scenario 3, where now overall negative effects are more significant than in the pre-sensitivity analysis ranking.

Both overall positive and negative effects increase as the move is made from scenario 1 to 3, i.e. development increases (see blue lines). In essence the larger the economic development, the larger some of the positive effects, but at the same time negative effects also increase. Negative effects outweigh positive outcomes for all scenarios, with the relative difference between the two increasing as the move is made from scenario 1 through to 3.

Positive variation

Chart 10 shows the order of preference of the scenarios as a result of changing low confidence indicators by one degree better. Positive and negative effects were added together to generate an overall effect to allow for the comparison between scenarios.

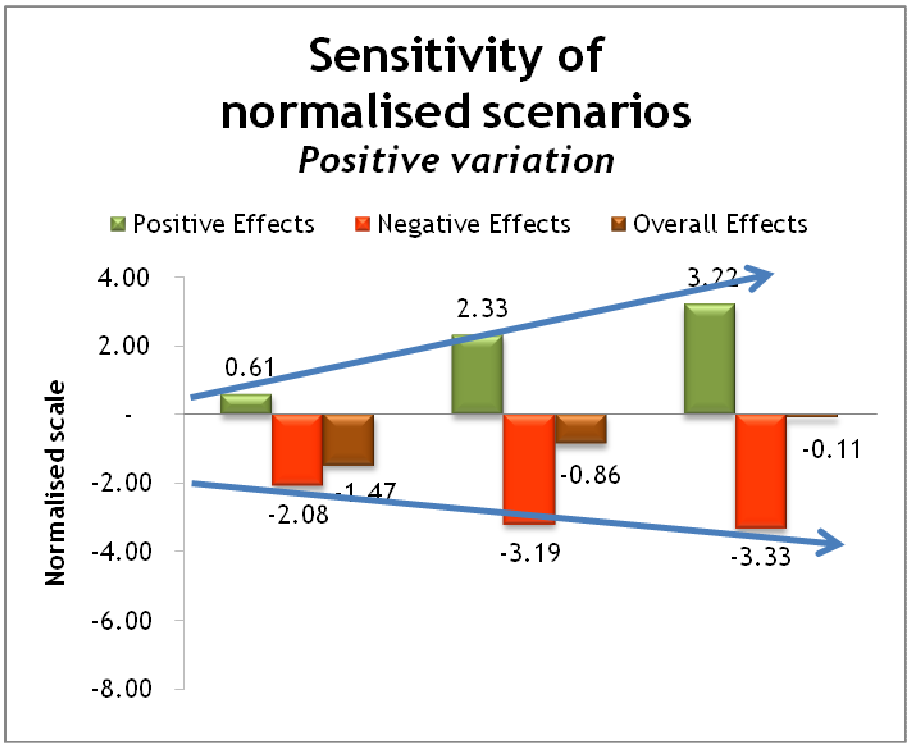

Chart 10 Comparison of normalised scenarios – negative variation

Assigning more positive values to low confidence indicators also changes the order of the scenarios. Ceteris paribus, scenario 3 has now the best overall outcome, followed by scenario 2 and then scenario 1. Again, positive and negative effects increase as the move is made from scenario 1 through to 3, i.e. similar trend to the previous graph, although the increase of negative effects between scenario 2 & 3 is much smaller (see blue line). Scenario 2 benefits from four times as many positive effects (2.33 as opposed to 0.61) than scenario 1, although negative effects are only 1.5 worse (-3.19 as opposed to -2.08).

Comparison of the original outcome (chart 4) with the negative variation (chart 9) and positive variation (chart 10) results shows that the MCA is highly sensitive to the rankings selected for low confidence indicators. For example, scenario 3 can be either most (chart 10) or least (chart 4) preferred. Consequently any conclusions about the relative preference between scenarios need to be made with great caution.

7 Conclusions

7.1 Introduction

When reading the conclusions, it has to be remembered that key assumptions were developed for the three scenarios and four indicator categories. This was partly to ensure that the MCA only considered "residual risks" of impacts – i.e. adverse effects beyond those matters that can be expected to be dealt with under the Resource Management Act 1991 (RMA) planning process.

One of the aims of the workshop was to reach consensus on the ranking through discussion. However, even with all the assumptions laid out some workshop participants still had doubts – this could have been about the assumptions themselves being optimistic. To some extent the poor performance of scenario 3 could be the result of participants retaining pre-conceived ideas (through their own experiences and perceptions) about effects on certain indicators. Where workshop participants could not reach consensus on the likely relative intensity of effects they assigned a low level of confidence to the ranking. Given the prior agreement that rankings should not just assume that adverse effects will be overcome by future innovative advances, a low level of confidence was also assigned where consensus was reached that currently anticipated levels of effect might be mitigated in the future. Similarly, a low confidence was also assigned when participants agreed that we currently lack sufficient understanding or knowledge to reliably rank effects on an indicator.

Another key assumption was that all indicators, once normalised, carried the same weight in terms of their effects. This assumption carries implications for the MCA results. Benefits to the economy in terms of finfish farming are likely to significantly outweigh opportunity or transaction costs. If this difference was to be weighted in the MCA, the overall effects on the economy would be skewed towards a more positive outcome. There is benefit in quantifying these effects in the future and assigning relative weighting to reassess the ranking of scenarios.

Applying weighting to some of the indicators to reflect individual or group preferences between indicators would provide further clarity on how scenarios are ranked. Although this is not part of the scope of this project, it may be research the ARC chooses to undertake in the future.

The four well-being categories - social, environmental, economic and cultural - have to be set in the context of this analysis. This report has provided a detailed record of how these four well-being categories and their indicators have been defined.

7.2 Comparison between the scenarios

7.2.1 Pre-sensitivity analysis

All three scenarios exhibit overall negative effects. Negative environmental effects intensify from scenario 1 to 3 (refer to chart 3). This would confirm the expectation that for some economic development increases, environmental impacts exacerbate. All three scenarios have very similar, although smaller, overall positive

effects on the economy (as defined by the MCA). None of the scenarios exhibit positive social effects – this could be a result of the way the indicators were constructed during the MCA. Most of the economic indicators have social implications within their definitions. Positive cultural effects are demonstrated by scenarios 2 & 3, whereas scenario 1 shows a negative effect (refer to chart 3).
Scenario 1 only shows positive outcomes in the economic category. Scenarios 2 & 3 score well in economic areas (including both the economic indicators and the specific cultural indicators for Maori economic opportunities), but these positives are partially outweighed environmentally and socially (refer to chart 3).

Scenario 2 proposes a further 1,000 ha of mussel and 387 ha of oysters. The MCA shows that the overall effect of this additional development would be no worse than scenario 1. Negative effects have increased for scenario 2, but these have been mostly counteracted by a growth in positive effects (refer to chart 4).
Scenario 3 introduces 40 ha finfish farming and 250 ha of experimental species. Despite the assumptions, uncertainty surrounding this type and scale of development resulted in workshop attendants scoring some indicators by one degree worse when compared to the two other scenarios. Some of these negative effects were offset by higher positive scores for the "effects on the local economy", "industry performance" and "economic opportunities for Maori", which carry significant weight in the overall assessment (see chart 2). Scenario 3 exhibits cultural and economic strengths, which are in contrast to a comparable number of lower negative environmental effects (see chart 2).

The overall outcome for scenarios 1 & 2 is very similar. Scenario 3 has the higher overall negative effect (refer to chart 4).

7.2.2 Post-sensitivity analysis

Environmental effects

The negative variation of the sensitivity analysis amplified overall negative environmental effects for scenarios 2 & 3, producing the most significant change in scenario 3 (see chart 7). Workshop participants felt confident about most of the effects in the other three categories, particularly for scenario 1. The positive variation showed that scenario 3's negative environmental effects have been reduced (chart 8). The latter are now equivalent in magnitude to scenario 2. It also showed little difference in terms of environmental effects for all three scenarios – scenarios 2 & 3 have the same effects, with scenario 1 demonstrating slightly improved outcomes (chart 8)

Social effects

In the negative sensitivity analysis variation, the social well-being category changed marginally for scenarios 2 & 3, with a slight increase in the intensity of one negative effect, i.e. "competition for space and public use" (charts 5 & 7). In the positive variation, there is now little difference in terms of social effects for all three scenarios – scenarios 2 & 3 have the same effects with scenario 1 demonstrating slightly improved outcomes (chart 8).

Economic and cultural effects

In the economic and cultural categories, application of the negative variation reduced scenario 3's positive overall effects to zero (chart 7). This was because the two indicators of "competing uses" and "opportunity costs of aquaculture" were relegated by one degree. This had a dramatic effect on the performance of scenario

3 as these indicators carry substantial weight within the Economic category (contributing 50%, or ½ of the four indicators).

Under the positive variation, scenario 3 scores considerably better culturally than the other two scenarios; it also shows higher economic benefits (see chart 8). This reflects the potential for increased marine farming development to generate higher economic opportunities for the wider society but also for Maori. Realising such economic benefits in a sustainable manner would be dependent upon minimising adequately any associated environmental, cultural and social negative effects. For scenario 1 there is no change as there was no uncertainty associated with any of the indicators.

Overall effects

As a result of the negative variation of the sensitivity analysis, the largest change in effects occurred for both scenarios 2 & 3 (see chart 9). This was due to the uncertainty in ranking most of the environmental indicators and three social, cultural and economic indicators (one in each category). Overall effects worsened for scenarios 2 and 3. Given the assumptions in section 4.4.1 on the adequate mitigation of adverse effects and staged development, a worsening of effects reflects a pessimistic view.

In the positive variation of the MCA, scenario 3 comes out as the most preferred outcome, with scenario 2 lagging significantly behind. Again, both positive and negative effects increase as there is a shift from scenario 1 to scenario 3 (see chart 10). However, negative effects for scenario 3 have fallen significantly. Scenarios 2 & 3 had their positive effects enhanced equally, but scenario 3 experienced a more significant drop in negative effects (chart 10).

Synthesis

Having performed two sensitivity analysis variations, a number of conclusions can be drawn. Low confidence or uncertainty concerning indicators does have an effect on the outcomes for each of the scenarios. Scenario 1 remains the same regardless of the variations as it has no uncertain indicators. However its place in the ranking moves due to changes in the other two scenarios (i.e. from second place to first place under the negative variation, and to third place under the positive variation).
Innovation may improve all three scenarios. Future knowledge on specific environmental effects or technological improvement is likely to change the outcome of scenarios 2 and 3. Particularly, improvements in the management of the adverse effects of finfish farming will influence scenario 3. Scenarios 2 and 3 are comparable when certain conditions are 'right': when low confidence levels are shifted positively.

Scenario 3 could be a viable option depending on new innovative technology and improved management of adverse effects. It has to be noted that there are elements such as innovation which could benefit from further research to raise the levels of confidence of some of the indicators.
Comparison of the original outcome (chart 4) with the results of negative (chart 9) and positive (chart 10) sensitivity analysis variations shows that the MCA is highly sensitive to the rankings assigned to low confidence indicators. For example scenario 3 can be either the most (chart 10) or least preferred option (charts 4 & 9). This suggests that comparison of overall effects between scenarios should only be made with caution and that perhaps greatest significance should be assigned to those findings that remain consistently unaffected by the sensitivity analysis. Examples include greatest positive economic benefits potentially being associated

with scenario 3, but also greatest potential for adverse social and environmental effects and greatest uncertainty over assigned rankings.

7.3 Strengths and weaknesses of each scenario

As indicated in the preceding section, caution should be applied when assessing the strengths and weaknesses of each scenario given that the outcomes of the MCA process are highly sensitive to such factors as the confidence in assigned rankings, to any applied weighting, and to any agreed assumptions. Therefore the following assessment does not set out to suggest that one scenario is preferred above another. Strengths and weaknesses are identified within the context of assumptions, known effects, and the MCA methodology applied within this report.

Scenario 1

Scenario 1's strengths lie in the fact that its effects are known with relative certainty. Workshop participants were most confident about the assessment of this scenario in all ranking categories. It's weaknesses are predominantly around its very limited potential to contribute to the regions (including Maori) economic growth. It also provides similarly limited opprtunities for increased Maori particpation.

Scenario 2

Scenario 2's strengths include:

- A focus on medium term expansion of well known and currently farmed species (oysters and mussels) with only minimal trialling of finfish aquaculture that would be new to the region. With this in mind the workshop considered that, inspite of the size of expansion, the management of adverse impacts should be able to be well controlled by applying current knowledge and methods of bivalve marine farming, but also possibly further improved by future techological developments.
- Expansion is localised with the largest new area envisaged in the western Firth of Thames. Most of the region would therefore remain unaffected.
- Scenario 2 has the potential to provide positive contributions to the regional economy and to Maori economic development without exposing the region to the same level of environmental and social risks and uncertainties as the larger and more experimental scenario 3.

Scenario 2's weaknesses are largely due to:

- Various parts of the community have previously expressed opposition to the expansion (Firth of Thames and southern Kaipara) envisaged by the scenario.
- Scenario 2 envisages comparatively limited and localised expansion predominanalty using currently farmed species and methods. While this 'plays it safe' by increasing confidence that potential adverse environmental and social effects can be reduced, this also limits the opportunities to discover new and innovative approaches to marine farming that may be able to produce valuable economic returns without compromising important social and environmental values.

Scenario 3

The introduction of new species and the larger expansion of currently farmed species suggests that scenario 3 could yield comparatively high economic returns but these benefits could come at the cost of increased risks of adverse social and environmental effects and overall increased uncertainty of outcome.

Scenario 3 strengths include:

- The introduction of new species and the larger expansion of currently farmed species suggests that scenario 3 could yield comparatively high economic returns that have the potential to benefit the region and include increased Maori economic opportunities.
- Potential for comparatively higher participation by iwi. Opening up new space should provide economic opportunities for Maori along with more active particpation in decision making concerning aquaculure. The other potential spin offs include better access to decision making processes, and more opportunities for training and employment.
- Establishing aquaculture in areas not previously farmed (e.g. mid and deep water polyculture areas) and the use of new species (e.g. finfish cultivation) has the potential to promote innovation and development of new technology. Such developments not only have the potential to provide new sources of economic benefit, but could also lead to technology and methods that reduce or avoid existing adverse effects. There is also greatest potential in scenario 3 for innovations that could improve the efficient use of space by marine farming activities (e.g. economic return per unit area) within the CMA.

Scenario 3 weakneses inlcude:

- The flip side of the strengths mentioned above relate to the movement into new areas and farming of new species which carries the greatest level of uncertainty over both the potential economic benefits and also over potential adverse social and environmental effects. This is reflected in the results of the sensivity analysis where scenario 3 can show as either the most or least prefered option.
- The location of much of the new farming space envisaged by scenario 3 is the most indicative and loosely defined. In comparison scenario 2 only envisaged developments within areas where applications for marine farming or spat catcing have already been lodged.
- The larger farmed areas envisaged and the movement towards innovative methods and use of new species is also associated with the greatest risks that could cause adverse social and environmental effects. Future technological developments might help to mitigate such adverse effects, and application of adaptive management mechanisms could help minimise them. However, scenario 3 still carries the largest risks of adverse effect.
- The increased area farmed under scenario 3 means that opportunity costs of aquaculture (i.e. loss of alternative economic use of affected resources) are greatest. Establishment of marine farms in such new areas would also require considerable investment so this scenario is also likely to be associated with the greatest transaction costs.

Summary

The MCA attempts to apply a rigorous methodology to a qualitative assessment process. It can provide valuable insights into the relative merits of the scenarios it

considers, but inevitably the results remain somewhat subjective and vulnerable to a number of factors. These include; the nature of the assumptions used to guide the MCA, the selection of experts contributing to the multidisciplinary workshop, the choice of indicators to represent the four well-being's, the level of confidence in the rankings assigned to indicators, the numerical values applied to the assigned ranks, and the weightings assigned to QBL wellbeing categories and to individual indicators.

Sensitivity analysis on the MCA used in this report revealed that the overall effect of the three scenarios considered was highly sensitive to the rank assigned to low confidence indicators. This means that the relative difference between scenarios shown by the MCA needs to be treated with caution and suggests that more reliability might be better placed upon those trends and conclusions that remained largely unaffected by the sensitivity analysis.

Such trends and conclusions include that the potential for positive contributions to the regional economy and to Maori economic opportunity increase from scenario 1 through to scenario 3. However, this trend of potentially increasing economic benefit is also associated with increased uncertainty over whether these benefits will actually be realised.

Associated with the increasing uncertainty as the move is made from scenario 1 to scenario 3 is a parallel increase in the risk that larger farmed areas, introduction of new species (e.g. finfish). The use of new methods and technology might cause adverse impacts upon important social and environmental values of the regions coast. Perhaps partially offsetting this, however, is another aspect of identified uncertainty that relates to possible future innovations and the development of new technology and methods that have the potential to avoid or reduce such risks.

In summary scenario 1, the status quo, carries low uncertainty and risk but also provides almost no opportunity. Scenario 2 envisages a comparatively conservative regional expansion that provides some increased economic opportunity using familiar species, technology and locations that comes at a cost of increased uncertainty and risk predominantly of adverse social and environmental effects. Scenario 3 envisages a more innovative and experimental development that provides the greatest potential economic and cultural opportunities but also carries the greatest uncertainty of outcome and greatest risks of adverse social and environmental effects.

7.4 Recommendations for future work

In light of the MCA, the following recommendations for future work can be drawn:

- There would be benefit in quantifying the economic effects (such as transaction and opportunity costs, effects on the local economy) and assigning relative weighting to reassess the overall ranking of scenarios.
- Environmental indicators of "physico-chemical", "marine mammals", "birds", "plankton", "fish", "natural character" and "biosecurity risk" could benefit from further research to refine the rankings.
- There are information gaps in the cultural category - at some future stage the MCA process can be applied specifically to those areas once more reliable information has been obtained.

- Applying weighting to some of the indicators to reflect individual or group preferences between indicators would provide further clarity on how scenarios are ranked.
- Future MCA projects may need to take into account changes in aquaculture legislation and statutory planning documents.

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Appendix One

Appendix One summarises the three aquaculture scenarios for the Auckland Region in detail.

SCENARIO 1 EXISTING FARMS

69 farms (Bio-marine Oyster Farm added) totalling approximately 341.5ha, 17 green-shell mussel farms, balance pacific oyster. Average farm size = 3.7 ha. The farms are positioned in sheltered inshore locations.
See Scenario 1 Map inserts showing location of existing marine farms and spreadsheet for further details

SCENARIO 2 EXISTING FARMS PLUS INDUSTRY MEDIUM TERM (TO 2025) EXPANSION ASPIRATIONS (from ARC/Macro-Plan/Industry meeting 15 March 2007)

The indicative "industry" expansion is based upon a planning horizon of 2025 and existing pre moratorium applications and the results of assessment work in the Firth of Thames. Expansion therefore would only occur in areas that have been previously investigated and where information is available to support any proposals. Scenario 2 includes all existing farms in scenario 1 plus the following additional areas:-

- Firth of Thames
    - previous study area (~1000 ha farmable space = ~1400 ha AMA minus access ways - mussels)
- Great Barrier Island
    - existing applications (approximately 18ha - mussels)
    - suggested trialling of farming finfish within some or all of these existing applications
- Wairoa Bay
    - increase from 14 ha to 35 ha - oysters
    - Pakihi Island
    - 10 ha - oysters
- Waiheke Island
    - Awaawaroa Bay increase from 10 - 13 ha - ~12 ha oysters and ~1 ha mussels
    - Mussel farm at eastern end of Waiheke (Waikopuai Bay) to be expanded from 15 to 24 ha, and
- South Kaipara Harbour
    - Previously proposed AMA's (308 ha ~100ha oysters and ~200ha mussels). Note Bio-marine's recently approved 76ha oyster farm (100ha applied for) is included under existing farms in scenario 1.

The industry expansion aspiration represents a predominance of existing species, with no proposed off shore (open coastal water) expansion and an increase of approximately 1269 ha over existing farms.

See Scenario 2 Map inserts showing approximate location and spreadsheet for additional data details.

SCENARIO 3 REALISTIC VALUE ADDING INNOVATION (TO 2050)

This scenario developed with advice from NIWA and Cawthron participants about the requirements and limitations of farming existing and emerging aquaculture species.

Scenario 3 comprises new space (as below) but also incorporates existing space (Scenario 1) plus a modified "industry" Scenario 2. See Scenario 3 Map inserts and spreadsheet for additional data details.

MODIFICATIONS TO SCENARIO 2 COMPRISE:-

Firth of Thames

Re-locating the proposed 1000 ha (farmable space within ~1400 "AMA") western Firth of Thames investigation area further north in deeper water to better enable poly-culture, including fish species. For the purposes of the multi-criteria analysis assume the following indicative species mix:

- Bivalves 80% mussels/20% oysters
    - 616 ha (mussels) out of 770ha
    - 154 ha (oysters) out of 770 ha
- Finfish (Kingfish possibly Hapuka)
    - 16 ha out of 130ha: Note this allows for 8 economic units 2 ha each and includes room for fallow space
- Other experimental species (seaweeds and sponges)
    - 100 ha
- Additional oysters at Pakihi (10 ha) and Wairoa (21 ha)

Great Barrier

Removing the industry proposed fish farming/poly-culture trials in Port Fitzroy at Great Barrier Island and replacing these with new indicative deeper water sites west and north of the island as detailed below but retaining the application areas as indicative small farm expansion.

NEW SPACE UNDER SCENARIO 3:

West of Great Barrier

Fish farming/poly-culture at three indicative sites (3 x 250 ha), each AMA comprised of a mix of single point and/or conventional multi-point moored structures). For the purposes of the multi-criteria analysis assume the following indicative species mix:

- Finfish (Kingfish, or possibly Hapuka) within 3 x 37.5 ha. Note this allows for 3 economic units at ~2 ha each (or 18 ha total) and includes room for fallow space (remaining 94.5 ha).
- Bivalves (Mussels (80%) – Oysters (20%): (175 ha of each 250ha AMA)
- Mussels 420 ha
- Oysters 105 ha
- Experimental species within remaining 112.5 ha (eg seaweeds, holothurians, kina, sponges).

North of Great Barrier

One additional indicative AMA of 250 ha for fish farming/poly-culture trials in open coastal water north of Great Barrier Island. For the purposes of the cost/benefit analysis use the same species ratios as for the other three areas west of Great *Barrier Island*

- Bivalves (Mussels (80%) - Oysters (20%) within 175 ha

- Mussels = 140 ha
- Oysters = 35 ha

- Finfish within 37.5 ha = 6ha with remaining 31.5 for fallow space
- Experimental species – 37.5 ha

Waiheke Island

- One indicative spat catching AMA for scallops east of Waiheke Island (10 ha)
- Additional 2 ha for oysters
- Additional 10 ha for mussels

South Kaipara

- Additional 204 ha for mussels
- Additional 104 ha for oysters

Scenario 3 new spaces and species summary (note the replacement of some of Scenario 2 two areas detailed above)

Farmed species	"Available" + Existing area	Farmed/occupied area
Fish	280 ha	40 ha (20 economic units)
Bivalves	1839. ha	1839. ha
Other mixed species	250 ha	250 ha
Scallop spat	10 ha	10 ha
Existing bivalves	341.5	341.5
Total	2720.5 ha	2480.5 ha

NOTES

1. The scenarios have been compiled for the purpose of a regional economic impact analysis and quadruple bottom line assessment of the costs and benefits of aquaculture in the Auckland Region. The report will assist the ARC to determine future aquaculture policy under the Auckland Regional Plan: Coastal. The scenarios do not represent ARC policy, nor do they constitute options for future development, but are an assessment tool for the purpose of this study.

2. Scenario 2 has been compiled following discussion with representatives of the aquaculture industry. Scenario 3 has been complied by ARC coastal policy staff following discussions with the aquaculture industry, with science providers (NIWA and Cawthron Institute).

3. Scenario 3 explanation

i. Movement of the Firth of Thames study area north into deeper water will allow species other than mussels, particularly fish, to be trialled and farmed. The use of poly-culture attempts to balance out nutrient releasing farming activities (eg fish) with nutrient absorbing activities (eg seaweed and shellfish) for mutual benefit and to help mitigate effects. The species mix is indicative but based on available advice of likely good practice.

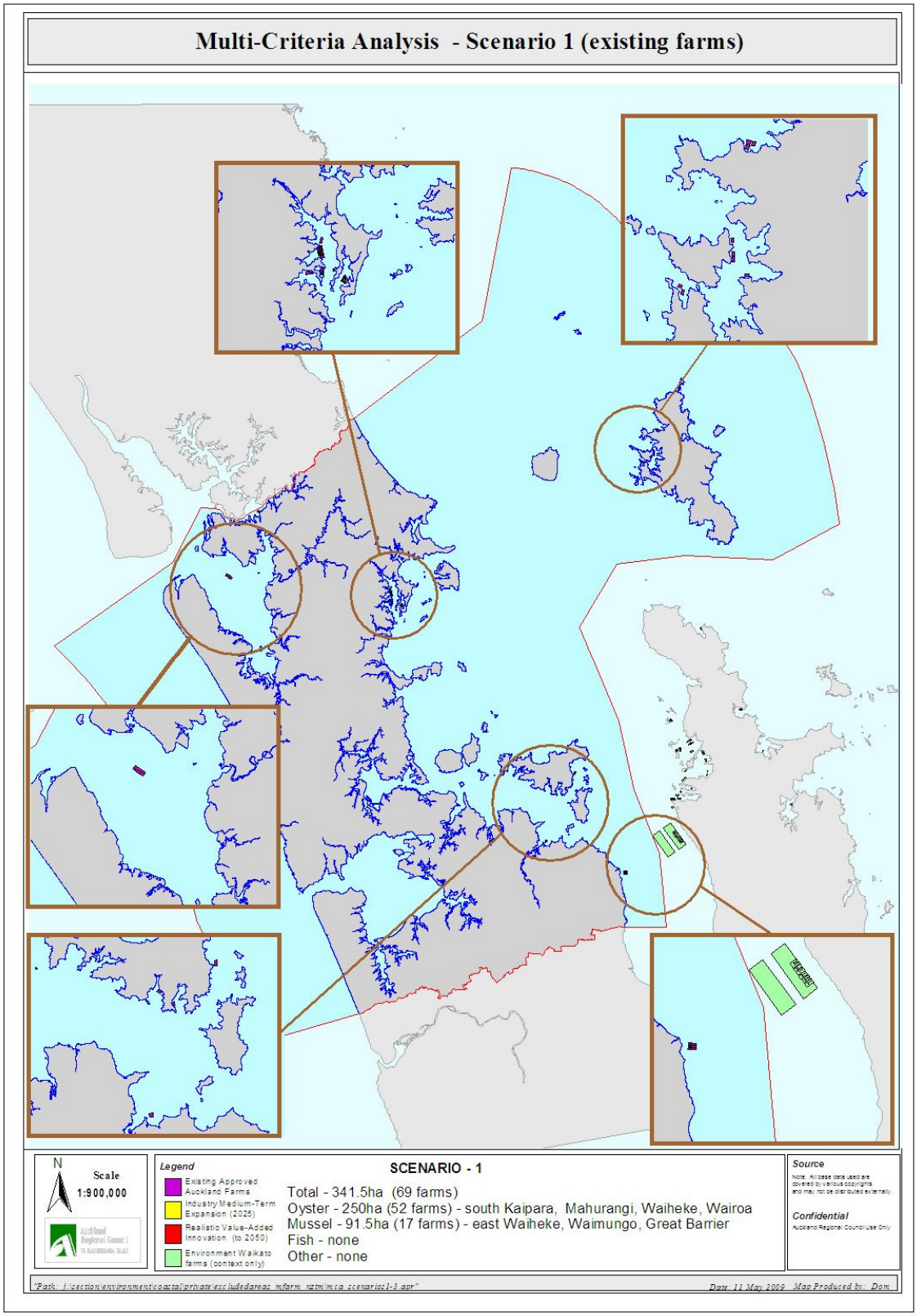
ii. Fish farm trialling in the indicative areas west of Great Barrier Island would provide deeper water (40-45m) than that of the industry application areas in Great Barrier Island and are further spaced to reduce bio-security risks of cross contamination between farms.

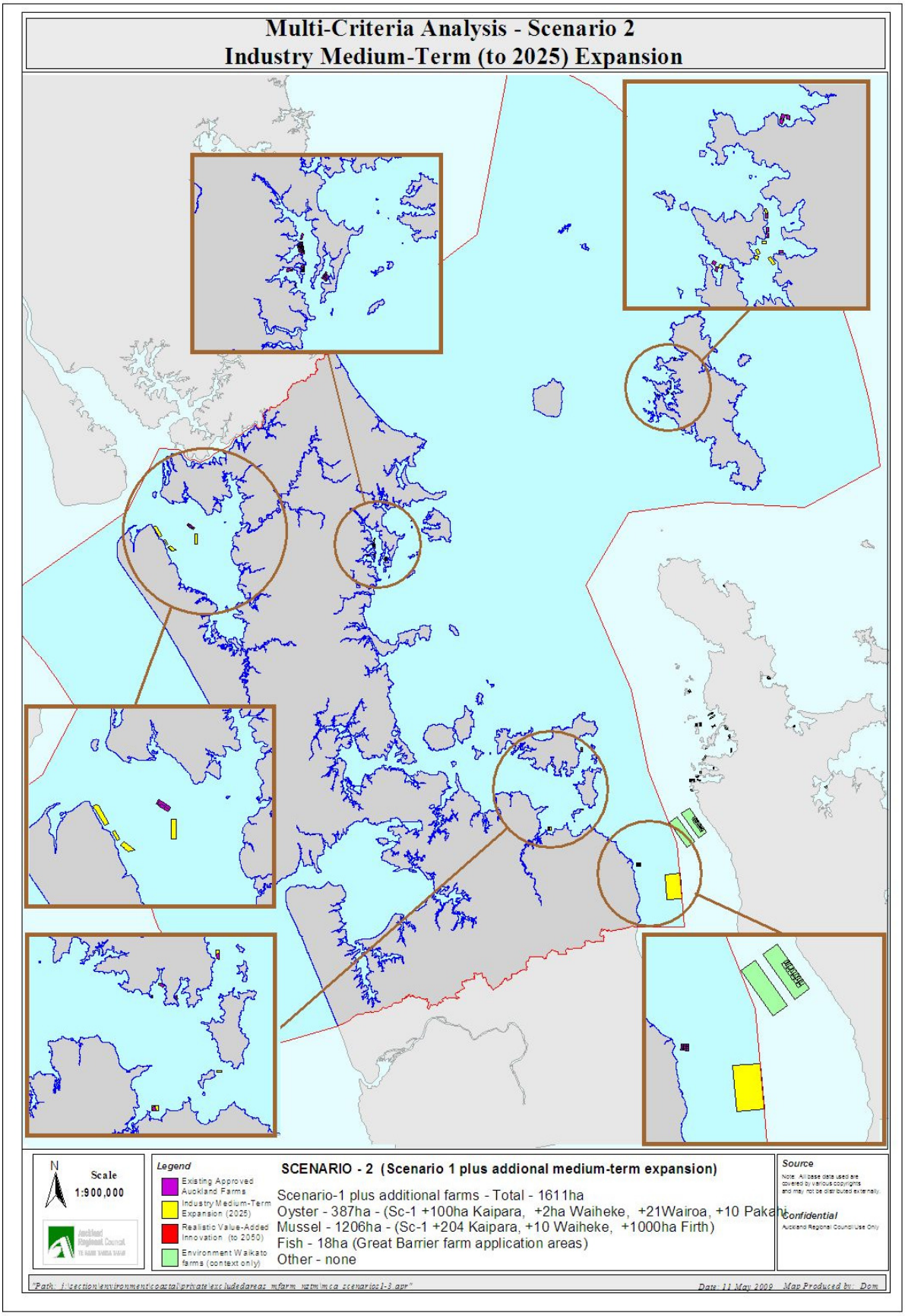
iii. The size of the indicative AMAs at 250 ha is based upon the lower of the range 250 - 500 ha estimated by Cawthron as necessary to accommodate poly-culture trial and farming, with sufficient space to allow the use of a currently experimental technique employing single point mooring systems. These require additional "swept" space compared with multiple point mooring systems but may reduce benthic effects. Only a small proportion of the total available space is occupied by structures at any one time, and a ratio of 1(structures):12.5(AMA area) as suggested by Cawthron is envisaged.

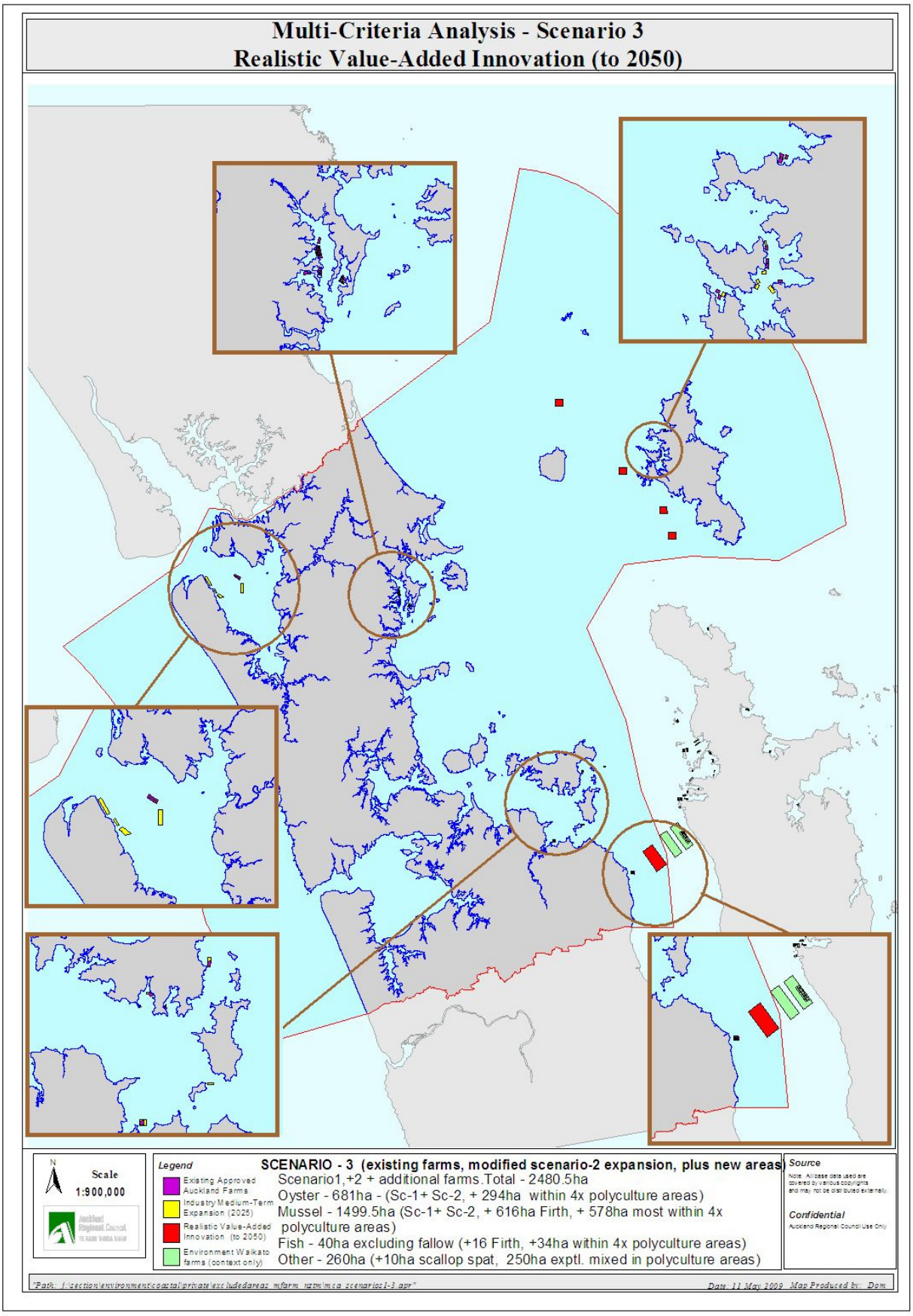
iv. A single additional indicative farm in deeper exposed water north of Great Barrier Island has been included at Cawthron's suggestion to trial the development of offshore farming in the region. It is anticipated that during the length of the study period the industry will become more interested in off shore farming as technology develops. It is likely that more sheltered sites (possibly such as the Firth of Thames and west of Great Barrier Island) would be used first, but for the purpose of this study all indicative areas have been assessed as operational at one time.

v. A single scallop spat collection area is indicated east of Waiheke Island in the vicinity of the existing commercial scallop fishery. This would give the potential for future seeding enhancement of this area. It is recognised that existing scallop spat catching areas in other parts of the country (eg Tasman) are of considerable size (2 x 500ha of subsurface structures permitted per season, industry advice to Tasman District Council that a ratio of 1:2 spat catching/seeded area is desirable), however, due to the higher use of the Auckland region's CMA any realistic spat catching area would need to be much smaller to avoid potential conflicts. Omaha Bay was suggested by NIWA as an additional spat catching area but this has been discounted due to likely use conflicts.

Appendix Two




Multi-Criteria Analysis - Scenario 2
Industry Medium-Term (to 2025) Expansion
N
Scale
1:900,000
Legend
Existing Approved Auckland Farms
Industry Medium-Term Expansion (2025)
Realistic Value-Added Innovation (to 2050)
Environment Waikato farms (context only)
SCENARIO - 2 (Scenario 1 plus addional medium-term expansion)
Scenario-1 plus additional farms - Total - 1611ha
Oyster - 387ha - (Sc-1 +100ha Kaipara, +2ha Waiheke, +21Wairoa, +10 Pakaki
Mussel - 1206ha - (Sc-1 +204 Kaipara, +10 Waiheke, +1000ha Firth)
Fish - 18ha (Great Barrier farm application areas)
Other - none
Source
Note: All base data used are covered by various copyrights and may not be distributed externally
Confidential
Auckland Regional Council Use Only
"Path: i:\section\environment\coastal\private\excludedareas_wfarm_wtm\mca_scenarios1-3.apr"
Date: 11 May 2009 Map Produced by: Dom


Multi-Criteria Analysis - Scenario 3
Realistic Value-Added Innovation (to 2050)
N
Scale
1:900,000
Legend
Existing Approved Auckland Farms
Industry Medium-Term Expansion (2025)
Realistic Value-Added Innovation (to 2050)
Environment Waikato farms (context only)
SCENARIO - 3 (existing farms, modified scenario-2 expansion, plus new areas)
Scenario1,+2 + additional farms.Total - 2480.5ha
Oyster - 681ha - (Sc-1+ Sc-2, + 294ha within 4x polyculture areas)
Mussel - 1499.5ha (Sc-1+ Sc-2, + 616ha Firth, + 578ha most within 4x polyculture areas)
Fish - 40ha excluding fallow (+16 Firth, +34ha within 4x polyculture areas)
Other - 260ha (+10ha scallop spat, 250ha exptl. mixed in polyculture areas)
Source
Note: All base data used are covered by various copyrights and may not be distributed externally.
Confidential
Auckland Regional Council Use Only
"Path: j:\section\environment\coastal\private\excludedareas_mfarm_wzm\mca_scenario1-3.apr"
Date: 11 May 2009 Map Produced by: Dom

Appendix Three

Minutes of MCA Workshop

INDICATOR	General Comments	Chris Batstone	Nigel Keeley	Barb Hayden	Dominic McCarthy	Catherine Murray	Kristy Hill	Annabelle Giorgetti	Jim Dollimore	Anaru Vercoe
ENVIRONMENT										
Physio Chemical	Innovation -small scale - nothing to compare scenario 3 to -for scenario 1 NIWA have data to show the effect is not significant - what about the effect of inter-tidal oyster farms, this leads to M- ranking -big increase in FoT of 1,000 ha. NIWA have data to show that it is not a very high impact (and it is in deeper water) for scenario 2 but issue is GB island where there is not as much water movement, exposure, but still only 18ha, 1,000ha is more extensive. For scenario 3, most are based in deeper waters -proposed sites are compromise between NIWA & Cawthron suggestions apart from FoT -assume that management plans will be in place to adequately mitigate the effects in advance -also staged development allows for an early recognition of negative effects -residual effects need to be accounted for -most concerned about finfish as data shows that effect of mussel/oyster is negligible.	Assumptions consider steps in innovation and could have a positive effect on the impact of scenario 2 & 3. If we consider the technology and what that could bring then we should consider how these scenarios could be affected. I don't agree that the risks are significantly different between scenarios 2 & 3 - they appear to be the same. There is an incentive to innovation (scenario 3) but there would also be low confidence due to the lack of information.	Intensity is also a factor to consider. Less space higher intensity - more space lower intensity. In regards to finfish - you need a large amount of fallow space - this would have an effect on sedimentation. Scale of physico-chemical effects different for waves versus sediment effects (waves not so localised). Expected effects will differ between sites considered; the offshore sites in scenario 3 (GB), have different physical environments than inshore sites and the large site proposed for the FOT. Higher energy = more dissipation/assimilation potential	Not high impact in scenario 2 (in particular looking at the Firth of Thames) and NIWA's knowledge of the effects of Wilson's Bay. Barb requested clarification concerning Great Barrier. Assumptions cover the larger farms regarding staged development so impact would be better controlled and better managed. Mixed species - multi-trophic/ co-culture would enhance marine farming. Larger farms under staged development (adaptive management) would not be fully developed until all steps in the process have been achieved. Assumptions for scenarios 2 & 3 were taken at face value, so assume all processes etc have been followed through and approved. Scenarios 2 & 3 present themselves as opportunities for high innovation.	Consider worst case scenario regarding scenario 3 and the positioning of a 1000ha farm next to the Wilson's Bay development. If we make too many assumptions then it would become difficult to assume that there would be as many solutions (or that there would be as many solutions found).	Important to create critical mass, as Chris has said mass in and mass out so what would be the point at which mass out is critical.		Should we consider the difference between scenario 1 & 2 - would scenario 2 be "worst"?	How would innovation affect environmental impacts - in 2050 would these rankings still apply? It may be that the solutions (in terms of the innovations) would be able to manage these effects better than what we currently have. Definite benthic physio chemical effects with existing rack culture but minimal with well run farms and much localized (C.O.P introduction would reduce serious effects). Also very transient. Effects much reduced in areas of higher energy (water flow, exposure to waves). Large areas have potential for greater effect, but still likely to be limited to actual farm area.	Is the debate around scenario 2 and in particular 3 about the level of uncertainty? Is it really about having the knowledge about what the effects would be regardless of innovation?

Rank	**Scenario 1 = 0 (high confidence) Scenario 2 = L- (med confidence) Scenario 3 = M- (low confidence)**									
INDICATOR	**General Comments**	**Chris Batstone**	**Nigel Keeley**	**Barb Hayden**	**Dominic McCarthy**	**Catherine Murray**	**Kristy Hill**	**Annabelle Giorgetti**	**Jim Dollimore**	**Anaru Vercoe**
Marine Mammals	Notes -lack of data leads to high uncertainty -bog risk for migratory whales - transportation of boats including acoustic effect is an issue -uncertainty of FoT accumulative effects -effect can be potentially large but the risk is v small -no documented incidents recorded yet by studies	There possibly would be some acoustic effects with larger structures.	Felt potential threat to marine mammals in scenario 1 and 2 were negligible. Offshore sites in scenario 3 poss. slightly greater threat to some whale species due to their offshore predicament and position relative to migratory pathways.	Need the data to establish whether there are any effects - need it to determine the risks to marine mammals. NIWA has not encountered this in relation to the Wilson's Bay marine farms, although they have only been partially developed. Potential impact on marine mammals often raised by opponents to marine farming but I know of no robust evidence to indicate any significant impacts (+ve or –ve)	No known recording of serious risk - but some capture of Maui dolphins in nets on the West Coast. More structures mean more likelihood of collision (interaction) with obstacles.					
Rank	***Scenario 1 = 0 (high confidence) Scenario 2 = 0 (low confidence) Scenario 3 = L- (very low confidence)***									
Birds	Notes -positive effect includes aggregation and roosting but effect could go in either direction (is it good to enhance natural population or not?) therefore there is an offset of +ve and +ve effects -like an artificial reef effect	Would have positive effects by creating artificial reefs for roosting birds.	Offshore roosting increased and likely aggregation of positive effects on sea going birds. Most of what is known stems from a wealth of anecdotal evidence and observations, but very little robust/quantitative information/studies. Offshore farms new = effects presumed. Artificial reef scenario provided by offshore sites likely to constitute positive habitat for seabirds.	Increase of nutrients (bird droppings - cause for concern in fish farms - spread of disease.	Uncertainty around site location but potential for wider effects.				Depends on where the location of the block will be. Effects are likely to be minor. Some additional roost sites on buoys etc. Some increased feeding opportunities. Possible alteration to plankton levels in enclosed waters like Firth but modelling indicates likely to be small. Hard to see any overall effects on shorebirds unless a lot of minor effects align, this would be very unlikely.	Should consider the wider effects - scenario 3 with large farms side by side are likely to have an effect on shoreline birds - roosting etc.
Rank	***Scenario 1 = L+ (High/med confidence) Scenario 2 = L+ (Low confidence) Scenario 3 = L+ (Low confidence)***									
INDICATOR	**General Comments**	**Chris Batstone**	**Nigel Keeley**	**Barb Hayden**	**Dominic McCarthy**	**Catherine Murray**	**Kristy Hill**	**Annabelle Giorgetti**	**Jim Dollimore**	**Anaru Vercoe**

Plankton	Notes -ranking depends on whether we consider farm level vs wider regional effect, an issue to be considered for all indicators -could be a +ve effect to remove plankton -lots of uncertainty about effects because of the size, prediction models at odds with reality -potential effect on fish larvae -less effect on zooplankton than phytoplankton -fish eggs eaten by mussels -jellyfish benefit from farms - variability of systems/temporal scale - changes in organisms after plankton supplies	A modelling exercise would not increase certainty and an outcome would not necessarily be predicted.	Studies to date suggest that phytoplankton depletion on small scale sites negligible. Consumption of fish eggs is an issue of potential importance and should be approached with caution, particularly with respect to large scale site in close proximity to high value fish habitat (e.g. FOT). Hence S2 & S3 being lower than S1. Point of interest often not considered is potential for jellyfish fish abundances to increase in association with fish farms (e.g. Marlborough Sounds). Jellyfish part of "plankton". Cause and effect still unclear, but potential issue on larger sites.	Would need to consider effects far field especially with Scenarios 2 & 3. Another indicator is zoo-plankton. It is dependent on how localised marine farms are (size and intensity) - so it would depend on scale - are we considering it on a region wide basis or is it more localised. If there is a minimal effect on plankton there will be a lesser effect on zoo-plankton.-L -L –L. Note that these scores are based on far-field effects. I would rank localised effects as –L, -M, -M. Most of the effects of phytoplankton depletion are likely to be observed within the farms themselves and it is likely that reduced stocking densities and increased longline spacing will be used by the farmers to avoid negative effects on production. Mussels can consume zooplankton and fish eggs but at much lower rates than for phytoplankton because of size and mobility of prey. There is evidence that NH4 produced by mussels may have a +ve effect on phytoplankton especially in summer when stratified surface waters are N limited.	ARC's investigation into the effect of plankton depletion in the Firth of Thames showed that there was an effect on fish larvae - worst case scenario was 15%+ (above?) natural mortality. That's the rational for off-shore development to minimise the depletion of plankton (especially for scenario 3). Larvae dependant on levels of plankton.				Modelling shows little effect. Actual studies of 3D mussel farms shows little affect and can be both enhancing and detracting from productivity depending on conditions. Little effect outside farm. Oyster studies we have done detected no effect at all, but oysters are effectively 2D and would have much less effect than mussels.	
Rank	**Scenario 1 = 0 (high *confidence*) Scenario 2 = L- (high confidence) Scenario 3 = L- (med confidence)**									

Benthic Ecology	Notes -oyster activities on seabed -fishfarms unknown elements and depends on management -assume staged process, effects mitigated -regionwide perspective -minor effects in scale -issue of scale and intensity -need to allow for commercially viable		Greater uncertainty around scenario 3. Benthic effects likely greater in association with fish farming (introduced in S3). But, also offset by offshore predicament (depth, currents & energy) and the ability to deintensify (space). Comment that in determining size of developmental steps', need to consider commercial practicalities, or else barrier to development. Also sensible to assess the first step as a small, but commercial practical scenario - as benthic effects are reversible within short-medium term (i.e. 5-10 years).	There are differences between scenarios 2 & 3 - but should not be a concern given it's largely bi-valve along with the assumptions. NIWA's information on the effects of Wilson's Bay shows that there are minimal effects. (0 -L -L)An insignificant negative impact only Insignificant far-field effect (based on Wilson Bay development) but will be –L localised effect Far-field effect. There will be localised –M	Wilson's bay not yet fully developed so difficult to project NIWA monitoring on fully developed sites - but assumptions would take into account adaptive management.				Related to physio-chemical so localized and transient. Uncertain about the effect of very large scale farms such as Wilson's bay but will know more when it is fully developed.	
Rank	***Scenario 1 = L- (high confidence)*** ***Scenario 2 = L- (med confidence)*** ***Scenario 3 = M- (low confidence)***									
Fish	Notes -flow-on effects to fish species -some risk from escapees/disease transfer -genetic transfer to local population -aggregation effects -with shellfish specifically longline have positive benefits but with fish higher risk eg snapper may be attracted from somewhere else -to hear political voices? -offsetting -ve and +ve effects	**Barb Hayden:** There is always a risk re interchange of disease -> use of native species is a good practice to follow re genetic exchange. Notable that "escapees" have low chance of survival having been reared in controlled environments. Have to be careful how you manipulate one species over another. Sites of aggregation attract fishers which have an effect on populations. Question of aggregation versus enhancement of wild fish remains undetermined for mussel and finfish farming. Some evidence to suggest finfish farms actually enhance wild fish populations and "commercial catches", but if the effect of a mussel farm is mostly to "aggregate, then additional fishing pressure may negatively affect stocks. Function of marine farms as artificial reefs "poorly understood, but likely to be some positive benefits from a productivity and fish perspective.		Mussel farms enhance some fish populations as they provide a good food supply (snapper). Genetic effects transfer to the wild population. (0 +M +M) Based on enhancement of habitat and recruitment sites.	Increase in mussels -> increase in effects on fish. Increase in fish farms -> possible increase in potential for escape. Outcome could be potential for disease/ modified species.			**Jim Dollimore:** There is unlikely to be any significant issues with fish. New habitat will probably increase numbers of some species but only within the ability of the new habitat to support them so the larger scale effects will be minor. Issue of depletion of fish eggs is only effect raised that will need monitoring if large scale mussel farming is contemplated in Firth. It should be considered however that Firth used to contain a large mussel population which co-existed with fish nursery.	
Rank	***Scenario 1 = 0 (high confidence)*** ***Scenario 2 = L+ (medium confidence)*** ***Scenario 3 = 0 (low confidence)***									

Natural Character	Notes -requires audience therefore is a value judgement -further off-shore less visible -philosophical attitude -marine farming vs traditional land-based farming, land-based farming has worse impact on natural character -are we harsher when judging aquaculture	**Barb Hayden:** Philosophical positioning as to what is natural character. Perspective is that natural character is something that is untouched by man - cross over with amenity value.		-L -L/-M? -L/-M?Most of area is well off-shore although some of Kaipara sites in Scenario 2 may warrant the –M score	It is not the same as amenity value. This is something that has an inherent (?) value. Preserved because they cannot be found -	Natural character is difficult to assess. As Chris says it is a matter of perception.			Very interested in Kathryn's idea of comparing natural character effects of aquaculture with the alternatives. There is always going to be some natural character effects so just giving a degree of natural character disturbance is pretty unhelpful.	Natural character does not have to be seen.
Rank	***Scenario 1 = L- (high confidence)***			***Scenario 2 = M- (high confidence)***		***Scenario 3 = M- (low confidence)***				
Resource Use Footprint	Notes -finfish farming requires high energy inputs from automatic feeding systems, high energy use for raising fingerlings on-land, feed embodied energy (the energy it takes to produce feed) and high material usage in form of pen cages, nets, etc - mussel and oyster have low material input such as longlines	Bivalves are less resource intensive - less equipment/ energy compared with fish farming. However, the larger the farm obviously the higher the energy input.	Mussels have a low level resource imprint.	0 -L -M				Fish farms are more energy intensive - bivalves less resource intensive.	**Jim Dollimore:** Shellfish aquaculture has very small footprint. Finfish is higher probably akin to other intensive agriculture such as poultry, but this has potential to be lowered significantly with new food sources. There is no resource use cost in maintaining the environment as it is with buildings on land which need air-conditioning. New species like seaweeds and sponges etc will have very small footprint.	
Rank	***Scenario 1 = 0 (high confidence)***			***Scenario 2 = L- (high confidence)***		***Scenario 3 = M- (high confidence)***				
Bio-security Risk	**Notes** -permanence of effects -inter-regional risk of spread for ecological ecosystems - movement of gear represents high risks not only across countries but between regions -low probability but high risk -bioinvasions is a point source issue and not dispersed effects -lack of info -side effects of farms.		**-L -M -M**							
ECONOMIC										

Opportunity Cost of Aquaculture	Notes -opportunity cost relates to the cost of the activity next best use, eg what the money could be spent on rather than aquaculture, eg hospital, education. It relates to the money which could be used on other investments by the government eg providing grants for research. As such it represents a cost to society -can also be viewed as a displacement cost, eg what activities on the water are displaced as the result of marina farming -if farms are tradable which they are, then there is a value and property right attached to it -not many activities defined as displacement, very little interfering with shipping, fishing boats, commercial activities etc -positive effect on fishing boats	Not likely to affect the offshore developments/ will not likely displace other activities (or would have very low impact).		It is likely that there would be minimal effect. +L +M +MBased on the discussion at the workshop, I may have misinterpreted this Indicator. My scores reflect the increase in opportunities such as tourism and jobs as a result of aquaculture.		Would create opportunities for other activities (Tourism).	Iwi have an interest in access to opportunity - while we are talking about what marine farming displaces, there as an "opportunity" here that could displace Maori - apart from the 20%.	Opportunity costs relates to the cost of the activity next best use: eg. What could be the money spent on, rather than aquaculture (hospitals, education). It relates to the money which could be used on other activities.	**Jim Dollimore:** Very low in that the areas considered for aquaculture have little other use capable of generating an economic return. It is doubtful that fisheries output is decreased it is more likely displaced and possibly enhanced as the fish production on a marine farm is at least as high as outside. Catch per unit effort may increase as fishing area is limited. There is still the possibility of extra opportunities like tourism and fishing trips with large world – scale aquaculture projects. There may be some opportunity cost with introducing large scale aquaculture into a more pristine environment which may support tourism reliant on the lack of development. If we are looking at the opportunity to use money to develop other industries rather than aquaculture, this would assume that money is a finite resource which it is not. Any project deemed by a developer to be economically sound can gain funding from somewhere in the world.	
Rank	***Scenario 1 = 0 (high confidence) Scenario 2 = L- (medium confidence) Scenario 3 = M- (low confidence)***									
Transaction Costs	Notes -substantial research $ are to be invested by governments, farmers, research institutes for realising finfish and experimental farming over the years -legislative procedures are resource intensive, many $ have been spent on research & legislation -on the other hand there will be a learning curve over the years where industry will become better at marine farming therefore there may be falling transaction costs over time -feedback loops of lessons learnt will reduce costs	Cost of marine farms increases as they move off-shore. Regulatory costs would not be that much different.		-L -M -M Costs of resource consent and monitoring to fulfil consent conditions are high regardless of the species		Clarify what we mean by transaction costs.		Transactions costs might be better placed under a larger umbrella / reflecting overall costs to the industry.	Has risen substantially with the new legislation introducing schedule 3 process to all farm applications. Increased monitoring with all new farms is inevitable. This may be offset to some extent with the increased knowledge of effects which will allow some parameters to be monitored less rigorously. However new questions often arise. We need to keep the monitoring relevant and reasonable given the scale of the activity.	
Rank	***Scenario 12 = L- (low confidence) Scenario 2 = M- (Low confidence) Scenario 3 = H- (medium confidence)***									

Effects on Local Economy	Notes -idea of GPI (Genuine Progress Indicator) as an alternative to GDP was raised. GDP only records $ earned to the economy but does not record whether the $ are earned locally, regionally or nationally. Also GPD excludes environmental effects and other social impacts as the result of economic activity whereas GPI does. However GPI is an indicator on how the scenarios perform on a whole range of indicators such as those highlighted here so it would be double-counting. -rename indicator to reflect the contribution to the local economy. -issue has been raised on who has the ownership, is it foreign, local or national - need to consider distributional effects	Increasing production will have a positive outcome on GDP. GDP still has some reference in terms of providing a national indicator - useful for determining site specific development.			What does this mean for the regional economy - No indication of what these particular scenarios would have on the region?			Suggest we look at a different indicator to reflect the concerns. GPI would be preferable for the scenarios/ regionally or locally specific.	Aquaculture is quite labour intensive and is largely a local activity. Most inputs are made locally. The measure of exports and general revenues does not really reflect the local effect on what is often employment poor rural areas All the scenarios will contribute to the local economy in a similar way, except No3 may have more spin-offs in terms of suppliers of the innovative equipment this scenario would hopefully generate. There may be an international market for some of this.	GDP considers the National scenario - 3 scenarios are for the region so how does GDP provide us with any indication on what the effects these developments would have in the region?
Rank	***Scenario 1 = L+ (High/med confidence) Scenario 2 = M+ (high confidence) Scenario 3 = H= (high confidence)***									
Industry Performance	There was some confusion when ranking this indicator. The discussion focused on innovation and this is a separate issue from industry performance in terms of contribution to the $1 billion sale.	**Chris Batstone:** As innovation goes up this produces other efficiencies not only in production. Innovation has an effect on time and costs on production particularly as the industry expands/ site expansion or further development does over the long term have an effect on the scale of economies.				Increased innovation would also translate into more effective management of farms (assumptions). But performance also would go up with smaller innovation in scenario 1				Are we talking about innovation or the performance of the industry here? You would expect that the performance would go up in scenarios 2 & 3.
Rank	***Scenario 1 = L+ (high confidence) Scenario 2 = M+ (high confidence) Scenario 3 = (medium confidence)***									

Innovation	Note - wide discussion on the degree to which innovation occurs particularly in regard to Scenario 1. Not clear from assumptions - but assume now that there would be minimal innovation within scenario 1.	**Chris Batstone:** Would expect that there would be some innovation in scenario 1 within the existing marine farms. The industry will incorporate new technology, not necessarily linked to increasing farm size or the introduction of new species.			There is an expectation that there would be some innovation - using the same space and the same species. Assumption was that scenario 1 would have a degree of innovation.	Do not expect to see no development in scenario 1.				Need to be clear about which scenarios use innovation. My understanding is that no innovation was to occur in scenario 1 - see it as a control option to the other two scenarios
Rank	***Scenario 1 = 0 (high confidence) Scenario 2 = M+ (high confidence) Scenario 3 = H+ (medium confidence)***									
SOCIAL										
Competition for space and public use	No consensus was reached. Notes - competition for general recreational use and public values. -perception of individual is key and may differ from person to person as was the case in the workshop -double counting with indicator 4 public access (unless perceived as a philosophical idea) therefore indicator was renamed and includes the concept of open access value for the community/individuals.	Access affected in all 3 scenarios. Could have a case for ramps to be built for better access to farms - has a spin off for general public. Who gets to have access/ unless you have a boat?		Sth Kaipara has active anti aquaculture faction. Possible conflict at Great Barrier?? (I don't know the area). (0 -L -L) My scores were based on fact that council hearings and Environment Court is the only avenue and these aren't that user friendly for the general public.I'm happy to change my scores to –M, -L, -L as agreed in the workshop because Scenario 1 farms were established with NO consultation and Scenario 2 & 3 do have a level of consultation, even though still not always user-friendly	More farms means less degree of access. Scenario 1 prohibits access by farms being there - if they weren't then farms would not be a problem. Access is limited in each scenario. Are there any boat ramps in the region that have been built by marine farmers? AYBA anchorages and destinations show that there are a large number of areas that boaties visit and require access to.	Would create more opportunities. Communities would come together and sort out differences - could be seen as unifying leading to a consensus.	Depends on who gets to say and access to what.	**Jim Dollimore:** Marine farmers could contribute to the building of boat ramps. I struggled with the idea that scenario 1 allowed no change at all as obviously even within a given set of species and a set growing area innovations will occur. I think that there is some ability to innovate within the present structure and I would give it a M+ but increasing the area without allowing new species would not help this measure much so still M+ however allowing new species and new types of growing areas will greatly enhance the industry's ability to innovate say H+. There are always opponents of every activity so there will always be some propensity for conflict. The scenario 1 has largely be accepted so this should be L+ however scenario 2 raises new areas in places where many interest groups can see them and so will raise the stakes considerably. The scenario 3 extra areas are largely out of sight and while they introduce some new risks and potential conflicts they are largely academic and will not raise the risks	Could be positive in that no further development under scenario 1 (status quo) people are happy with this level of development.
Rank	***Scenario 1 = 0 (medium confidence) Scenario 2 = L-/M- (low confidence) Scenario 3 = L-/M- (low confidence)***									

Community participation	Notes: -public can be involved through the consent process, but once at the appeal stage it may be too expensive for community to further participate. -when scenario 1 was established the legislative framework was different from what it is now, it is now easier to participate -even though it is still hard to participate there have been efforts to encourage participation, eg MfE fund. -there is a greater need for involvement in response to the treaty settlement - positive element is information so that people can be involved -social cohesion and collectivism of society: to what extent do the scenarios provide this - livelihoods enhanced from community groups				Could be expensive for the community and prohibit certain groups from taking appeals further. Consider the pending changes to the RMA where there is less opportunity for community groups to be able to participate.	Ranked all scenarios the same because the process is the same. Opposing positions would share knowledge/opinions on the nature of the resource consent - would possibly focus the community's interest.	There is a lack of Treaty engagement in these processes. While it is "part" of the RMA process, there seems to be little opportunity for Maori to actively participate.		MfE holds a fund that community groups can use to support them through the appeal process. At present no real opportunity to participate in scenario 1 but some when AMAs come up for renewal in 20 yrs. Very extensive opportunities to participate in scenarios 2 & 3 as there are planning and resource consent processes. So rates higher M+ . Public participation needs to mature from simplistic points of view to construct working groups representing all points of view.	Depends on the nature of the resource consent/ extent, scale of the farm. Highly likely that community groups will be at a disadvantage because of the expense.
Rank	***Scenario 1 = M- (high confidence) Scenario 2 = L- (medium confidence) Scenario 3 = L- (medium confidence)***									

Amenity Values and Open Space	Notes -Kaipara harbour was turned down because of amenity values. 90% of rejection in Cawthron study showed that amenity values were the reason. -Could be that perception changes over time, so people may get used to the visual impacts -also affected by air and boat users, but was felt that it is a small and temporarily effect	Community may be become used to this affect over time - eventually consider it as part of the landscape. Boat users more likely to complain?		The biggest increase is in FoT but so far off-shore, will be low visual impact Fish farms have more visual impact unless they are subsurface (although the area of these is relatively small and they are sited well off-shore). (-L -L -M) Wouldn't have got consent if there had been access issues	At sea level it would be difficult to see a farm that's a 1000m from shore. If you're up in the hills it would be difficult not to see it all the time.	Could be that perception changes over time.		Depends on where you view a marine farm. If you are walking, your view of the farm is held for much longer.	Existing aquaculture has little effect as generally no sited where alternate uses are available. Scenario 2 & 3 would extend into areas with amenity value, probably to a broadly similar amount so would rate an M-. None of the scenarios have more than a minor effect on public access	
Rank	***Scenario 1 = L- (high confidence) Scenario 2 = M- (med confidence) Scenario 3 = M- (med confidence)***									
CULTURAL										
	Dominic Anaru Kristy (combined comments from meeting on 11 June)			**Assumptions for this indicator**						
Competing Uses	**NOTE: New assumptions developed and now considered within collapsed indicator**. Competing uses and values for the purposes of this indicator looks at marine farms that impinge or prevent iwi related activities from occurring. For the purposes of this MCA the assumptions take into consideration specific instances, where for example, iwi make an application within an area that has high cultural significance (like waahi tapu) as opposed to any other applicant making an application. While there is a viable argument supporting differences in terms of positives and negatives to iwi in relation to who the marine farm applicant is (if iwi are applying then there is less of a problem and probably no issue), this level of analysis would be better served in a more focussed MCA for cultural indicators. This analysis is at a broader level. It was agreed that aspects concerning Kaitiakitanga (conservation, guardianship of natural and physical resources etc) is better placed under this indicator as it raises the importance of Maori cultural well-being and the importance of protecting it in the region. It was accepted that there are specific Maori nuances attached to the environment but which could be better dealt with under a more specific MCA. Given these parameters it was agreed that cultural values and uses would be negatively affected by aquaculture development. Scenario 1 marine farms were subject to Ministry of Fisheries permits which did not include a Treaty element (as it is under the RMA). However scenario 1 was ranked "0" because there was no clear -ve of +ve aspect identified.			Where marine farms have a negative impact on the cultural activities of iwi or on where opportunities to advance iwi aspirations occur at a regional level. It is acknowledged that there are differences in competing uses where iwi applications for marine farms are not seen to impinge on the cultural activities of iwi (because they would be in control of the application process). However for the purposes of this regional MCA it is assumed that the general planning processes are sufficient to take into account matters that would affect all cultural activities or interests held by iwi.			Important to consider that the impact on the entire CMA has less relevance for iwi and that competing uses can only be viewed based on rohe moana.			
Rank	***Scenario 1 = 0 (high confidence) Scenario 2 = L- (med confidence) Scenario 3 = M- (low confidence)***									

	Dominic Anaru	Assumptions for this indicator				
Maori Economic Opportunities	**NOTE: New assumptions developed and now considered within collapsed indicator**. The original Treaty of Waitangi indicator was inserted under this indicator - it was felt that allocation of space under the legislative provisions fed into economic opportunities (20% space provides greater opportunity for economic development as we move up through the scenarios). The Treaty is not being marginalised in this case, but is taken as implicit - there was difficulty arriving at the value of a separate indicator for the Treaty when it is only considered in the context of allocation of space (or legislative obligations). The Treaty component whilst providing a clear opportunity for Maori to participate in aquaculture development would not preclude independent private development (as on Great Barrier). It was also noted that while there is an obligation on the Crown to settle with iwi there is no obligation on Regional Councils to create space specifically to fulfil Treaty obligations. However where new space was created the Regional Council would be bound to identified representative economic space. Social considerations such as employment, access to education, development of skills and leadership opportunities were all considered as outcomes of economic opportunity and so were also considered under this indicator. In discussion it was agreed that there would be an increase in economic opportunity through the scenarios with scenario 3 having a high positive impact.	Treaty of Waitangi matters are considered under this indicator in relation to the allocation of space. While there is no obligation on a regional council to create space specifically for iwi, when it is created the regional council will fulfil its statutory obligations. Economic opportunities for iwi increase in scenarios 2 & 3. Assume that as economic opportunities increase, social benefits increase as well (development of skills, management opportunities, employment etc).			**Kirsty Hill:** More space encourages greater opportunity for economic development as it is directly connected to resource provision although its availability is dependent on mana moana. The Crown has a greater asset to distribute in a regime that provides for more AMA provision increasing opportunities for employment joint venture partnerships training. The encouragement of marae farms may encourage local economic development to support kaitiakitanga. More space would allow more opportunity for access to resources, innovation would require greater monitoring of quality, effect on stocks with increased use of space and water quality, although there is an assumption that significant sites are prohibited areas it is difficult to restrict effects in water due to Maori holistic view. Scenario 3 tends to provide a greater scope for uncertainty which would have a procedural impact on Maori	
Rank	***Scenario 1 = L- (high confidence) Scenario 2 = M+ (med confidence) Scenario 3 = H+ (med confidence)***					

Barb Hayden's General Comments:

1. I considered "far-field" effects rather than localised "farm-scale" effects. This is an important consideration in scoring the MCA indicators because a particular type of marine farm, e.g. a finfish farm, may have medium to high benthic effects at a farm scale. However, if (a) its size is small relative to the whole water space and/or (b) mitigation options such as fallowing or coculture are included (which they are), then the overall environmental effects may be low (cf. the economic benefits). I believe that ARC should take a far-field view of environmental effects as well as localised because focussing solely on the latter could unreasonably hinder economic growth.

2. Important to not overlook the assumptions, e.g. developments are staged and well-managed, because the assumptions have a significant impact on the indicator scores.

3. I am familiar with the Firth of Thames, Kaipara, Waiheke, and Mahurangi having worked in all these areas. I do not know Great Barrier Island.

4. The area of environmental impacts will increase as we go from scenario 2 to scenario 3 because the area being farmed increases, but this does not necessarily mean a comparable increase in the intensity of impacts over the whole area. This is because the impacts will depend on the tonnage of each species to be farmed. The total area of finfish to be farmed in scenario 3 is only 40 ha, which is not a large area; there will be localised impacts for sure but in the overall context of the water space under ARC jurisdiction, they may not be that significant. We really need to do some a priori dynamical modelling to get a handle on this.

5. Need to account for change in technologies of farming e.g. most oysters are currently grown on intertidal racks but the industry is increasingly moving into longline culture in deeper water as well. These two culture types will have different impacts.

6. Terminology: The term polyculture is usually used to indicate more than one species grown on the same farm. Integrated Multitrophic Aquaculture (IMTA), where one or more species utilises the waste material generated by another species, is usually referred to as coculture or IMTA. NIWA is doing research on IMTA, both as a means to increase productivity of marine farm space and as a means to mitigate environmental effects. When scoring, I interpreted "mixed species" as polyculture when IMTA may have been the intent.

7. In the Notes section of the explanation of Scenario 3 provided to the workshop participants (MCA Aquaculture Scenarios – words.doc), it states: "A suggested mussel spat catching area by NIWA has not been specifically provided for within scenario 3 as the large space allotted to possible mussel farming activities should provide adequate room for mussel spat collection". This is not an accurate assumption to make because, while the area is large, it is not necessarily suitable for spat catching. Mussel larvae are in the water column for 2-3 weeks before they are ready to settle on the spat catching surfaces and during that time can move considerable distances from where they were spawned, depending on current flows. Viable spat catching areas tend to be where hydrodynamic conditions facilitate accumulation of the late-stage larvae; this is unlikely to be in the middle of the Firth of Thames for instance. Securing an adequate and economic spat supply remains a big issue for the mussel industry so it may be wise to reconsider the need for mussel spat catching space in future scenarios. Spat catching farms have even lower environmental impacts

than crop farms.

8. Cultural Impacts. I did not score these (i) because I didn't feel qualified to do so and (ii) because the notes sent out by Anaru prior to the workshop suggested that these Indicators had already been scored.

Catherine Murray's Additional Comments

9. With regards to natural character, I had made a comment that natural character is a social construct, or oftentimes idealised to some notional state (not sure whether this is worth including).

10. Under resource use footprint, comment about need to compare resource use footprint with alternatives of producing food (protein).

11. Under opportunity cost of aquaculture, I made a comment about opportunity lost under scenario 1, given constraints to expansion of the industry.

12. Transaction costs are costs of entering contracts and in general include regulation costs. The generally relate to costs of information (which is high, given the uncertainty in the industry around policy direction), costs of information within the industry seems to be low, given that there is cooperation (marketing of oysters for example).

13. Effects on local economy would increase moving from scenario 1 to 3. This would be dependent on the structure of industry (ownership and investment of assets would be notable – if foreign investment, may not be such reinvestment in local economy). Otherwise assume that effect on local economy (community) would be substantial. In terms of overall contribution of aquaculture to the Auckland economy, it is still marginal (given levels of manufacturing, financial services contribution to the regional economy). However, aquaculture is a primary industry, and structurally in the future, New Zealand will be looking to create value added from primary industry – as with biotechnology, innovation in agriculture etc.

14. Under social effects, I thought that social capital would be created, both positive and negative for the industry – chances for collective marketing and collaboration in industry; but also potential to give rise to environmental and cultural resistance to the developments in the scenarios. People coalesce when their livelihoods are threatened – and aquaculture expansion could be a catalyst for this social action.

15. This links with community participation, as there is a potential for conflict.

16. In terms of amenity value, I had a comment about similarity of public perception of windmills. Perhaps aquaculture is a good means of harvesting fish, which meets with public resistance in the first instance but once public is aware of trade off (between depleting wild fish stocks and aquaculture), the importance of this variable declines.