LECG

# Aquaculture in New Zealand:

## Preliminary analysis of "New Space" settlement obligation

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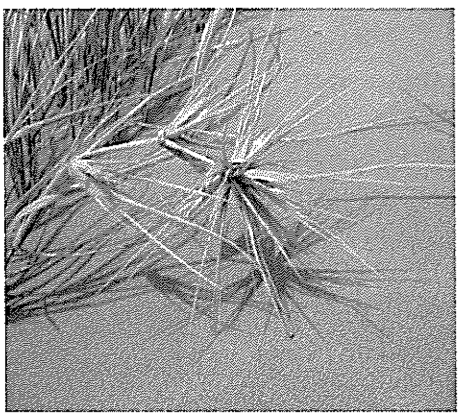

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# 1 Introduction

The Ministry of Fisheries commissioned LECG to give an indication of the possible extent of the Crown's "New Space" settlement obligation ('the obligation'). The obligation arises under section 9 of the Maori Commercial Aquaculture Claims Settlement Act 2004 ('the Act'), which commits an allocation of 20% of all "new" space to Maori. The Act provides for this obligation to be provided by way of specially allocated space in AMAs. However, the Ministry of Fisheries is interested in the value of these allocations if they were to be settled using a payment of financial equivalent.

This estimate includes both inshore space (in statutory harbour and coastal regions) and offshore space (in areas that are currently uneconomic to farm).

The Act contains a more detailed description, but generally speaking "new space" is aquaculture space approved under section 150B(2) of the Resource Management Act 1991, or which is approved as part of an aquaculture management area established under section 165C(1)(b) of the Resource Management Act 1991. Space that was approved under the old legislation, or approved under the interim provisions, or which otherwise qualifies as pre-commencement space is not "new space".

Our value assessment asks what the extent of the obligation might be if it were settled using a payment of "financial equivalent" for all new space created to 2020 or to 2030. We do not provide an estimate of the value of the obligation beyond 2030, as this is too far into the future to be discernable. The amounts are reported in 2010 real dollars, and no provision for interest between the date the space is created and the payment of financial equivalent has been provided.

## 1.1 Restrictions

This report was prepared in order to give Ministry officials more information about the likely extent of "new space" might be, and what value that space might have in the future. The scenarios were compiled using the best information to hand, and within a relatively short space of time. The scenarios are provided not as a determinative estimate of the obligation, but rather are provided in order to start the discussion about what the obligation might extend to.

The scenarios should be considered illustrative rather than authoritative, as it is not possible to accurately generate estimates of the amount of "new space" that will be approved, nor is it possible to predict the value of that space at the date at which it is created. Therefore, this document should be considered more the presentation of relevant information and possible outcomes for "New Space" rather than a valuation exercise. It should not be used to substitute or supplement specific valuation advice in the event of a settlement being sought by the Crown or by iwi.

This report is intended for Ministry of Fisheries officials and the Minister of Fisheries, and is only intended for use in relation to early investigations regarding the new space obligation. LECG will not accept any responsibility for loss occasioned to any person other than the Ministry acting or refraining from action as a result of any material in this publication, or for any loss occasioned as a result of this report being used for any other purpose than its intended purpose.

## 1.2 Definitions used

The definitions used in this document are set out in the table below. All other definitions are as per section 2 of the Maori Commercial Aquaculture Claims Act 2004.

| Term | Definition |
|---|---|
| **$** | Unless otherwise stated, New Zealand dollars, Real as at May 2010. |
| **Coastal space** | Aquaculture space that is not harbour space, nor offshore space, but which is in the Coastal Marine Area. |
| **Financial Equivalent** | A payment reflecting the value of the obligation at the date of settlement. Has the same meaning as in the Maori Commercial Aquaculture Claims Settlement Act, and as articulated by LECG in the methodology documents supporting the Pre-Commencement Space settlement. |
| **GWT** | Greenweight tonnes. |
| **Ha.** | Hectares (of surface area). |
| **Harbour space** | Inshore space used for aquaculture activities in statutory harbours. |
| **New Space** | Has the same meaning as in the Maori Commercial Aquaculture Claims Settlement Act. |
| **New or Other species** | For the purposes of this report, 'new species' or 'other species' include any species for which research is being conducted in New Zealand currently, to our knowledge. These species include: Eels, Groper, Bluff and rock oysters, Rock lobster, Seaweed (wakame), Butterfish, Snapper, Abalone, Scallops and Clams, Kingfish, Snapper. |
| **Offshore space** | Aquaculture space that is more than 5km offshore and is not in a harbour. |
| **Other species** | |
| **RMA** | Resource Management Act 1991. |
| **Space** | The area of sea used for aquaculture activities in the coastal marine area. |
| **The Act** | The Maori Commercial Aquaculture Claims Settlement Act 2004. |
| **The obligation** | The obligation under section 9 of the Maori Commercial Aquaculture Claims Settlement Act 2004 to compensate for 20% of new space. |

### 1.3 Accompanying model

We have prepared a scenario model, "LECG Scenario model – New Space.xls", which should be viewed alongside this report and forms part of our deliverables.

# 2 Conclusions

Based on the scenarios modelled, and under the assumptions presented in this report, the obligation value at 2020 could fall within a possible range of [redacted] By 2030, the range could increase from [redacted] On the basis of projections of global demand by reputable agencies, it appears that there could be insufficient global demand for New Zealand's aquaculture products to drive producers to fill harbour and coastal areas to their inshore capacity.

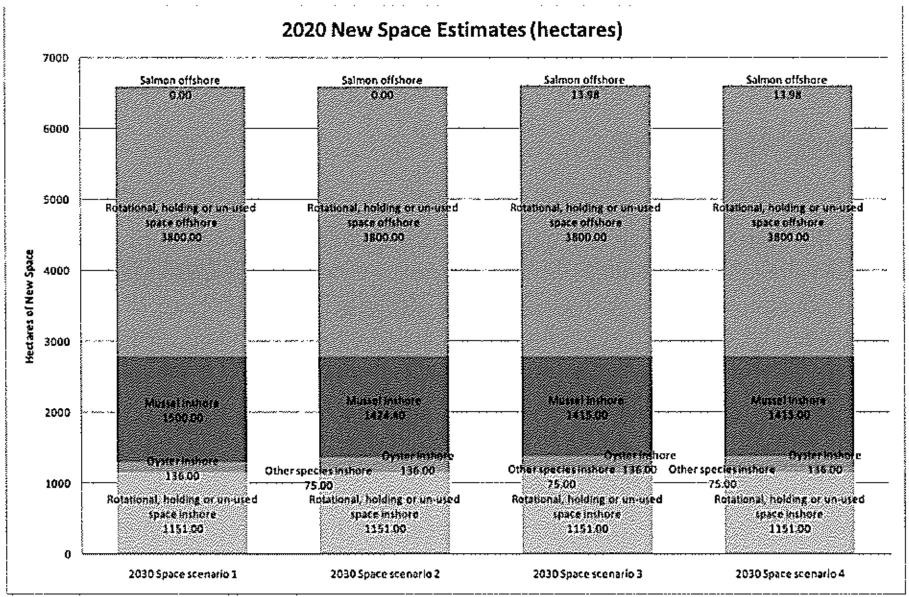
In recent years vast tracts of space have been permitted and a significant jump in production would be needed just to fill them. If those sites are filled, then further development of 'new space' inshore will appear, but these developments may be slow to emerge. Only when inshore sites have filled will large-scale production offshore be sought.

Figures 1 and 2 on the following page illustrate the scenarios modelled and provide an indication of possible new space to be created by 2020 and 2030 respectively. Scenario 1 assumes that only the applications which are known to the Ministry go ahead and are approved. The upper and lower bounds given for each scenario show the possible range of real per-hectare values for space that might be seen in 2020 and 2030. Scenarios 2, 3 and 4, which we feel are more realistic, assume that global demand for aquaculture products drives the demand for new space. Underlying this is an assumption that New Zealand's market share of global growth will not change dramatically, due to intense competition from other producing nations. Innovation and investment in the sector will be required just to retain market share over this period. In each of these scenarios some new sites are opened as a result of industry growth.

Figures 3 and 4 show the possible obligation value, if this amount of new space is approved in 2020 and 2030 respectively.

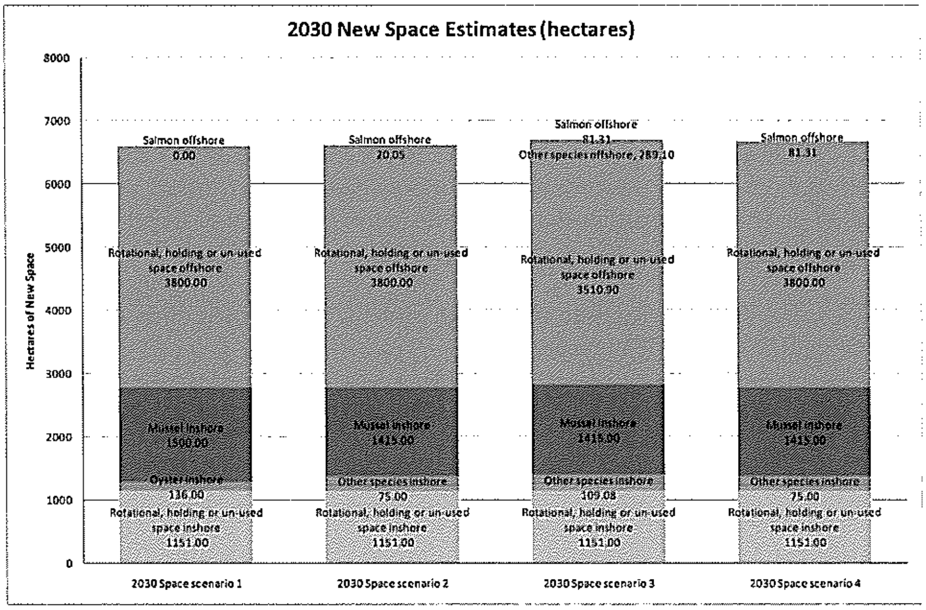
More detail about the methodology used to generate these scenarios is given in Chapter 3, Methodology.

**Figure 1 New Space estimates 2020**



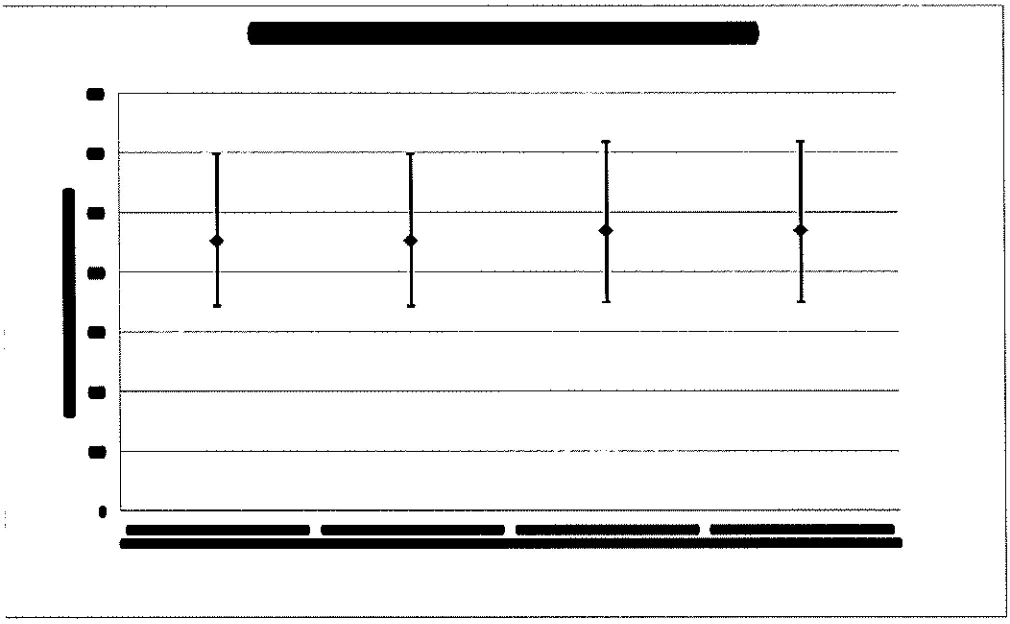

*Source: LECG*

**Figure 2 New Space estimates – 2030**




*Source: LECG*

[redacted]



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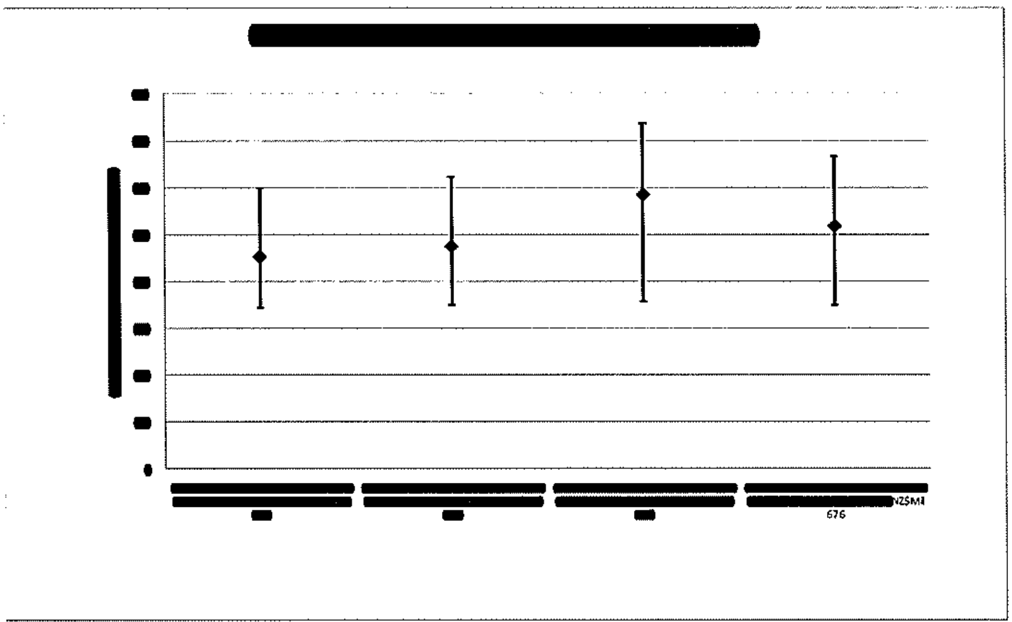

# 3 Methodology

The methodology used to prepare this value assessment consists of three key components:

1. Four scenarios, based on research by LECG about the trends in aquaculture globally and locally, and the long term prospects for demand for space. A basic outline of the scenarios is set out in section 3.2.3.

2. A method to allocate forecast production into productive sites. This method prioritises sites according to their suitability and availability. This is set out in section 3.2.5.

3. Estimates of the NZ$ value of new space, per hectare, by region and harbour. This is set out in chapter 4.

## 3.1 Other scenario reports

We are aware of reports prepared by Ernst & Young and NZIER which are currently in circulation. These reports include scenarios for mapping industry revenues and net economic benefits from aquaculture. For example, Ernst & Young presents a range of possible outcomes for the industry. Under these scenarios, it concludes that Aquaculture farming and processing in New Zealand could generate $623 - $858 million in nominal annual revenue in 2025 if the industry remains at 'business as usual'. However if high value or high production strategies are followed, this annual nominal revenue could increase to as much as $2,190 million.[1]

Both Ernst & Young and NZIER include scenarios which depend on 'new space' becoming available. It is important to distinguish between the space estimates included in those reports and the space estimates set out in this report. New space in the Ernst & Young and NZIER reports includes any new growing zones that were not in operation at the time of writing. The majority of those areas in the NZIER base case are already permitted, and thus qualify as existing space in our report.

Another difference between this report and the Ernst & Young and NZIER reports, with regards to requirements for new space, is our approach to the productivity of existing sites. We assume that all existing space becomes more productive over time as a result of new technologies such as basket culture for oysters or selective breeding for mussels.

[1] In real terms, using the NZ inflation rates applied by Ernst & Young, $2,190 million equates to around $1,464 million.

This means in situations where demand growth is low to moderate there is little need for new space because existing zones can be used more effectively.

In order that the new space estimates can be compared with the much publicised industry revenue target of $1 billion per annum, we have included industry revenue estimates alongside our estimates of new space. We note that the $1 billion target is a real (not inflation adjusted) target, but that the Ernst & Young scenarios are nominal (inflation adjusted). This means that while the Ernst & Young scenarios may show industry revenues of more than $1 billion, this can be the result of inflation adjustments rather than real growth in production or prices.

We note that a subsequent review of the Ernst & Young scenarios noted them as 'optimistic'. This critique extends to the 'Business as Usual' scenario, which shows positive revenue trends in all sectors, despite a rapidly changing and highly competitive global market for seafood protein[2]:

*"The resulting scenarios should be regarded as generally optimistic. To the extent that the underlying positive revenue trend breeds complacency about the configuration or performance of the current industry structure, such complacency is almost certainly dangerous."*

What can be concluded from the scenarios is that the $1 billion target has to arrive as a result of a combination of increased production and increased value, in addition to what can be described as 'business as usual'.

We have been asked to prepare a supplementary paper which utilises the Ernst & Young and NZIER scenarios, using our model, and predicts new space. This paper will be available shortly.

## 3.2 New space estimates

### 3.2.1 Existing new space

We understand that there no areas that would currently qualify as "new space". There are two applications that are likely to be approved shortly, however. These are:

- the interim AMAs in Tasman Bay and
- Area B in Wilsons Bay, Coromandel.

The Tasman Bay interim AMA consists of 850ha which has been approved by the Ministry, and a further 1151 ha which has 'reservations' over it and has been appealed.

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[2] Toroa Strategy, *New Zealand Aquaculture: Industry Growth Scenarios*, p. 9

It has not yet made it to the Council yet for the 20% identification, and indications are that it will take a while to come out the other end. For purposes of modelling we have assumed that all of this space will be approved, but that the 1151 ha may be rotational.

Area B in Wilsons Bay consists of 520ha. It is situated adjacent to Wilson's Bay Area A, which is a productive mussel growing area. We understand that an application may be made for 75 ha for Kingfish farming in the zone, but we note that the Waikato Regional Council Plan, which includes the Coromandel currently only allows shellfish farming and prohibits all other types of aquaculture. In every scenario, we have assumed that by 2020, farming of finfish or other species in Wilson's Bay is allowed over 75ha and the remainder of the 520 ha will be used for farming mussels or scallops.

### 3.2.2 Applications for new space

Figure 5, below, shows the hectares for:

- existing farms;
- aquaculture areas which do not qualify as "new space" because they were or will be approved under section 67J of the RMA;
- existing or likely applications for new aquaculture areas that would qualify as "new space" because they have been or will be approved under section 150B(2) of the RMA;
- sites that are interim AMAs (these sites qualify as "new space" but could be settled with 20% allocation instead of financial equivalent).

**Figure 5 Existing space and applications for "new space"**

| Region and location | Total existing space (ha.) | Additional space, which does not qualify as new space (ha.) | Existing or likely "new space" from known applications (ha.) | Interim AMAs (ha.) | Comments and likely species use |
|---|---|---|---|---|---|
| Auckland Coastal | 326 | Nil | 4130 | Nil | Primarily mussels, but some oysters and farmed scallops, and a small amount of fish |
| Bay of Plenty | 9.654 inshore<br>3800 offshore | Nil | Nil | Nil | |
| Chatham Island Coastal | 8 | Nil | Nil | Nil | Probably mussels |
| Canterbury Coastal | 179.361 | Nil | Nil | Nil | Mussels |

| Region and location | Total existing space (ha.) | Additional space, which does not qualify as new space (ha.) | Existing or likely "new space" from known applications (ha.) | Interim AMAs (ha.) | Comments and likely species use |
|---|---|---|---|---|---|
| **Hawkes Bay and Gisborne** | Nil | Nil | Nil inshore<br>3800 hectares offshore | Nil | Mussels |
| **Marlborough Coastal** | 3496.491 | About 810 ha (includes 770 ha Wakatu site) | (13 unknown sites, max 10 hectares each) | Nil | 10 hectares salmon, remainder split between mussels and new species (eg scallops) |
| **Northland** | 712.3949 | Nil | 136 (mussels and oysters) | Nil | Oysters |
| **Southland Coastal** | 285.8702 | Nil | Nil | Nil | Mussels and maybe farmed bluff oysters. |
| **Tasman Coastal** | 6081.8 (excludes 4011 which is the challenger scallop space and does not contribute to the earnings of the aquaculture industry) | 2404 (ring road sites, which are rotational) | 6780 (currently in prohibited areas in the Coastal Plan) | 850 approved by MFish<br>1151 reserved | Primarily mussels, farmed scallops/higher value species, and some finfish (snapper, groper, cod, butterfish) |
| **Wellington** | 4.307 | Nil | Nil | Nil | |
| **Waikato / Coromandel Coastal** | 1003.185 | Nil | 577 (currently in prohibited areas in the Coastal Plan in the Firth of Thames) | 520 ha approved in Wilson's Bay B | Mussels and farmed scallops/higher value species. Limited space for Kingfish/fish farming. |
| **West Coast Coastal** | 45.6 | Nil | Nil | Nil | Mussels |
| Grand Total | **11,841.18 inshore** | | | | |

*Source: Ministry of Fisheries*

### 3.2.3 LECG space estimates (four scenarios)

We have attempted to form a view on the possible demand for new space using a 'top down' approach. This approach considers the future production profile of the industry, given the demand and supply forces affecting aquaculture firms.

We have conducted research to attempt to establish the progression of the aquaculture industry from its current state to what it might be in 2020 and 2030. This research is set out in the appendix of this report.

While it is difficult to settle on any particular forecast, we have settled on four scenarios which we feel best reflect the potential for industry growth over the next 10-20 years, and the consequential demand for "new" space. These scenarios combine a number of factors which influence both the demand for, and the supply of, space for aquaculture. The demand for space directly reflects the demand for productive capacity. In turn, this is affected by the profitability of the industry and the potential to market and sell New Zealand aquaculture products to a World market.

Many of these factors, and in particular, exchange rates and real prices, are exogeneous and are impossible to predict with any degree of certainty. The supply of space, on the other hand, reflects a number of institutional, social and cultural factors from within New Zealand. For example, one could argue that while there is a supply of recently approved and available space in the coastal marine zone, there currently is insufficient demand to utilise this space from aquaculture companies because the profitability of marine farming has fallen.

The four scenarios we have modelled are as follows:

- Scenario 1 – Existing and/or known applications for new space only, as shown in the second column of Figure 5 above. No new demand for new space, or alternatively, there is no material change to the regulatory system that allows new space to proceed.
- Scenario 2 – Demand for new space is driven by moderate global increases in demand for seafood based proteins (1.92% CAGR) which drives demand for mussels, oysters and salmon. There is strong demand for new 'other' species, which command higher prices in the market (10.0% CAGR). The productivity characteristics for farm sites are based on Ernst and Young's 'Business as Usual' scenario, where sites are 1% more productive every year (we differ from Ernst & Young in that we deem oyster space to be twice as productive by 2020, due to the widespread introduction of basket technologies and other labour-saving devices). Tracts of existing available mussel space, both inshore and offshore, is converted for use on new species. New salmon farms are allowed to proceed inshore, particularly in Marlborough. Technological development is

slow but consistent: "*Technologies and market conditions stay relatively constant over the scenario period and permitted undeveloped space is gradually developed if it is in a productive aquaculture region.*[3]"

- Scenario 3 – Same as above, except demand for new space is driven by strong, continuing increases in global demand for seafood based proteins (3.5% CAGR) which drives demand for mussels, oysters and salmon. Strong demand for new 'other' species remains at 10.0% CAGR. Tracts of existing available mussel space, both inshore and offshore, is converted for use on new species.
- Scenario 4 – A composite scenario. Demand for space is driven by strong growth in new species (10.0% CAGR) and salmon (3.5% CAGR). Mussels demand is moderate (1.92% CAGR) and oyster demand experiences zero growth, as fewer marketing opportunities for oysters are found. Tracts of existing available mussel space, both inshore and offshore, is converted for use on new species.

The research behind the CAGR rates used in the scenarios is summarised in chapter 5, and outlined in detail in Appendix A.

### 3.2.4 Discussion on the scenarios

The scenarios set out in this report are a sample of an infinite number of possible scenarios that could have been selected. The scenarios selected are reasonable and moderate, rather than aspirational or pessimistic.

In particular we have not considered:

- a worst case scenario in which an environmental event or disease outbreak significantly diminishes production from aquaculture in New Zealand relative to current levels; or
- a best case scenario in which there is strong and consistent demand growth for farmed seafood and widespread acceptance of fish farming amongst communities and applications for new inshore space for this purpose are readily approved.

Much has been made of the target for the NZ Aquaculture industry to reach $1 billion revenue by 2025. While there is no doubt that this target is possible under certain conditions, it is also equally possible that these conditions may not eventuate.

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[3] Ernst and Young, *Report for NZ Trade & Enterprise – Aquaculture Industry Growth Scenarios*, 10 September 2009 (Reliance Restricted), p.8.

Because we view the $1 billion target as possible, but aspirational, we have not modelled it here. The Ministry has asked us to model this scenario in a supplementary document to provide more context to the scenarios presented here, but this is not presented in this report as a central scenario.

### 3.2.5 Prioritisation of space (the allocation 'waterfall')

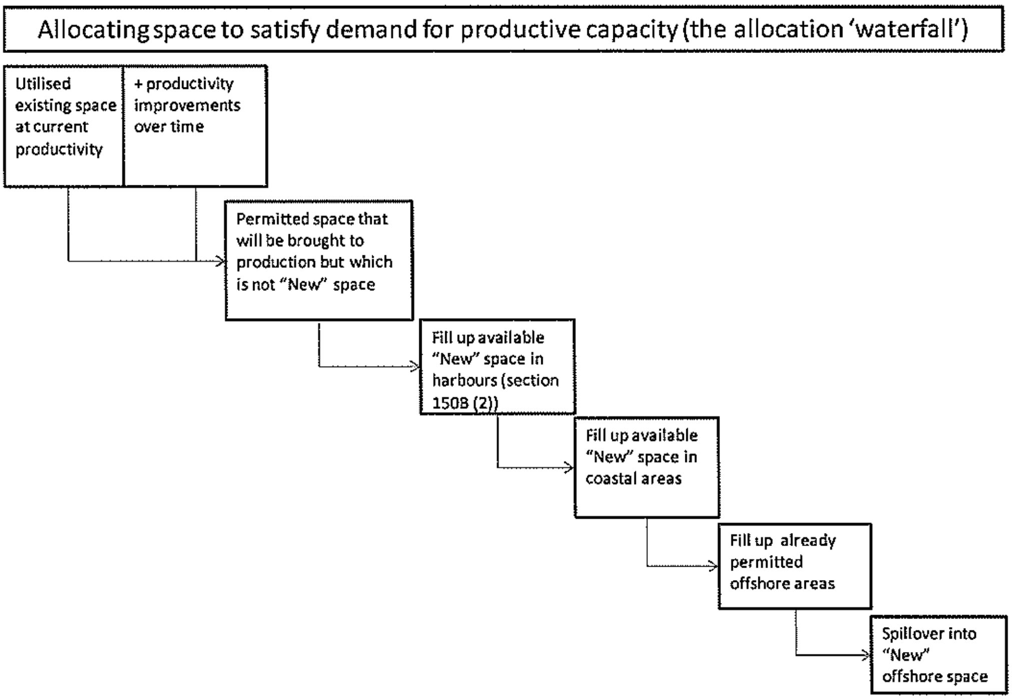
In order to accurately forecast the amount of new space that would be created, it was necessary to understand how productive existing space might be in the future, and to understand what existing, un-utilised spaces were available that could be filled. These un-utilised sites include sites that have been recently permitted but qualify as 'pre-commencement' space.

The demand for new space is modelled like a 'waterfall' in the sense that more desirable space fills up first. We have made a judgement on which spaces are more desirable.

- First, existing space is assumed to get more productive over time, with the advent of new technologies like uniform spat breeding.
- Second, permitted but currently un-utilised sites will be filled.
- Third, there will be applications for new sites in harbours, and these sites will be filled up to a cap. More detail on this cap is provided in the next section 3.4.
- Fourth, there will be applications for new sites in coastal areas, but again these will be filled up to a cap.
- Then, existing permitted offshore sites will begin to fill, and if technology allows, there may be some conversion of these sites from their current designated uses (such as mussels) to other uses (such as seaweed or finfish).
- The last space to fill up is the least desirable – new offshore space.

Figure 6, overleaf, illustrates.

**Figure 6 Prioritisation of space**




### 3.2.6 Summary of key assumptions about new space

This table sets out the key assumptions used to generate the new space estimates for the scenarios 2-4. Scenario 1 is driven by the amount of space in known or expected applications, rather than being assumption based.

**Figure 7 Key Assumptions**

| | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|
| **Current production** | As per Ernst & Young report – shown in chapter 4 | As per Ernst & Young report – shown in chapter 4 | As per Ernst & Young report – shown in chapter 4 |
| **Productivity growth of existing space** | Existing mussel space is 1.0% more productive each year, due to improvements in spat technology. This amounts to productivity of approximately 35GWT/ha.(variable by region).<br><br>Existing oyster space doubles in productivity by 2020, due to increased use of basket technology and | Existing mussel space is 1.0% more productive each year, due to improvements in spat technology. This amounts to productivity of approximately 35GWT/ha.(variable by region).<br><br>Existing oyster space doubles in productivity by 2020, due to increased use of basket technology and improved grading methods. | Existing mussel space is 1.0% more productive each year, due to improvements in spat technology. This amounts to productivity of approximately 35GWT/ha.(variable by region).<br><br>Existing oyster space doubles in productivity by 2020, due to increased use of basket technology and improved grading methods. |

| | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|
| | improved grading methods. This equates to productivity of approximately 15,000 doz/ha.<br><br>Salmon space increases productivity to 80GWT/ha. by 2020. | This equates to productivity of approximately 15,000 doz/ha.<br><br>Salmon space increases productivity to 80GWT/ha. by 2020. | This equates to productivity of approximately 15,000 doz/ha.<br><br>Salmon space increases productivity to 80GWT/ha. by 2020. |
| **Productivity per hectare of new space** | Productivity the same as existing space | Productivity the same as existing space | Productivity the same as existing space |
| **Global demand growth (Refer to Appendix analysis).** | 1.92% CAGR for all species except "other species", which has 10% CAGR. | 3.5% CAGR for all species except "other species", which has 10% CAGR. | 1.92% growth in demand for mussels, 3.5% growth for salmon, 10% CAGR for other species and 0% for oysters. |
| **Technology restrictions on offshore farming** | No technology restrictions (all species may be farmed offshore) | No technology restrictions (all species may be farmed offshore) | No technology restrictions (all species may be farmed offshore) |
| **Substitution of sites** | 'Other Species' will be able to generally be farmed on existing or unutilised mussel farm sites.<br><br>Substitution of mussel space for salmon space is not possible, because of the differences in environmental impacts between these two species. | 'Other Species' will be able to generally be farmed on existing or unutilised mussel farm sites.<br><br>Substitution of mussel space for salmon space is not possible, because of the differences in environmental impacts between these two species. | 'Other Species' will be able to generally be farmed on existing or unutilised mussel farm sites.<br><br>Substitution of mussel space for salmon space is not possible, because of the differences in environmental impacts between these two species. |
| **Global market share** | New Zealand's market share of global growth will not change dramatically, due to intense competition from other producing nations. Innovation and investment in the sector will be required just to retain market share. | New Zealand's market share of global growth will not change dramatically, due to intense competition from other producing nations. Innovation and investment in the sector will be required just to retain market share. | New Zealand's market share of global growth will not change dramatically, due to intense competition from other producing nations. Innovation and investment in the sector will be required just to retain market share. |

We reiterate that these assumptions reflect a selection of the numerous many assumptions that could be made about aquaculture development over the next 10 to 20 years. Combining assumptions such as these is more an art than a science and we would be the first to say that this exercise is an exercise in speculation.

## 3.3 Productive space deficit

Using these assumptions it is possible to estimate:

a. How much production might be demanded in 2020and 2030;
b. How much production existing space can deliver;
c. The difference between a. and b.; and
d. Given this difference, how much additional 'new space' is needed to deliver production to meet global demand.

The difference between a. and b. we have named "productivity deficit". We have estimated this by species, by scenario. These deficits are then allocated to 'new space' in either harbours, regions or offshore using the allocation waterfall.

**Figure 8 Productivity deficit for mussels**

| | Unit | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Production demand (rounded to nearest thousand) | (GWT) | 89,000 in 2010<br>108,000 in 2020<br>130,000 in 2030 | 89,000 in 2010<br>126,000 in 2020<br>177,000 in 2030 | 89,000 in 2010<br>108,000 in 2020<br>130,000 in 2030 |
| Production able to be delivered using existing space (rounded to nearest thousand) | (GWT) | 89,000 in 2010<br>157,000 in 2020<br>157,000 in 2030 | 89,000 in 2010<br>157,000 in 2020<br>157,000 in 2030 | 89,000 in 2010<br>157,000 in 2020<br>157,000 in 2030 |
| Production needing new space (rounded to nearest thousand) | (GWT) | 0 in 2020<br>0 in 2030<br>(but existing applications for new space go ahead) | 0 in 2020<br>10,700 in 2030<br>(but existing applications for new space go ahead) | 0 in 2020<br>0 in 2030<br>(but existing applications for new space go ahead) |

**Figure 9 Productivity deficit for Oysters**

| | Unit | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| **Production demand (rounded to nearest thousand)** | (doz.) | 3,500,000 in 2010<br>4,200,000 in 2020<br>5,100,000 in 2030 | 3,500,000 in 2010<br>4,900,000 in 2020<br>7,000,000 in 2030 | 3,500,000 in 2010<br>3,500,000 in 2020<br>3,500,000 in 2030 |
| **Production able to be delivered using existing space (rounded to nearest thousand)** | (doz.) | 3,500,000 in 2010<br>7,000,000 in 2020<br>7,000,000 in 2030 | 3,500,000 in 2010<br>7,000,000 in 2020<br>7,000,000 in 2030 | 3,500,000 in 2010<br>7,000,000 in 2020<br>7,000,000 in 2030 |
| **Production needing new space (rounded to nearest thousand)** | (doz.) | 0 in 2020<br>0 in 2030<br>(but existing applications for new space go ahead) | 0 in 2020<br>0 in 2030<br>(but existing applications for new space go ahead) | 0 in 2020<br>0 in 2030<br>(but existing applications for new space go ahead) |

**Figure 10 Productivity deficit for Salmon**

| | Unit | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| **Production demand** | (GG tonnes.) | 9,300 in 2010<br>11,248 in 2020<br>13,600 in 2030 | 9,300 in 2010<br>13,119 in 2020<br>18,505 in 2030 | 9,300 in 2010<br>13,119 in 2020<br>18,505 in 2030 |
| **Production able to be delivered using existing space** | (GG tonnes.) | 9,300 in 2010<br>11,200 in 2020<br>11,200 in 2030 | 9,300 in 2010<br>11,200 in 2020<br>11,200 in 2030 | 9,300 in 2010<br>11,200 in 2020<br>11,200 in 2030 |
| **Production needing new space** | (GG tonnes.) | 48 in 2020<br>2,404 in 2030 | 1,919 in 2020<br>7,305 in 2030 | 1,919 in 2020<br>7,305 in 2030 |

**Figure 11 Productivity deficit for Other Species**

| | Unit | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| **Production demand** | (GWT) | 716 in 2010<br>1,857 in 2020<br>4,817 in 2030 | 716 in 2010<br>1,857 in 2020<br>4,817 in 2030 | 716 in 2010<br>1,857 in 2020<br>4,817 in 2030 |
| **Production able to be delivered using existing space** | (GWT) | Approx. 50,000 in 2020 and 2030 (assumes there is the ability to convert mussel sites) | Approx. 50,000 in 2020 and 2030 (assumes there is the ability to convert mussel sites) | Approx. 50,000 in 2020 and 2030 (assumes there is the ability to convert mussel sites) |
| **Production needing new space** | (GWT) | 0 in 2020<br>0 in 2030 | 0 in 2020<br>14,835 in 2030 (this is because mussel space is utilised, and conversion is not possible) | 0 in 2020<br>0 in 2030 |

## 3.4 Maximum levels of development in harbour and coastal space

The Ministry of Fisheries has supplied us with an opinion on the maximum amount of new space that could be developed in inshore regions. We have used this opinion in order to model the waterfall steps described in Figure 6, in particular to give us some idea about the extent to which harbours and regions could fill up before applications for offshore space are seen.

The Ministry estimated the maximum amount of space that would be able to be realistically developed in harbour and coastal areas, given physical constraints, current social and cultural attitudes to the marine environment, and commercial interests. The estimate includes a break-down by region and species.

### 3.4.1 Status of opinion

Within the time available, the Ministry was the best placed to form a coherent view about development capacities without having to resort to more involved or more public processes. As this exercise is illustrative in nature, the Ministry's judgement has not been widely tested with council officers and industry players. This judgement was formed using available information, and was not intended to inform detailed settlement negotiations. As a next step, we would recommend more widely testing this opinion.

### 3.4.2 Ministry's opinion

In the Ministry's view, a maximum of 8,890 new hectares of space could be developed inshore (in harbours and coastal areas). In order to form this opinion, the Ministry has considered existing applications, social and cultural attitudes to aquaculture, the constraints placed on uses for aquaculture space due to regional fisheries, and environmental suitability of the sites. This estimate includes existing applications for new space, overlaid by a judgement about likelihood of success of those applications. This maximum holds for both 2020 and 2030.

In addition to this inshore space, the Ministry foresees a possible 3800ha. farm near Gisborne as "new" offshore space. We feel that this 3800 ha. is the maximum amount of new space that will be developed offshore for the purposes of cultivating mussels. We hold this view for two reasons. Firstly, further development of offshore space is only likely if no inshore space is available. Secondly, because the existing offshore spaces would likely be sufficient for industry's needs. These 'existing' offshore sites include the 3800ha. staged site near Opotiki and the likely 4008 ha. staged site near Whakatane, the 2695 ha. offshore site in Pegasus Bay, and the staged 2469 ha. site in Hawke Bay. These sites are gigantic and provide a significant amount of additional space that would be filled up before new offshore sites would be created.

The Ministry's detailed workings about the likely maximum amount of developable harbour and coastal space are not shown in this report for reasons of commercial and political sensitivity. To reiterate, the information provided was illustrative only, and in no way prejudices any negotiation for settlement.

# 4 Value-per-hectare estimates

As a starting point we have used estimates based on the per-hectare values agreed on for the Coromandel and Te Wai Pounamu settlement, agreed in late 2008.

These values are confidential, we have not included them in this report. We have attributed these values to the harbours and coastal areas around New Zealand, to the best of our knowledge about the regions and their productivity.

## 4.1 No movement in values assumed

We think it is unlikely that the per-hectare values for harbour and coastal space would have changed significantly between 2008 and the present day, as production profiles for sites have not changed significantly and while prices have dropped for some species in the last year (in particular for mussels), they appear not to have changed so markedly as to put them outside a normal range.

Should a settlement be forthcoming, we recommend testing whether transaction prices have changed markedly and permanently with aquaculture firms and valuers before relying on this assumption.

## 4.2 Values modelled in a band

It is not easy to estimate how values will change going forward. In order to give an idea of magnitude, we have modelled values in a band.

For the upper band, we have modelled a scenario in which the real values of space for mussels, salmon and other species increases from current values by 35% between now and 2020. This 35% value growth assumption is consistent with an assumption that a given hectare of farming space could become 1.5% more productive a year and/or that real prices for aquaculture products could rise from current levels. This is combined with an assumption that the value of additional productivity and better real prices flows through into the value of permitted space rather than to say, the suppliers of technology or capital financing. We have kept the values of oyster space the same, as the per-hectare value used was based on a sale and purchase of an oyster farm with very high productivity (almost double that of the productivity average).

For the lower band, we have modelled a scenario in which the real value of space decreases by 25% of its current value. This scenario is entirely possible if the market for aquaculture products becomes increasingly commoditised and if producers overseas continue to capture market share.

## 4.3 Values on offshore space more difficult

The value of offshore space is more difficult to judge. We have a reference point, which was the agreed values for offshore space used for the Coromandel and Te Wai Pounamu settlement, based on an assessment by Mr. Lex Hayward, Valuer of Blenheim.[4] Mr. Hayward's value assessment was based on the fact that in 2009 (and still) offshore space is experimental in nature. We do not place any reliance on Mr. Hayward's figures: an LECG peer review performed on Mr. Hayward's value assessment in early 2009 highlighted some inconsistencies in Mr. Hayward's approach.

No offshore sites in New Zealand have yet proven to be commercially or technologically viable. By 2020, we expect that offshore sites could well be commercially viable. However, we feel that due to their distance from shore and greater maintenance costs, these sites are likely to be less valuable than inshore sites. As our base point, we have

[4] Note this report does not constitute an opinion of value. Rather, it was a preliminary assessment. No reliance should be placed on these figures for the purposes of a settlement.

assumed that offshore aquaculture sites of all species are 75% as valuable as onshore sites in the same region. To indicate the 'lower band' of values for offshore sites we have applied Mr. Hayward's estimates. To indicate the 'higher band' of values we have assumed an increase from current values by 35% between now and 2020. This is consistent with the upper band applied to inshore per-hectare values.

# 5 Industry production forecasts

## 5.1 Introduction

This chapter sets out the assumptions and methodology we have used to generate our estimates of the new space requirements in 2020 and 2030. In essence, performing a top-down estimate of new space requirements involves an industry-forecasting exercise. This is what we have done. We have used different possible states of future industry development to estimate a range of plausible industry responses with respect to applications for new space.

## 5.2 Context for industry forecasts

### 5.2.1 Industry development

Economists do have some tools in their tool kit to help them understand industry cycles and industry development. For example, we expect that in general, the evolution of a technology-based industry will be characterised by the well-known S-shaped curve – which effectively represents the lifecycle of the technology (cycles of incubation, technological growth and diversity, market growth and segmentation, maturity and decline). We also know that the analogy for resource-based industries (like fishing) is somewhat different. Development paths for resource-based industries tend to be characterised by more gradual growth path that plateau when limits to growth are met (either limits to resource extraction or development, or in market demand).

Economists also know that a particular resource-based industry's 'size' may either:

- Remain at this plateau for an extended period;
- Enter into further growth as limits to growth are overcome; or
- Decline as the resource base is depleted or market demand is reduced.

Rather than becoming obsolete, most resource-based industries can move from extended periods of relative growth to long periods of decline and back again as either supply or demand factors change. The profile for a specific industry is characterised by high levels of uncertainty leading to periods of boom and bust.

Aquaculture is a combination of a resource-based industry and a technology-based one. In the past, it fit more into the mould of a resource-based industry. Increasingly, however, technological change will determine the industry's evolution.

### 5.2.2 Industry returns

Related to forecasting industry growth rates is forecasting returns made by participants in that industry. For technology-based industries the greatest returns are generally made during the period of market growth and segmentation. For resource-based industries profitability is a function of:

- Levels of supply and demand (market prices); and
- Exchange rates between the country of supply and market of demand.

As with forecasts of industry growth, forecasts of both exchange rate and market price forecasts are notoriously inaccurate. And, as so many factors are involved in determining demand and supply, it is seldom possible to correctly predict what revenues an industry may generate in the future.

### 5.2.3 More of an art than a science

Some words of warning about forecasting an industry's development. Historically very few industries come close to matching the textbook examples. For this reason, forecasting industry growth rates over time is far from being an exact science.

Despite our general reservations about the accuracy of predictions, reasonable estimations can be made of what an industry and market might look like should fundamental assumptions prove to be correct.

Assumptions of cause and effect (or vice versa) can be made with varying degrees of certainty, for instance:

- High level of certainty - total market demand for protein will increase as a result of global population growth as more people want to eat the same amount of protein per capita;
- Medium level of certainty – global market demand for aquaculture products will correlate with growth in market demand for protein, which will itself reflect growth in world population and GDP; and
- Low level of certainty – prices for aquaculture products will merely remain constant in real terms as population growth will in general be in countries not able to afford to pay for aquaculture-based protein grown in New Zealand.

## 5.3 Drivers of demand and supply for space

The demand for space will be driven by the growth and profitability of the aquaculture industry as a whole (demand side factors), and by various constraints on the development of new space (supply constraints). For accurate projections to be made about the new space that may be developed in New Zealand over time one has to define a position on several factors, and determine conclusively how they inter-relate.

These factors include the following:

***Demand side factors***

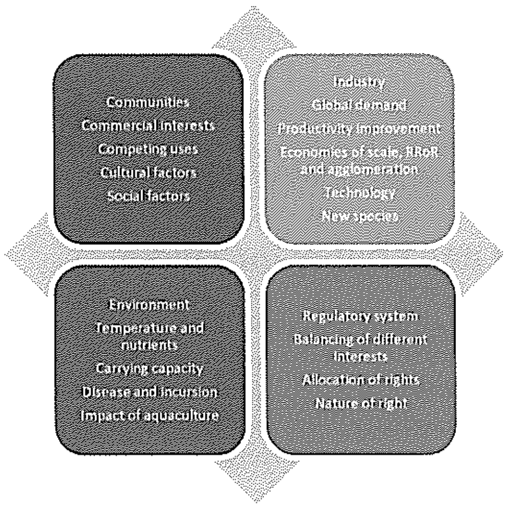
- Global and local market demand for aquaculture products able to be produced in New Zealand.
- Industry profitability, which is determined by a multitude of factors including: real prices, relative exchange rates, productivity, the degree of agglomeration in the industry, required rates of return on capital and the marginal costs of production.
- Space which is already available for use in production and best practice farm management on those sites.

***Supply constraints***

- Technological change, particularly around the offshore technologies and the viability of 'new' species
- Regulatory frameworks (overlaid by cultural and social attitudes to aquaculture development)
- Economies of scale, required rates of return on capital, and business agglomeration
- Disease, incursions, water quality issues, and the impacts of environmental change (e.g. temperature changes)

The factors driving demand and supply for space are inter-related to such a degree that the levers are difficult to model separately. But the forces can be summarised into four general areas: the industry itself, environmental factors, the regulatory system and communities. These forces and their inter-relatedness are illustrated in the diagram below.

**Figure 12 Forces affecting demand for, and supply of, 'new' aquaculture space**



## 5.4 Current production levels

Our forecast starts with current production levels, upon which we add assumptions regarding future production growth.

We have used the Ernst & Young Scenarios report[5] as the most reliable source of information on current production levels. We note that these estimates are for the 2008 year. However, we understand that these estimates are the latest and best available. Aquaculture NZ believe the Ernst & Young report to contain the most recent and reliable data. Aquaculture NZ does produce industry statistics but these are gathered from levy returns and are "not particularly reliable when it comes to local markets"[6].

According to Aquaculture NZ there has been very little change in industry exports of oysters since 2008, and the 2008 figures could be applied as estimates of likely production in 2010. Mussels had a dreadful sales year in 2009, but according to Aquaculture NZ the 2008 production figures provide a reliable estimate of more sustainable production. Salmon had a particularly good year in 2009, but according to Aquaculture NZ the 2008 production figures nevertheless provide a reliable estimate for production in 2010.

**Figure 13 Production estimates for 2010**

| | MUSSELS | OYSTERS | SALMON | OTHER SPECIES | TOTAL |
|---|---|---|---|---|---|
| **Space** | 2750 ha. utilised (with 520 ha. for spat holding) | 500 ha. utilised | 130ha. permitted | 8ha. Permitted | 6,602 ha |
| **Production** | 89000.0 | 3.5 | 9300.0 | 716.0 | N/A |
| **Production units** | GWT/annum | Million Dozen/annum | GWT/annum | GWT/annum | N/A |
| **Revenue (NZ$ at the farm gate)** | 239,000,000 | 26,000,000 | 104,000,000 | Unknown | 399,000,000 |

*Source: Ernst & Young, Report for Aquaculture NZ – Aquaculture Industry Growth Scenarios, 10 September 2009* (Reliance Restricted).

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[5] Ernst & Young. *Report for Aquaculture NZ – Aquaculture Industry Growth Scenarios, 10 September 2009* (Reliance Restricted).

[6] Conversation with Rebecca Clarkson, Communications Manager, Aquaculture NZ on 4 May 2010.

## 5.5 Global demand forecasts by reputable agencies

In order to form a view on how aquaculture production may evolve in New Zealand over the next 10 to 20 years, we have researched articles from:

1. The Food and Agriculture Organisation of the United Nations (FAO);
2. International Food and Policy Research Institute (IFPRI); and
3. A general literature search using Google and Googledocs.

Our findings, in summary form, are set out in Appendix A.

## 5.6 Application of research to NZ situation – development of growth scenarios

As stated above, we have researched historical and projected industry production growth rates. A difficulty in undertaking formal inquiry into production forecasts is the complexity involved with using data produced independently and then aggregated to the global level in broad commodity groups. There is a wide range of information available, but it is challenging to synthesise it down into meaningful information that can be applied to a New Zealand context. To our mind, the most applicable conclusions about future production growth from New Zealand are those set out in the table below.

**Figure 14 Summary of annual growth projections, derived from literature search**

| Source | CAGR to 2020 | CAGR to 2030 |
|---|---|---|
| FAO (2005) | 3.1% - 3.4% | 3.4% - 3.6% |
| FAO (2008) | 1.92% | 1.92% |
| IFPRI –World (2003) | 2.8% | 2.8% |
| IFPRI – 'Other' Developed World (2003) | 2.9 % | 2.9 % |
| NZ Historic Production Trends, 1994 - 2003 | 8.5% Mussels<br>4.5% Salmon<br>0% Oysters | 8.5% Mussels<br>4.5% Salmon<br>0% Oysters |
| Global Historic Production Trends, 1998 - 2008 | 2.94% Mussels<br>7.7% Salmon<br>2.47% Oysters<br>5.91% - 6.88% Other | 2.94% Mussels<br>7.7% Salmon<br>2.47% Oysters<br>5.91% - 6.88% Other |
| Global Historic Production Trends, since 2000 | 6.3% all species | 6.3% all species |

## 5.7 Production growth scenarios modelled

The table below shows the production growth scenarios we have modelled. The scenarios are meant to provide an indication of the upper and lower bounds of realistic, expected production growth if new space were available. They are based on a judgement, formed using the researched information available and set out in Appendix A.

**Figure 15 Demand Scenarios Modelled**

| Scenario | PRODUCTION GROWTH IN MUSSELS TO 2020/30 | PRODUCTION GROWTH IN OYSTERS TO 2020/30 | PRODUCTION GROWTH IN SALMON TO 2020/30 | PRODUCTION GROWTH IN HIGH VALUE SPECIES TO 2020/30 |
|---|---|---|---|---|
| Scenario 1 | N/A | N/A | N/A | N/A |
| Scenario 2 | 1.92% | 1.92% | 1.92% | 10.00% |
| Scenario 3 | 3.50% | 3.50% | 3.50% | 3.50% |
| Scenario 4 | 1.92% | 0.00% | 3.50% | 10.00% |

*Source: LECG*

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# Appendix A – Detailed research on aquaculture trends

## Global production trends

The Food and Agriculture Organisation of the United Nations (FAO) is one of the World's most reputable sources of information regarding global food production and demand trends. The FAO describes how world aquaculture has grown dramatically in the last 50 years. From a production of less than 1 million tonnes in the early 1950s when the FAO first began collecting statistics, production including aquatic plants was reported to have risen to 68 million tonnes, with a value of US$106 billion, by 2008.[7]

The FAO has also discerned a trend in the past decade of an overall slowing in the growth rate of aquaculture (measured in production volume). Growth in global production per annum since the year 2000 averages 6.3% (cumulative) per year. This contrasts with growth rates in the early 1990s, which peaked at over 15% per year.

In its *State of World Fisheries and Aquaculture 2008* report (*State 2008*), the FAO notes that aquaculture in the marine environment contributes 34% of world production by volume, and 36% of production by value. The remainder is produced on land. In the same report, the FAO explains that while "much marine production is high-value finfish, production in this environment also consists of a large amount of relatively low-priced mussels and oysters".

FAO analysts conclude that the importance of aquaculture in overall fish supply is growing. In their view, in the not too far future, aquaculture will overtake capture fisheries for human consumption of fish.[8]

## Regional production trends

A closer look at the recent history of aquaculture growth in *State 2008* shows that growth has not been uniform. It has been faster in some regions of the world than in others, and in particular, growth in Asian countries outstrips other regions. About half of exports now come from developing countries, and about 75% of imports by value are by industrialised countries. Asian countries account for almost 90% of aquaculture production by weight (FAO, 2007a), 67% in China alone. The FAO posits that simple

[7] FAO statistics retrieved using the FAO online aquaculture database http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en

[8] Josupeit, H *FAO presentation on commodity trade development*, presentation delivered in Rome in April 2008.

explanation for these differences is that producers and marketers have different abilities to provide fish at prices consumers can afford.

The International Food Policy Research Institute (IFPRI) is a globally respected organisation that produces aquaculture and fisheries forecasts. A 2003 report on the supply and demand for fish summarizes results for production, consumption, net exports and real price changes for 10 economic categories of fisheries items, disaggregated into 15 geographic regions of the world.[9]

In the IFPRI's baseline scenario, total production of food fish from aquaculture is expected to grow by 2.8 percent (CAGR) every year to 2020. These growth rates vary markedly by region. In the developed world, aquacultural production is only expected to grow by 0.4 percent annually. In Latin America, growth in aquaculture production is expected to be 3.5 percent, and in Asia, annual growth rates between 2.6 percent and 4.0 percent are seen.

The table below illustrates the different production growth rates reported. It also shows that aquaculture growth trends are almost twice as high as those for capture food fish for most of the world. The IFPR predicts that the share of food fish production from aquaculture will increase markedly by 2020, from 31 to 41 percent.[10] This is particularly the case in developing countries (not only in China). These countries will increasingly produce low-value fish in tanks or on farms instead of capturing it.

[9] Delgado, C. et al, *Fish to 2020 – Supply and Demand in Changing Global Market,* The International Food Policy Research Institute, 2003.

[10] Above, n.11, p.58.

**Figure 16 IFPR Projected food fish production and share of aquaculture**

| Country | Projected 2020 Production<br>Million metric tonnes | Projected 2020 Share from Aquaculture (percent) | Projected Annual Growth Rates 1997-2020 (percent) | | |
|---|---|---|---|---|---|
| | | | Capture | Aquaculture | Total |
| China | 53.1 | 66 | 1.1 | 2.6 | 2.0 |
| Southeast Asia | 17.5 | 29 | 0.8 | 3.6 | 1.4 |
| India | 8.0 | 55 | 1.0 | 3.7 | 2.3 |
| Other South Asia | 3.0 | 39 | 0.6 | 4.0 | 1.7 |
| Latin America | 8.8 | 16 | 1.1 | 3.5 | 1.4 |
| West Asia and North Africa | 2.8 | 16 | 0.6 | 3.6 | 0.9 |
| Sub-Saharan Africa | 6.0 | 2 | 2.0 | 5.8 | 2.1 |
| United States | 4.9 | 16 | 0.1 | 2.7 | 0.5 |
| Japan | 5.2 | 20 | -0.3 | 1.2 | 0.0 |
| European Union 15 | 6.7 | 29 | 0.0 | 2.1 | 0.5 |
| Eastern Europe and former Soviet Union | 5.0 | 4 | 0.1 | 0.4 | 0.1 |
| Other developed countries | 5.8 | 20 | 0.5 | 2.9 | 0.8 |
| Developing world | 102.5 | 47 | 1.0 | 2.8 | 1.8 |
| Developing world excluding China | 49.4 | 27 | 1.0 | 3.6 | 1.6 |
| Developed World | 27.6 | 19 | 0.1 | 2.1 | 0.4 |
| World | 130.1 | 41 | 0.7 | **2.8** | **1.5** |

## Population growth and per capita consumption

Population growth is a major driver of demand for aquaculture products. Population growth increases pressure on wild fish stocks, which drives prices, which in turn creates supply of lower cost alternatives such as farmed fish. In addition, as per-capita incomes increase, the more people are inclined to increase their levels of dietary protein. There is a particularly high correlation between incomes and consumption of fish.[11] But per capita growth in demand cannot be explained by income levels alone. For example, consumption per capita for different countries appears reflects cultural factors as well as wealth (e.g. considerable variance between per capita consumption in Germany versus Japan or Norway). There is less variance resulting from the relative ratio of capture to aquaculture production.

In *State 2008* the FAO describes how apparent global per capita fish consumption has been increasing steadily, from an average of 9.9 kg in the 1960s to 11.5 kg in the 1970s, 12.5 kg in the 1980s, 14.4 kg in the 1990s, and reaching 16.4 kg in 2005. However, China has accounted for most of the per-capita growth; with per capita fish supply about 26.1 kg in 2005 from a relatively low base in the 1980s. If China is excluded, per capita fish consumption is about 14.0 kg, slightly higher than the average values of the mid-1990s, but lower than the maximum levels registered in the 1980s (14.6 kg).

The FAO posits the question of whether per capita supplies of fish and aquaculture products for human consumption will remain steady or peak in the near future and then start to fall . In the outlook section of *State 2008* the FAO notes that aquaculturalists would probably be better equipped than wild capture fishers to overcome barriers to production if the worldwide price levels for fish rise significantly. However, the FAO considers that it "would seem unwise to rely only on an increase in price, which, if it happens, is likely to be in nominal rather than real terms".

## Prices and industry maturity

As sources of supply of particular aquaculture products gear up to meet demand, the global market becomes more competitive and prices fall. For example, the 1980s to 1990s marked a transition in global salmon markets - quantities of both farmed stock and wild-caught fish increased dramatically. With a substantial degree of consumer substitution among salmon species, prices fell as a result of increased market supply. Between 1992 and 2005, the price of farmed Atlantic salmon fell by 22% and the price declines for Alaskan wild salmon ranged from 18% for coho to 44% for sockeye salmon. Prices of Chinook salmon fell 66% between 1992 and 2003. Once an industry is mature, its prices tend to stabilise (at overall lower levels).[12]

## Global demand and national aquaculture development plans

An indication of possible growth prospects can be derived from the bottom-up by looking at national development plans, at a country-by-country level. In 2004, the FAO prepared aggregated country production forecasts for aquaculture producing countries,

[11] Delgado, C. et al, *Fish to 2020 – Supply and Demand in Changing Global Market,* The International Food Policy Research Institute, 2003, p.41.

[12] Josupeit, H *FAO presentation on commodity trade development*, presentation delivered in Rome in April 2008.

and then compared these forecasts with national development plans.[13] They found that that the demand projections could be met by producing countries, particularly if China could be expected to continue to supply the bulk of production and if Brazil and Chile achieve their production plans. The FAO concluded that aggregated demand for aquaculture is expected to grow at an average annual growth rate of 4.5 percent over the period 2010–2030.[14] We are not entirely clear where the 4.5 percent figure came from, as in the projections modelled cumulative annual growth was 3.5-3.6 percent, as shown in the table below.

[13] Brugere, C. and Ridler, N., *Global Aquaculture Outlook in the Next Decades: An Analysis of National Aquaculture Production Forecasts to 203*, FAO Fisheries Circular No. 1001, FIPP/C1001 (En), 2004.

[14]Above n.13, p.32.

**Figure 17 FAO projections of demand for aquaculture products**[15]

| | 2010<br><br>Demand, in '000 tonnes | 2020<br><br>Demand, in '000 tonnes | 2030 (adjusted)<br><br>Demand, in '000 tonnes | Average annual growth (CAGR) to 2020 | Average annual growth (CAGR) to 2030 |
|---|---|---|---|---|---|
| Optimistic scenario simulation 1 (using China growth rate at 3.5%) | 51,100 | 69,500 | 102,000 | 3.1% | 3.5% |
| Optimistic scenario simulation 2 (using China annual growth rate at 2.0%) | 51100 | 69,500 | 102,000 | 3.1% | 3.5% |
| Stagnating Fisheries scenario simulation 1 – using China annual growth rate 3.5% | 59,700 | 83,600 | 121,600 | 3.4% | 3.6% |
| Stagnating Fisheries scenario simulation 2 – using China annual growth rate 2.0% | 59,700 | 83,600 | 121,600 | 3.4% | 3.6% |

The FAO surmised that under each of the scenarios, existing producing countries could meet this demand. The FAO tempered this conclusion by saying that this conclusion was dependent on many assumptions underpinning national production targets, stating:

> *"Many factors affect the evolution of an activity like aquaculture and setting realistic production targets is a difficult task. The sector is susceptible to unforeseen shocks, meteorological, pathological or economic, when countries compete in marketing a commodity and expand their production simultaneously."*

This analysis supports the view that small, but emerging producing countries like New Zealand will find it extraordinarily difficult to capture increasingly greater levels of market share. Global production seems to be prepared to keep up with global demand.

[15] Above n.13, table 10, p.29.

## Future trends in relation to capture fisheries

The FAO has made more recent projections of global growth in aquaculture production and also aquaculture demand. Underlying these projections was a relationship with capture fisheries.[16] In a 2008 presentation of food fish capture production the FAO forecast ancumulative annual growth rate to 2020 and 2030 of 1.92%.

**Figure 18 FAO (2008) Projections for aquaculture production (MT)[17]**

| | 2010 Production in '000 tonnes | 2020 Production in '000 tonnes | 2030 Production in '000 tonnes | Average annual growth (CAGR) to 2020 | Average annual growth (CAGR) to 2030 |
|---|---|---|---|---|---|
| Aquaculture Production | 57,515 | 69,593 | 84,208 | 1.92% | 1.92% |

This later forecast could be interpreted to suggest that the FAO revised its forecast production growth rates downward substantially, from 3.6 percent CAGR in 2004 down to 1.92% CAGR in 2008.

In *State 2008* the FAO makes the following observations about global demand for fish (which includes both capture fisheries and aquaculture), which support the view that predictions have softened:

> *In the second half of 2007 and early in 2008, energy costs and the prices of basic foodstuffs rose rapidly worldwide. This also affected fish prices – particularly those for wild-caught fish – which rose in real terms for the first time in many years. These increases will affect demand for fish, which is likely to suffer a setback in 2008 and 2009.*
>
> *...When demand growth for fish resumes, it could be satisfied if fish supplies for human consumption increased by between 1.2 and 1.5 million tonnes per year. This amounts to an annual growth in fish supplies of between* ***1.1 and 1.4 percent in volume terms****. Most of this increase in demand will be caused by population growth; the remainder will be the result of gradually rising disposable incomes, particularly in developing countries.*
>
> *...However, the likelihood that supplies will grow at this pace differs from region to region. Some regions (North America, Japan, and Western Europe) have stagnant demand and are likely to experience little economic difficulty in maintaining per capita supplies even if landings from capture fisheries fall. Apparent consumption in South Asia is well above that supplied by capture fisheries. The region is dependent on aquaculture for fish supplies.*

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[16] The FAO typically includes finfish, crustaceans, molluscs, and other aquatic animals in its use of the word "fish" and when discussing fish aquaculture, but typically does not include aquatic plants, which is discussed separately or not at all.

[17] Above n.12

> *...In North America and Japan, aquaculture accounts for a minor portion of fish supplies, whereas in Europe it provides about 20 percent. However, it seems plausible that aquaculture in these three regions could expand to cover for shortfalls in capture fisheries, but it would probably face fierce competition from aquaculturists elsewhere (principally in Asia and Latin America).*
>
> *...It is a possible, but demanding, undertaking for aquaculturists in Europe, North America and Japan to make inroads in high-priced markets in Asia and Latin America. Thus, marketing, sales promotion and continued cost-cutting will be essential if aquaculturists in the developed world are to remain competitive.*
>
> *...The market for aquaculture products produced in the industrialized world will not expand rapidly at present price levels. At the current prices for salmon, trout, catfish and sea-bass, consumers in these markets seem unlikely to increase their consumption unless capture fishery supplies of similar products fall.*

## New Zealand historical growth trends

While the past is no predictor of the future, it is worth looking into recent history to see how future predictions compare with historical performance.

The most detailed data available for this purpose is statistics from the NZ Marine Farming Association, which were summarised in the a market intelligence report prepared by PricewaterhouseCoopers in 2006.[18] These statistics show that, on average, salmon production increased by 4.5% per annum between 1994 and 2005, mussels increased by 8.2% per annum, and oyster production remained relatively static.

New Zealand's contribution to global aquaculture is about 0.02% of sales by weight. New Zealand's proportion of global aquaculture production has remained broadly static over the period 1994 to 2003,[19] despite world aquaculture increasing significantly due to large volumes of low-value products from nations such as China and Chile.

## Global historical growth trends by species

### *Salmon and finfish*

Looking at the FAO's statistics on the global supply of all marine Salmon (King and Atlantic), there has been an average annual increase in production of 7.70% for the ten years ending 2008. In *State 2008* the FAO notes the strength of salmon aquaculture in recent times, with industry concentration in aquaculture and year-round fish availability leading to strong market growth.

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[18] *Aquaculture in New Zealand*, Market Intelligence Report prepared for Investment New Zealand by PricewaterHouseCoopers, 2006.

[19] *Aquaculture in New Zealand*, Market Intelligence Report prepared for Investment New Zealand by PricewaterHouseCoopers, 2006.

On its website the FAO explains that because of rapid increases in production over the last 10-15 years, ex-farm prices for most salmon have fallen sharply. Many producers in Europe are unable to sell fish into the market at the cost of production. Much of the state-of-the-art research into salmonid farming still takes place in traditional Northern European producing countries, and much of this focuses on developing economies of scale in order to reduce unit production costs and protect profit margins. However, it seems likely that significant future production increases will take place in Chile, where costs of production are generally lower due to lower cost of labour and raw materials.

#### *Molluscs*

According to the FAO, global growth in the production of mussels for the ten years to end 2008 averaged 2.94%. Global growth in the production of scallops and pectens for the ten years to end 2008 averaged 5.91%.

#### *Oysters*

According to the FAO, global growth in the production of oysters for the ten years to end 2008 averaged 2.47%.

On its website the FAO notes that much of the oyster production of the major producing countries is absorbed by domestic markets and is supplemented by imports from adjacent countries and trading partners (e.g. trade within the EU). The relatively short shelf life of this species is an impediment to large-scale global trade for fresh product, and consumer preference is often for live, half shell oysters or freshly shucked meats. Value-added and convenience products, including canned oysters and frozen or vacuum packed oysters prepared with various sauces, appear from time to time and have potential for global distribution. However, they represent only a small proportion of total production at present.

The FAO further notes that worldwide aquaculture production of the Pacific cupped oyster continues to expand steadily, having expanded from 156 000 tonnes in 1950 to 437 000 tonnes by 1970, and 1.2 million tonnes by 1990. Expansion was very rapid in the 1990s, rising to 3.9 million tonnes by 2000. Expansion is continuing, reaching nearly 4.4 million tonnes by 2003. Production is likely to continue to expand, albeit at a slower rate due to coastal urbanisation and the increasing need to share the common coastal resource with other users.

#### *Marine plants*

The culture of aquatic plants has increased consistently, with an average annual growth rate of 6.88% in the 10 years to 2008. The majority of aquatic plant production occurs in China (over 70% by volume), with high value production occurring in Japan in particular (approximately half a million tonnes with a value of US$1 billion).

Over 1.76 million tonnes of wakame (undaria pinnatifida), which is present in New Zealand waters but not commercially grown, was produced via aquaculture in Japan and elsewhere in Asia in 2008, with a market value of approximately US$749 million.

### Commentary - aquaculture growth is constrained

While historical growth in aquaculture has been strong, it is clear that future growth in aquaculture, both locally and globally, will be constrained by both physical factors (productive capacity) and market factors. Factors that might act as a constraint on future aquaculture in New Zealand and elsewhere include:

***Natural environmental characteristics***

Natural environmental characteristics always act as a constraint on development. For example, despite the size of New Zealand's fisheries waters they are not as productive as in other parts of the world.[20] In New Zealand we have limited suitable species for aquaculture, certainly compared with countries with warmer water temperatures and more sheltered water conditions. Salmon is currently our leading finfish and Kingfish has been proven despite the short-term commercialisation problems. There are indications that the supply of mussels currently outstrips market demand, but that there appears to be growth potential for scallops. Other finfish and seaweed species show promise, and barriers to the commercialisation of the later may be more regulatory than technical/commercial (such as undaria).

Arguably, the premium locations for aquaculture (in New Zealand, at least) have already been taken.

***Competition from lower cost producers***

Competition from lower cost, higher productivity (water temperature), and/or closer to market (transportation cost) producers will present a competitive constraint for countries like New Zealand, which are at a far distance from markets.

For example, New Zealand is a high cost producer of salmon compared to other suppliers. New Zealand salmon niche export. Part of the reason for this is that New Zealand producers have to import feed, and feed is 75% of the production cost of salmon.

***Product substitution***

The FAO commentary around development of fish aquaculture suggests we are likely to see product substitution to more sustainable (and cheaper) herbivorous finfish or other sources of protein, produced on land or in different locations.

Even if product substitution to higher-value aquaculture is possible, the process takes time. For example, a new fin-fish operation would need to get permits, build infrastructure, and develop hatchery etc before its operation can become profitable. In Australia, for example, it took one of the larger producers of Kingfish ten years to increase production to 3,370 tonnes following grow-out trials (a third of the production of the salmon industry in New Zealand currently).

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[20] http://www.fao.org/fishery/countrysector/FI-CP_NZ/en

### *Offshore technologies*

There are still major technical, economic, and even political barriers to offshore development, not only in New Zealand but in competing countries. We expect these barriers to have eased significantly by 2020. If widespread offshore development is feasible, however, there would likely be a decrease in product prices and the value of underlying offshore space.

Large investments in new farms offshore will only occur when the viability of offshore pioneers has been established.

### *Rising costs of fish feed*

Rising costs of fish feed will constrain growth in carnivorous fish production. Changes in capture fisheries from output fish such as salmon to the input species used in feeds (which are in some cases also consumed directly in developing countries). Experts developing a report on aquaculture's prospects for the FAO identified feed and energy costs as key constraints on the expansion of global aquaculture production over the next 15 years (from 2009). However, emerging feed technologies coupled with marketplace sustainability initiatives may unravel some of these linkages, and begin to solve some of the more ecological problems from of catching wild fish to feed farmed fish. The case for energy efficiency reducing costs is less certain but may result from economies of scale.

### *Disease and incursion*

Disease is also considered by the FAO to be a major constraint on increasing global aquaculture output to 2030. The example of shrimp production in Europe halving during the 1990s is used as a particularly telling example. There have also been regular outbreaks of disease in salmon farms.

Biosecurity risk and disease outbreaks are identified by experts selected by the FAO as very important issues for aquaculture in Asia Pacific. Undaria and clubbed tunicate have both been found in New Zealand. Undaria is listed among the world's 100 worst invasive species; the seaweed can rapidly displace native kelps, restrict the lifecycle of shellfish, such as paua, and threaten aquaculture. Clubbed tunicate, a sea squirt, could smother much of our marine-farming industry. Both have the potential to multiply and spread rapidly.

MAF Biosecurity estimates that should the Northern Pacific Seastar became widespread in New Zealand, stock could be reduced by 10 – 50%. Any biosecurity response to Northern Pacific Seastar would entail domestic and international controls to limit further spread; further impacting the industry. The impact overseas from disease or incursion can be severe (reported incidents widely reported ranging from a third of production to a near total loss) and can be a permanent decrease in productivity or cause repeated outbreaks. There is no treatment for some bacterium or viruses and the eradication of some invasive species is similarly impossible.

### *Social carrying capacities*

As countries become increasingly environmentally aware, social "carrying capacities" may fall. Most forms of aquaculture are best suited to production in sheltered and semi-sheltered coastal inlets. Experience across wealthy countries is that development approval in many instances is not able to be obtained because of objections from local stakeholders. In many coastal regions the recreational and amenity values are now very high and aquaculture is perceived to be a threat to these values. Further barriers are erected to industry development as more and more of the coastline becomes inhabited by often wealthy people. The growth-limiting factor for the expansion of marine farming areas is therefore the "social carrying capacity"; especially where such developments are actively encouraged by governments in some lower cost emerging nations with productive waters and capital is relatively free to move.[21]

### *Property rights and regulatory constraints*

Increasingly, people are seeking greater clarification over the property rights that exist in marine environments whether they be customary, commercial or recreational fishing rights or claimed rights in the foreshore and seabed and what the relationship is between such rights. In New Zealand, for example, it has been recognised that one of the most fundamental issues facing the industry is the need for greater clarification of the nature and extent of existing property rights in the marine environment and the rights and approvals necessary to support aquaculture investment. A secondary layer to this issue concerns the appropriate processes by which the environmental impacts of aquaculture should be managed and regulated by Government.[22]

Historically, the aquaculture sector has adopted the strategy of denying the existence of other property rights in the marine environment, or at least, denying that the expansion of aquaculture in particular circumstances would impinge on them. As noted by Toroa Strategy[23]:

> *"If a starting point for analysis of the sector is that market requirements, technologies and competitive threats are all going to change in an unpredictable but rapid fashion over the next 15 years, then a key issue for the aquaculture industry is that of flexibility or the capacity of the sector to switch species, products and*

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[21] For example 95% of the refused marine farm consent applications examined at the Marlborough District Council denied at least partially on social grounds. Acting in combination with continued uncertainty over the full environmental impact of most aquaculture activity, such social resistance can be a determining factor in applying a 'precautionary' approach to development - irrespective of formal policy.

[22] Toroa Strategy, *New Zealand Aquaculture: Industry Growth Scenarios*, p. 4.

[23] Toroa Strategy, *New Zealand Aquaculture: Industry Growth Scenarios*, 2009.

*customers in response to changing circumstances. That general capacity is weak at present, but if flexibility is a need, then it must be accommodated within the design of the legislative framework for the sector. This observation reinforces the comments above about the difficult policy and statutory reform required before the sector has a legislative framework in place suitable to support a dynamic industry."*