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# Potential economic impacts of providing for Aquaculture Management Areas in Canterbury

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## Summary

This research estimates the commercial costs and benefits associated with selected aquaculture projects in the Canterbury region.

Mussel farming employment will most likely be generated in coastal communities that at present have few employment opportunities. These communities are likely to profit as well from increased infrastructure needs for the marine farming enterprise.

Any development in the marine farming industry will take many years to reach full potential. This means that the costs and benefits from increased marine farming activities will be staggered over a number of years.

It is acknowledged that the gains might be achieved at different locations than the losses occur. The effects on other stakeholders are often uncertain.

## Key words

Mussel farming, economic impact, scenarios

# An indicative scenario evaluation

## The scope of this report

This analysis estimates the employment generated around Canterbury or where possible at more specific sites. Capital investment requirements, value-added output and gross output are estimated where possible.

### Limitations

At the moment Canterbury's mussel industry is serviced exclusively from the Marlborough Sounds. The research aims to point out thresholds for the development of the marine farming industry in Canterbury. On the cost side the report presents different scenarios on how other industries could be affected by an extension of the amount of coastal marine area occupied by marine farms.

This report looks particularly at commercial tourism operators and commercial finfisheries when considering other industries. Hence, privately organised recreational activities are excluded from detailed evaluation.

While the benefits deriving from marine farming and their impacts can be estimated from past experience, the costs imposed on other stakeholders of coastal space are less certain. This uncertainty is due to a lack of detailed information about some stakeholder's current activities as well as about the effects marine farming might have on these stakeholders.

The research does not focus on the environmental value of the resource nor does it examine whether there might be effects on the market values of adjacent properties.

## Aquaculture in New Zealand

### Current situation

In New Zealand's open waters there is marine farming of mussels, salmon, pacific oysters and paua. Seaweed is mainly grown for feeding purposes. Experiments are being conducted with other species such as rock lobster, crayfish, snapper, and sponges to test their suitability for commercial aquaculture. Some of these species have promising outlooks, and are considered to be areas for value-added growth in the future if cultivation proves successful and development is not blocked by political or regulatory barriers. In 2002 the total space used for all New Zealand aquaculture was around 5,500 hectares, generating in excess of $340 million in sales.

Marine farming generates employment in coastal communities that typically have otherwise limited employment opportunities. Mussel farming is not a labour intensive activity. Mussel processing on the other hand is a very labour intensive activity at present.

Around 84% of all Greenshell™ mussel product is exported. Export receipts were $91.8 million for the year ending March 1998 with processing generating 90% of the export value (Donnelly 1999). The mussel industry contributed $49.8 million to New Zealand's national GDP in 1998. Of this total, mussel farmers contributed $12.4 million (24.9%) while processing's share was $37.4 million (75.1%).

A regional impact study from the McDermott Fairgray Group Ltd (2000) commissioned by the Seafood Industry Council (SeaFIC) estimated the direct, indirect and induced impacts of the seafood industry in New Zealand as well as for certain regions (Table 2). The information is based on the year 1998. Canterbury had salmon and paua farms but no mussel farming in that year.

The type II multiplier effects give the direct, indirect and induced impacts of an activity and are summarised below for the Canterbury region. No specific multiplier was found with respect to household income.

Table 1 Seafood Type II Multipliers

| Impact | Fishing in inland waters and fish farming | Fish and shellfish processing |
|---|---|---|
| Output | 2.77 | 3.54 |
| Value Added | 5.14 | 4.45 |
| Employment | 1.36 | 2.88 |

### Existing marine farming in Canterbury

Current marine farming and applications for marine farming centre on Banks Peninsula and the coast of northern Canterbury. On Banks Peninsula marine farming activities and applications are clustered around Akaroa Harbour and the northern bays.

Processing of marine farming products in Canterbury occurs almost exclusively in Christchurch and Banks Peninsula. Products from Marlborough also contribute to current volumes of mussels processed in Canterbury.

At present Canterbury has four working marine farms totalling 51 hectares of which 32 hectares are currently used. There are three approved additional spaces (51

hectares), two applications currently processed (79 hectares), two applications with 19 sites voluntarily put on hold (103 hectares), two stopped by the Aquaculture Moratorium (10,835 hectares), and one declined but appealed (27 hectares).

At the moment 160 tonnes of finfish and 800 tonnes of shellfish are produced by Canterbury's marine farms. All of the finfish and paua are processed in Christchurch but only a small part (approximately 25%) of the local mussel production is processed locally. Currently 4 FTE are employed on Canterbury's green-lipped mussel farms. The value of annual output from Canterbury mussel farms is estimated at around $0.5 million.

The sole marine salmon farm in Akaroa Harbour produces approximately 160 tonnes of salmon per year for the domestic market. The farm employs six staff. Processing of the salmon occurs in Christchurch where around eight FTE staff are employed. There is one paua farm in Akaroa Harbour producing meat and blue pearls. The firm employs a total of eight staff directly and produces more than 5000 pearls per year.

## Effects on other stakeholders

For the purpose of this research the other stakeholders are commercial finfishers, commercial tourism operators and existing marine farming businesses as outlined above.

Marine farming competes with other stakeholders for use of the coastal space, and could also have wider effects. For example, commercial fishers, recreational users or tourism operators might use the same part of the ocean. Some applicants have tried to select areas that other stakeholders do not use intensively for other purposes.

The effects of marine farming do not usually stop at the farm boundary, as is the case with many other enterprises. Marine farming in particular may have visual impacts for recreational users, the tourism industry, adjacent property owners and locals. In addition, the marine farming activity could affect the local ecosystem for example, bryophytes, shellfish and dolphins. In turn this could have wider economic effects, for example on the tourism operators.

This report focuses on the financial and employment effects deriving from marine farming, mussel farming in particular. Marine farming activities can have positive as well as negative direct and indirect effects. Economic effects for example might also include the valuation of nearby sea space, changes in property and commodity prices or the effects on the resource and affected species. However, given the scope of this report a restricted range of issues is discussed.

Some of the positive effects of marine faming are increased employment, investment, establishment of service industries, and supply security for industry. Positive externalities can include better infrastructure in the bays and road improvements. Some of these activities may provide useful assistance to the economy of small coastal communities. .

Possible positive externalities include improvements in recreational fishing, mooring opportunities and pride in the activity among the local community. Negative impacts on other industries might include reduced activity or higher production costs for a limited number of other industries. This could potentially decrease employment in those industries and diminish profits. Further negative externalities are navigational hazards and visual impacts

Study of effects should not just focus on the direct impacts but also take into account the impact of the respective industries on their suppliers, service industry and household spending. These impacts are typically estimated with the use of multiplier effects.

# Scenarios

## Scope

The status quo is the current marine farming situation in Canterbury at its full potential. This includes salmon, paua and green-lipped mussel farming. Full potential implies full production from consented but idle farms or farms which are not fully developed in December 2003. The idle status predominantly results from lacking a permit from the Ministry of Fisheries.

All mussel farms will be developed with a staged approach. Business practice and environmental impact assessments make such an approach necessary. Hence the effects described will not be achieved in the short term. Some developments will take up to 20 years from the day of receiving the last necessary permit. The current political and legislative situation does not favour a swift uptake of mussel farming activities. This also means that potential negative effects will be staggered.

There is little detailed information available with regards to other commercial stakeholders of coastal space. Particularly, the possible effects on other stakeholders are hard to quantify. Hence the effects on other commercial stakeholders of coastal space are dealt with in a generic manner. Given current business practice of other stakeholders and current application details, assumptions are made about the potential negative impact of increased mussel farming activities.

Only the effects to Canterbury are reported here. The discussion below is exclusively with respect to the status quo and the increases in mussel farming. To make the comparison of the different scenarios easier salmon and paua farming are not discussed in the scenarios. Some of the information presented distinguishes between offshore, headlands (near-shore) and sheltered bays (inshore).

This report does not comment on the feasibility of individual business ventures. There are likely to be engineering issues associated with offshore marine farms that are more exposed to storms than are inshore farms but engineering issues are beyond the cope of this report.

## Assumptions

The underlying data was generated from information gained from resource consent applications, interviews, internal reports and published information. The information provided was averaged over the ranges given.

### Mussel Farming

The productivity assumptions are either built on information gained from the resource consent applications or on averages based on output per backbone metre. The output per backbone metre is a crude assumption since mussel farms will have different depths within and across farms. Nevertheless, given the lack of detail in the underlying data it appears to be a good approximation.

To date some exposed near shore marine farms might not be able to raise spat to reseeding size themselves but need to be stocked from inshore farms. It is not clear whether this will continue to be the case. Possible development of land based hatcheries to large scale juvenile mussel production would reduce the pressure on inshore farms. Local spat nursery is preferred due to its simpler logistics and reduced transport stress on juvenile mussels.

Two scenarios were created. One assumes a higher productivity than the other. However, to the authors' best knowledge even the high productivity figure is below the industry average. If no other information is available, a backbone length of 115 metres is used in the scenarios. This is equivalent to the average in the Marlborough Sounds and Nelson, but below the national average backbone length. Offshore and near shore mussel farms generally have longer backbones.

The higher productivity scenario, A, is based on information directly provided by the existing or applicant company. Where there is no such information available industry averages are used. The output results are hence based on total estimated output for certain farms, estimated output per hectares or per backbone, average output per unit calculated on a company basis, and information gathered for different reports.

The lower productivity scenario, B, is based on averages from the above information sources as well as the low to medium range productivity figures from scenario A. In the case that the productivity estimate for scenario B is higher than the productivity figure provided by the company, the company value is used.

The lower productivities assumed are 0.1 tonnes per backbone metre for inshore farms. This is equivalent to 11.5 tonnes for a 115-metre backbone. The industry estimates productivity is between 0.07 and 0.15 tonnes per backbone metre. The information provided in the different resource consent applications uses conservative estimates.

For near shore farms there was no information available which differed from inshore farm productivities. Hence the same conservative value is used. It could be that near shore farms are less productive due to their exposed nature. But, the weather exposure might also be counterbalanced by higher nutrient availability.

There is no quantitative data available for the productivity of offshore farms. The Applied Ocean Physics and Engineering Department, WHOI, in Boston successfully trialed a mussel line in the Atlantic Ocean 10 miles off the coast. Due to a lack of information from other sources only the applicant's information could be used. This equates to 0.05 tonnes per backbone metre or 5.75 tonnes for a 115-metre backbone.

An important figure with regard to employment is the threshold for having the first fulltime multi-purpose farming boat in Canterbury, which is able to seed and harvest as well as do service maintenance. Once this threshold is crossed the employment for the mussel farming is assumed to be relatively linear. However, actual employment is more likely to increase in discrete jumps.

Employment, aside from the status quo, is estimated in a linear fashion. A labour productivity of 1 FTE for every 680 tonnes is assumed which is lower than Donelly's estimate. Only full time employment in the farming sector is incorporated in the effects for Canterbury. The wages are assumed to be at the national average for the sector of $16,000 per FTE.

Farming activities mainly need set-up capital investments. To develop a mussel farm inshore or near shore will cost around $20,000 to $40,000 per hectare. The farming sector will only be able to establish a service industry for its infrastructure once a significant size is reached. Otherwise the development of new farms is likely to be contracted out to companies from the top of the South Island. Hence the benefit during the development stage to Canterbury would include mainly logistic support and accommodation for development crews.

Processing plants could take up some additional volumes, but would have to invest in capacity expansions for certain scenarios. These investments would occur in discrete jumps.

Industry insiders estimate that around 1,500 to 2,000 tonnes green-weight harvest are needed to justify the deployment of one small to medium size multi-purpose boat. It is noted that these figures do not take into account coordination problems should the harvest come from different companies or dispersed farm locations.

To provide an indication of possible output values two wharf prices for mussels were used. Currently $650 per tonne is paid for green-lipped mussels. The industry expects a price recovery in the medium to short term. Historically Greenshell™ mussels achieved around $700 per tonne averaged over the last 5 years, and around $850 per tonne averaged over the last 3 years. For the scenarios two conservative price situations are used with $600 per tonne and $700 per tonne of green-weight mussels, respectively.

**Mussel Processing**

Employment in the processing sector is close to linear at 50 tonnes per FTE. Wages are assumed at the national processing average of $20,400 per FTE.

The need for a new shift is accompanied by discrete jumps in employment. The addition of another shift also brings along capital investments, either due to upgrading the current equipment or new equipment. At the moment the Canterbury processing plants have some over-capacity. Hence, different amounts of output could be processed without adding a new shift. The amount depends on the farming company.

It is current practice in the mussel industry to transport harvested product for processing between regions and islands. It is important to note that some applicant companies are unlikely to process the locally farmed product in Canterbury. These companies either have their own processing plant outside of Canterbury or a (planned) joint venture with companies which process outside of Canterbury.

Based on industry information the recovery rate from turning green-weight mussel into half-shell product is 48% of the green-weight, meaning that 1 tonne of harvested product will make 480 kilograms of half-shell product. The majority of the industry product is sold in the half shell and exported. To give an indication of possible export income to Canterbury two FOB prices are assumed for the half-shell product, $1,700 per green-weight tonne and $2,000 per green-weight tonne. The average for 2003 in the US market is around $2,200 and averaged over the last three years it is around $3,200. The strong New Zealand dollar has an impact on the price. As with the raw product the industry expects this price to recover in the future.

## Results

The results are summarised in Appendix tables A and B.

The results below are an indication of what could happen given different scenarios provided by Environment Canterbury. It has to be remembered that development of farming sites will not happen in the near future due to constraints outside of the industry's influence nor will farms reach their potential for some years after the first backbone is in place.

In addition, as Tvertas and Battese (2002) point out, a marine farming industry might refrain from establishing itself in a region and even withdraw if economies of scale are not expected to be achieved.

### Status Quo

Some near shore farms might not be able to produce their own juvenile stock. At the status quo this is not expected to effect the total output much beyond usual business practice.

The output potential ranges from 1,800 tonnes to 2,000 tonnes per year. The lower value might not be enough for a full time farming boat with crew to be stationed in Canterbury. Even the higher output will not necessarily justify one. Nevertheless, for the higher output the employment of three crew members as well as one medium size multi-purpose boat is assumed. In addition the farm management will run maintenance checks and sourcing trips. With regards to processing it is expected that around one tenth of all output will be processed in Canterbury.

Due to staged development approaches these investments will not occur immediately. Therefore, it is expected that most structures and inputs will be imported from outside of Canterbury.

No significant investments into the processing capacities in Canterbury are expected. The permanent stationing of a farming vessel in the region is doubtful due to the number of firms producing the total tonnage.

The locations of the mussel farms are not expected to effect other stakeholders in a direct manner. As discussed above, possible effects on fish stocks and dolphin behaviour are excluded from the analysis. There will be minimal visual impact for the tourism industry.

### First extension

The first extension includes the status quo as well as mussel farm applications around northern Banks Peninsula not caught by the Aquaculture Moratorium.

The green weight tonnes will range from 6,800 tonnes to 10,800 tonnes. Even the lower estimate of green-weight tonnes should make it feasible to station one multi-purpose boat in Canterbury. The processing share is expected to increase from one tenth to two thirds of Canterbury's crop.

Total farming set up costs will be between $5 million and $10 million, most of this will probably still flow out of Canterbury. Capital investments in further processing capacity will not be great if they occur at all in this scenario, as there is considerable excess capacity at present in Canterbury processing.

The visual effects for the commercial tourism operators are likely to be minimal given their current cruise routes. However, some buoys might be seen in the

distance. Commercial fisheries are unlikely to be adversely effected, since most mussel farms are in locations close to shore and these locations are not known for their abundant fish stocks at present.

**Second extension**

This includes the first extension as well as additional farm applications around Banks Peninsula not caught by the Aquaculture Moratorium.

Given the location of the farms included it is likely that Canterbury will have at least two multi-purpose boats. One of these is expected to be located on a permanent basis outside of Lyttelton Harbour together with three to four permanent crew members each. This would strengthen economically weaker communities in Akaroa Harbour and the northern Banks Peninsula more than the previous scenarios.

Some of the capital investments into mussel farming structures, ranging from $10.9 million to $21.7 million, might stay within Canterbury.

Capital investment is likely to increase processing capacity, even without creating a new shift. At least one new shift is expected to be set up compared to the status quo.

Commercial fisheries are no more or less effected than in the first extension, since the mussel farms are not located where commercial fishing, including commercial fishing tours occurs.

Existing marine farms might experience food depletion due to the increase of marine farms around Banks Peninsula. To date there is no conclusive evidence about such effects and staged development approaches are usually taken. Some applications have been modified in the resource consent process to reduce their potential impacts on other farms.

Tourism might be negatively affected in this scenario; this may be especially true if visual impacts are not reduced by submerging the majority of floats. Tourism output with respect to all activities is around 26% of Akaroa's tourism output. The FTE jobs dependent on activities are around 9% of all direct tourism jobs. Activities have type II multiplier values between 1.08 and 1.17. (Butcher *et al*., 2003)

Table 2 Tourism impact and possible losses in Akaroa

| | | | | | | **Possible impacts with 10% and 20% loss** | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tourism** | Type II | **Current situation** | | **40% visitor growth** | | **Current situation** | | **40% visitor growth** | |
| **Activities** | Multipliers | absolute | % | absolute | % | 10% | 20% | 10% | 20% |
| Output | | | | | | | | | |
| direct | | 4.51 | 26.07 | 6.31 | 26.07 | 0.45 | 0.90 | 0.63 | 1.26 |
| total | 1.16 | 5.23 | | 7.32 | | 0.52 | 1.05 | 0.73 | 1.46 |
| Value-added | | | | | | | | | |
| direct | | 1.94 | 32.33 | 2.72 | 32.33 | 0.19 | 0.39 | 0.27 | 0.54 |
| total | 1.17 | 2.27 | | 3.18 | | 0.23 | 0.45 | 0.32 | 0.64 |
| Employment | | | | | | | | | |
| direct | | 15.0 | 9.38 | 21.0 | 9.38 | 1.5 | 3.0 | 2.1 | 4.2 |
| total | 1.08 | 16.2 | | 22.7 | | 1.6 | 3.2 | 2.3 | 4.5 |

A loss of 10% of tourism business in Akaroa would mean a loss of total output ($0.52 million) plus total value-added ($0.23 million) summing up to around $0.75 million using a Type II multiplier of 1.16 (output) and of 1.17 (value-added). If 10%

of activities' employment were lost and using a Type II multiplier of 1.08 this would mean approximate total losses of 1.6 FTE jobs in the community.

A loss of 20% of business and employment might mean a loss of total output ($1.05 million) and total value-added ($0.45 million) summing up to around $1.5 million as well as 3.2 FTE jobs lost. Taking into account 40% growth of the tourism industry in Akaroa during the next five years and a 20% loss of the activities, Akaroa might lose $1.46 million of total output and $0.64 million of total value-added ($2.1 million in total) as well as 4.5 FTEs.

Table 3 Possible impacts from 1,500t mussel production in Akaroa Harbour

| | Farming | | | | Processing | | | |
|---|---|---|---|---|---|---|---|---|
| multipliers | 2.77 | | 1.36 | | 2.54 | | 2.88 | |
| | Output | | FTE | | Output | | FTE | |
| | direct | total | direct | total | direct | total | direct | total |
| | $0.98 | $2.70 | 3 | 4.1 | $1.33 | $3.38 | 30 | 86.4 |

On the other hand, the additional 1,500 tonnes of mussel output from scenario 2B as well as the location of the production, would add one working boat with three crew members on the western side of Akaroa Harbour. This does not include the servicing boat or other support staff and logistics. The resulting employment for the community would be a minimum of 4 FTEs. The additional tonnes would create around 30 FTE direct processing jobs, most likely in Canterbury and via the processing multiplier, a total of around 86 jobs in Canterbury.

The wharf value of Akaroa Harbour's output could be around $1 million, assuming $650 per tonne. The total value of processed output could be around $3.8million, assuming $1,850 per green-weight tonne.

The employment gained is likely to be in different communities around Banks Peninsula such as smaller bays on the northern Banks Peninsula and the west side of Akaroa Harbour, and Canterbury and not specifically in the centres where employment may be lost, such as Akaroa. Due to the labour intensity of processing Canterbury/Christchurch will gain most employment.

**Third extension**

This scenario includes suggested AMAs that survived a preliminary constraints mapping analysis undertaken by Environment Canterbury staff. It is not a straightforward extension of any of the previously discussed scenarios, as some AMAs will be below their size assumed in the second extension.

The decreased inshore as well as increased near shore and offshore farming activity will considerably increase the pressure on inshore spat nurseries. The demand will by far exceed the supply should near shore farms not be able to stock their own spat. Should near shore farms be able to contribute to nursing stocks the pressure will ease to a theoretically manageable level. Total output of Canterbury mussel farms might be reduced by between 16% and 20%. This reduction is not taken into account in the scenarios since the underlying data is too uncertain.

The total output is projected to range from 31,000 to 32,700 green-weight tonnes, which would be around half of the current output of the Marlborough Sounds. The processing share in Canterbury will reach 91 - 93% with the balance being processed in Nelson or other centres.

Most of the product will be destined for export, generating export receipts for Canterbury. The total value of output will be between $81 million and $103 million.

The staged development has to be kept in mind, for example the offshore marine farms will take 20 years to reach full development. Nonetheless, expectations are that a higher proportion of the investments will stay in Canterbury compared to the second extension.

Capital investments of at least $2 million will be necessary for increasing processing capacity in Canterbury. There will be multiple farming and surveying boats in the region. The boats will be designed primarily for offshore usage but they will service both offshore and near shore activities because of the location of inshore and near shore farms.

Given the scale of activity in this scenario it is possible that a service industry could be established in Canterbury. Service industry includes engineering, repair, logistics, business support, monitoring and the like, whereas the maintenance checks and servicing by farming boats are included in the direct effects. However, the staged development will not warrant such an event for at least the first few years.

Given the location of the mussel farms no additional negative impacts are expected on tourism operators or existing marine farmers compared to the second extension.

The magnitude of offshore farming activities might effect commercial fishing. However, the information available to the researchers suggests that any negative effects are likely to be minimal with present fishing practices and the farming activity could also have some positive effects.

**Fourth extension**

This scenario includes all suggested AMAs with respect to mussel farming activity in Canterbury.

Compared to the third extension the pressure is reduced on inshore farms to produce stock for the increased area of near shore and offshore farms. Total production might be 15% to 18% lower than calculated for this scenario should near shore farms be able to contribute to nursery stock.

The estimated output ranges from 59,900 to 74,300 tonnes of green-weight mussels, which is around the current production in the Marlborough Sounds. Of this output 95% is likely to be processed locally.

Investments into marine farming structures will range from $342 million to $684 million which is expected to attract the establishment of businesses carrying out the necessary work. Since the output tonnes roughly double from the previous extension the building of new processing plants is likely. The number and respective size would depend on the prevailing industry structure at a future point in time.

This scenario is expected to provide enough work for multiple inshore and offshore boats as well as a significant servicing industry. However, especially offshore farming activities will require many years to reach full production levels. It could be the case that the development of new farms will be based in Canterbury.

The potential effects on other stakeholders will be the same as the potential effects discussed in the second, for tourism and existing marine farmers, and third extension, for commercial fisheries.

**Fifth extension**

This scenario adds a further 10,700 hectares off the South Canterbury coast. To date no company has shown interest in such a site. Possible reasons are wide ranging including sea currents, lack of suitable ports, lack of labour supply and weather patterns.

The inshore and near shore mussel farming space was not increased from the fourth extension and would not be able to supply sufficient mussels for reseeding on all offshore farms. However, due to high offshore production the total production might only be 18% to 20% lower than estimated for this scenario should the excess reseeding stock come from elsewhere.

The establishment of such large-scale mussel farming around Canterbury will require major capital investments. Processing capacity would have to be significantly increased by the time of full development and probably require further production plants.

The impact on existing marine farmers as well as on tourism would be the same as for the third extension. It is not known whether the effect on commercial fisheries would be similar to the effects outlined in the fourth extension.

This research estimates the commercial costs and benefits associated with selected aquaculture projects in the Canterbury region. This analysis estimates the output, employment and wages of the mussel industry generated around Canterbury.

## Summary

While the benefits deriving from marine farming and associated activities can be estimated from experience in other regions, the potential impacts imposed on other stakeholders of coastal space are less certain.

Farming is capital intensive and processing is labour intensive. It is unlikely, however, that the processing sector will develop without a considerable local harvest to process. The main reasons for this are existing processing plants in other regions either have excess capacity at the moment or could easily increase their capacity.

Mussel farming employment will most likely be generated in coastal communities that at present have few employment opportunities. These communities are likely to profit as well from increased infrastructure needs for the marine farming enterprise once the marine farms reach sufficient scale to warrant local provision of those services.

Farming activities mainly need set-up capital investments. The marine farming sector will only be able to establish a service industry for its infrastructure once a significant size is reached. An exact figure cannot be derived, but is most likely to occur between extensions three and four.

The mussel farming activities have the potential to directly add significantly to Canterbury's output, employment and wages. The mussel industry also has a large multiplier effect for the region.

Any development in the marine farming industry will take many years to reach full potential. This means that the costs and benefits from increased marine farming activities will be staggered over a number of years.

There might be some negative impacts on tourism activities, particularly around Akaroa. The negative effects on tourism are expected to be offset by the gains from the marine farming activity. It is acknowledged that the gains might be achieved at different locations than the losses occur at.

The effects on commercial fisheries are uncertain. The negative effects on production processes of existing marine farming enterprises are likely to be negligible and they are likely to benefit from economies of scale and increased availability of service industries.

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# Appendix

## Appendix A

Table 4 Scenario input for Canterbury – Summary

| | | | Status Quo | Extension 1 | Extension 2 | Extension 3 | Extension 4 | Extension 5 |
|---|---|---|---|---|---|---|---|---|
| Hectares | | *total* | *71.28* | *250.61* | *307.32* | *9113.41* | *17398.43* | *28062.43* |
| | per type | inshore | 35.78 | 153.11 | 209.82 | 62.80 | 245.60 | 245.60 |
| | | nearshore | 35.50 | 97.50 | 97.50 | 241.11 | 304.11 | 304.11 |
| | | offshore | | | | 8845.00 | 16920.00 | 27584.00 |
| Output A | tonnes | *total* | *2000.00* | *10824.20* | *13805.66* | *32742.17* | *74337.38* | *104337.38* |
| | per type | inshore | 1000.00 | 8624.20 | 11605.66 | 2706.46 | 12605.66 | 12605.66 |
| | | nearshore | 1000.00 | 2200.00 | 2200.00 | 6664.00 | 6376.83 | 6376.83 |
| | | offshore | | | | 24371.71 | 57354.89 | 87354.89 |
| | t/ha | | | | | | | |
| | per type | inshore | 30.22 | 35.17 | 37.10 | 47.41 | 37.10 | 37.10 |
| | | nearshore | 28.17 | 23.76 | 23.76 | 26.20 | 25.07 | 25.07 |
| | | offshore | | | | 2.76 | 2.70 | 3.64 |
| Output B | tonnes | *total* | *1837.91* | *6832.10* | *8819.74* | *31028.71* | *59966.93* | *89966.93* |
| | per type | inshore | 967.91 | 5063.10 | 7050.74 | 2182.49 | 8018.66 | 8018.66 |
| | | nearshore | 870.00 | 1769.00 | 1769.00 | 4474.51 | 6054.81 | 6054.81 |
| | | offshore | | | | 24371.71 | 47731.38 | 77731.38 |
| | t/ha | | | | | | | |
| | per type | inshore | 28.68 | 31.94 | 32.28 | 34.51 | 32.28 | 32.28 |
| | | nearshore | 24.51 | 19.50 | 19.50 | 18.14 | 19.78 | 19.78 |
| | | offshore | | | | 2.76 | 2.83 | 2.82 |

**Appendix B**

Table 5 Scenario results for Canterbury – Summary

| | | GSM status quo | | Extension 1 | | Extension 2 | | Extension 3 | | Extension 4 | | Extension 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | A | B | A | B | A | B | A | B | A | B |
| Wharf price | $600/t | 1.20 | 1.10 | 6.49 | 4.10 | 8.28 | 5.29 | 19.65 | 18.62 | 44.60 | 35.98 | 62.60 | 53.98 |
| in $ million | $700/t | 1.50 | 1.38 | 8.12 | 5.12 | 10.35 | 6.61 | 24.56 | 23.27 | 55.75 | 44.98 | 78.25 | 67.48 |
| Processing | share | 0.13 | 0.12 | 0.67 | 0.55 | 0.74 | 0.65 | 0.93 | 0.91 | 0.95 | 0.95 | 0.97 | 0.96 |
| Halfshell value | $1,700/gwt | 0.20 | 0.18 | 5.88 | 3.09 | 8.31 | 4.71 | 24.74 | 23.03 | 57.71 | 46.27 | 82.19 | 70.75 |
| in $ million | $2,000/gwt | 0.24 | 0.22 | 6.92 | 3.64 | 9.78 | 5.54 | 29.11 | 27.09 | 67.89 | 54.43 | 96.69 | 83.23 |
| FTE | farming | 2.94 | 2.70 | 15.92 | 10.05 | 20.30 | 12.97 | 48.15 | 45.63 | 109.32 | 88.19 | 153.44 | 132.30 |
| | processing | 5.00 | 4.49 | 144.15 | 75.75 | 203.78 | 115.50 | 606.36 | 564.45 | 1414.41 | 1133.96 | 2014.41 | 1733.96 |
| | total | 7.94 | 7.19 | 160.07 | 85.80 | 224.08 | 128.47 | 654.51 | 610.08 | 1523.73 | 1222.15 | 2167.85 | 1866.26 |
| Wages | in $million | 0.15 | 0.14 | 3.21 | 1.71 | 4.50 | 2.57 | 13.17 | 12.28 | 30.68 | 24.61 | 43.66 | 37.58 |
| | | | | | | | | | | | | | |
| *Type II Multiplier* | | | | | | | | | | | | | |
| Output | $600/t | 3.32 | 3.05 | 17.99 | 11.35 | 22.95 | 14.66 | 54.42 | 51.57 | 123.55 | 99.67 | 173.41 | 149.53 |
| 2.77 | $700/t | 4.16 | 3.82 | 22.49 | 14.19 | 28.68 | 18.32 | 68.02 | 64.46 | 154.44 | 124.58 | 216.76 | 186.91 |
| Processing | $1,700/gwt | 0.72 | 0.65 | 20.82 | 10.94 | 29.43 | 16.68 | 87.58 | 81.52 | 204.29 | 163.78 | 290.95 | 250.44 |
| 3.54 | $2,000/gwt | 0.85 | 0.76 | 24.49 | 12.87 | 34.63 | 19.63 | 103.03 | 95.91 | 240.34 | 192.68 | 342.29 | 294.63 |
| FTE | Farming | 4.00 | 3.68 | 21.65 | 13.66 | 27.61 | 17.64 | 65.48 | 62.06 | 148.67 | 119.93 | 208.67 | 179.93 |
| 1.36 | Processing | 14.40 | 12.92 | 415.15 | 218.16 | 586.89 | 332.65 | 1746.32 | 1625.61 | 4073.51 | 3265.81 | 5801.51 | 4993.81 |
| 2.88 | Total | 18.40 | 16.60 | 436.80 | 231.83 | 614.50 | 350.29 | 1811.80 | 1687.67 | 4222.19 | 3385.74 | 6010.19 | 5173.74 |

**Appendix C**

Table 6 Nursery space requirements and capital investments – Summary

| | status quo | Extension 1 | Extension 2 | Extension 3 | Extension 4 | Extension 5 |
|---|---|---|---|---|---|---|
| Percentage of farm space needed for nurseries | | | | | | |
| only inshore farms stock juveniles | | | | | | |
| % of ha needed to stock all farms | 25.94 | 20.20 | 18.79 | 361.31 | 152.95 | 253.21 |
| % of ha needed to stock near shore and offshore farms | 10.94 | 5.20 | 3.79 | 346.31 | 137.95 | 238.21 |
| inshore and near shore farms stock juveniles | | | | | | |
| % of ha needed to stock all farms | 15.00 | 15.00 | 15.00 | 80.82 | 75.18 | 119.98 |
| *% lost of total output:* | | | | *20.24* | *18.42* | *20.30* |
| % of ha needed to stock offshore farms | 0.00 | 0.00 | 0.00 | 65.82 | 60.18 | 104.98 |
| *% lost of total output:* | | | | *16.48* | *14.75* | *17.76* |
| Capital investments for setting up farm structures | | | | | | |
| $20,000.00 per hectare | 1.43 | 5.01 | 10.87 | 182.98 | 341.82 | 555.10 |
| $40,000.00 per hectare | 2.85 | 10.02 | 21.73 | 365.96 | 683.64 | 1,110.20 |