NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Hector's & Māui Dolphin Threat Management Plan

NZIER report to Fisheries NZ

November 2019

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NZIER was established in 1958.

Authorship

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Key points

Fisheries New Zealand (FNZ) has asked NZIER to undertake economic impact assessments to estimate the impacts of three closure options for both set net and trawling under the Hector's and Māui dolphins Threat Management Plan (TMP). This work follows NZIER's peer review of the methodology used to estimate the foregone economic value of commercial fishing arising from proposals to implement spatial closures.

As a result of our peer review, NZIER advised FNZ to use computable general equilibrium (CGE) analysis to provide economic impact assessments of the proposed spatial closures as CGE models are considered more reliable than multiplier analysis.[1] FNZ followed NZIER's recommendations.

Our report shows how the closure options for set net and trawl fishing may affect demand for and prices of inputs in fishing and across other sectors of the economy, with effects on Gross Domestic Product (GDP), household spending and exports.

These estimates, reported annually, are not forecasts because we do not know precisely how the proposed closure options might play out in the New Zealand set net and trawl fishing industries, e.g. changes in fisher behaviour. However, they do help to quantify the potential economic impacts from proposals to implement spatial closures.

Our report refers to the closure of fishing areas for set net fishing as 'set net options' and refers to the closure of fishing areas for trawl fishing as 'trawling options'.

New Zealand's annual GDP could be reduced by between $6.2 million and $9.4 million from the set net options, and by between $7.8 million and $18.3 million from the trawling options

New Zealand-wide results flow logically from the direct and indirect impacts at the regional levels as a result of the closure of fishing areas for set netting and trawling under Options 2, 3 and 4.

Overall, the economic impacts are expected to be higher for trawling options as the catch value of trawl fishing ($115 million) is about 9 times bigger than the catch value of set net fishing ($13 million).

Our report and the following sections focus on the economy-wide effects for the South Island, North Island and at the regional levels. The overall national effects can be found in Appendix B.

[1] See Appendix B for further explanations as to why CGE are considered more reliable than multiplier analysis.

The North Island's GDP is reduced by between $2.1 million and $8.3 million from the set net options, and by between $2.0 million and $9.9 million from the trawling options

Amongst the set net and trawling options, the overall economic impacts are expected to be higher under Option 4 compared with Options 2 and 3 in the North Island. This is because Option 4 is more restrictive.

- For set netting, it represents a full closure of the harbours on the west coast of the North Island, contrary to the other options which are more partial.
- For the trawling, it represents a larger restriction area on the central west coast of the North Island (Maunganui to New Plymouth).

Table 1 and Table 2 show the annual macroeconomic impacts of each option for set net fishing and trawl fishing, respectively, in the North Island.

Table 1 Macroeconomic impacts from the set net options in the North Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.001%	-2.1	-0.001%	-2.9	-0.004%	-8.3
Household consumption	-0.001%	-1.6	-0.002%	-2.1	-0.003%	-4.2
Export volumes	-0.003%	-1.8	-0.004%	-2.2	-0.007%	-4.2
National output	-0.001%	-2.5	-0.001%	-3.5	-0.003%	-11.5
Employment	-0.001%	-0.6	-0.001%	-0.8	-0.002%	-1.6

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

Table 2 Macroeconomic impacts from the trawling options in the North Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.001%	-2.0	-0.004%	-8.3	-0.005%	-9.9
Household consumption	-0.002%	-2.1	-0.005%	-6.0	-0.004%	-4.9
Export volumes	-0.003%	-1.9	-0.010%	-5.9	-0.009%	-5.2
National output	-0.001%	-2.4	-0.003%	-10.7	-0.003%	-13.4
Employment	-0.001%	-0.6	-0.002%	-1.90	-0.002%	-1.7

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

The South Island's GDP is reduced by between $1.1 million and $4.1 million from the set net options, and by between $1.3 million and $5.8 million from the trawling options

Amongst the set net and trawling options, the economic impacts in the South Island are expected to be higher under Option 3 compared with Options 2 and 4. This is because the restrictions under Option 3 are higher than under Option 2, while for Option 4, there is no trawling or set net restrictions proposed in the South Island.

Table 3 and Table 4 show the annual macroeconomic impacts of each option for set net and trawl fishing respectively, in the South Island.

Table 3 Macroeconomic impacts from the set net options in the South Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.006%	-4.1	-0.007%	-4.9	-0.002%	-1.1
Household consumption	-0.004%	-1.4	-0.004%	-1.7	-0.001%	-0.5
Export volumes	-0.008%	-1.8	-0.010%	-2.2	-0.004%	-1.0
National output	-0.005%	-5.9	-0.006%	-7.5	-0.001%	-1.2
Employment	-0.002%	-0.5	-0.002%	-0.7	-0.001%	-0.2

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

Table 4 Macroeconomic impacts from the trawling options in the South Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.009%	-5.8	-0.015%	-10.1	-0.002%	-1.3
Household consumption	-0.004%	-1.7	-0.008%	-3.0	-0.001%	-0.6
Export volumes	-0.011%	-2.5	-0.019%	-4.3	-0.005%	-1.1
National output	-0.006%	-7.0	-0.010%	-12.0	-0.001%	-1.2
Employment	-0.002%	-0.6	-0.004%	-1.0	0.000%	-0.1

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

Northland, Auckland, Waikato-Taranaki, Nelson-Tasman, Wellington and Canterbury experience the greatest impacts on GDP and household spending from closure options on set net fishing

Table 5 and Table 6 describe the annual impacts on GDP and household spending, from the set net and trawling options, respectively, for the most affected regions. All the regional economies of New Zealand are expected to contract due to the direct and flow-on effects associated with the closure of set net and/or trawl fishing areas.

- Annual regional GDP in dollar value (Table 5) is expected to decrease the most in Northland, Auckland, Waikato-Taranaki, Nelson-Tasman and Canterbury. This is because the fishing boats used in set net fishing originate from these regions, which, are expected to be more affected by the closure options.
- Annual regional household spending – our proxy for 'economic welfare' – in dollar value (Table 6) is expected to decrease the most in Auckland, Waikato-Taranaki, Wellington and Canterbury. This is because household spending is higher in regions that are more populated and wealthier. Therefore, even a small percentage decrease will have a larger monetary impact than less populated and wealthy regions.

Table 5 GDP impacts in the most affected regions from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Regions	Option 2	Option 3	Option 4
Northland	-0.39	-0.61	-3.25
Auckland	-0.45	-0.72	-2.88
Waikato & Taranaki	-0.84	-1.01	-1.50
Wellington	-0.27	-0.32	-0.35
Nelson & Tasman	-0.76	-0.79	-0.40
Canterbury	-2.88	-3.41	-0.35

1 Figures in percent changes differ at the four-digit level.

2 These regions are the most affected in dollar value for at least two options.

Source: NZIER

Table 6 Household spending impacts in the most affected regions from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Regions	Option 2	Option 3	Option 4
Auckland	-0.67	-0.89	-1.89
Waikato & Taranaki	-0.32	-0.38	-0.54
Wellington	-0.29	-0.37	-0.40
Nelson & Tasman	-0.25	-0.27	-0.13
Canterbury	-0.99	-1.24	-0.29

1 Figures in percent changes differ at the four-digit level.

2 These regions are the most affected in dollar value for at least two options.

Source: NZIER

Auckland, Bay of Plenty, Waikato-Taranaki and Canterbury experience the greatest impacts on GDP and household spending from closure options on trawl fishing

- For the trawling options, annual regional GDP (Table 7) and household spending (Table 8) in dollar value are expected to decrease the most in Auckland, Bay of Plenty, Waikato-Taranaki, and Canterbury. This is because the fishing boats used in trawl fishing originate from these regions, which, are expected to be more affected by the closure options.

Table 7 GDP impacts in the most affected regions from the trawling options

Annual changes from 2018 baseline, in $ millions (real terms)

Regions	Option 2	Option 3	Option 4
Auckland	-0.90	-4.34	-5.75
Bay of Plenty	-0.13	-1.31	-1.82
Waikato & Taranaki	-0.63	-1.55	-1.53
Nelson & Tasman	-0.43	-2.05	-0.61
Canterbury	-3.85	-5.70	-0.34

1 Figures in percent changes differ at the four-digit level.

2 These regions are the most affected in dollar value for at least two options.

Source: NZIER

Table 8 Household spending impacts in the most affected regions from the trawling options

Annual changes from 2018 baseline, in $ millions (real terms)

Regions	Option 2	Option 3	Option 4
Auckland	-0.99	-2.90	-2.61
Bay of Plenty	-0.11	-0.48	-0.53
Waikato & Taranaki	-0.41	-1.08	-0.86
Wellington	-0.34	-0.83	-0.50
Canterbury	-1.16	-1.99	-0.46

1 Figures in percent changes differ at the four-digit level.

2 These regions are the most affected in dollar value for at least two options.

Source: NZIER

Supplying and downstream industries that are closely related suffer from a contraction in the set net and trawling fishing industries

Industries that supply the trawl and set net fishing industries with intermediate inputs are likely to be negatively affected. Such industries include construction, finance and insurance, or industries of transport.

For example:

- Transport equipment manufacturing, which includes boatbuilding, shipbuilding and repair services, is negatively affected from fewer operating fishing vessels and fewer vehicles transporting fish across regions.
  - For set net options, the industry output decreases by $0.08 million (Option 2) to $0.11 million (Option 3).
  - For trawl options, the industry output decreases by $0.06 million (Option 2) to $0.15 million (Option 3).
- Construction services (such as electricity and plumbing services) output is also likely to decrease due to less repairs needed for vessels used for set net and trawl fishing.
  - For set net options, the industry output decreases by $0.09 million (Option 2) to $0.17 million (Option 4).
  - For trawl options, the industry output is reduced by $0.08 million (Option 2) to $0.21 million (Option 3).
- Petroleum and coal product manufacturing is also decreasing with the reduction in petroleum fuel products (i.e. diesel, petrol and light fuel oil) required from fewer fishing trips and fewer vehicles transporting set net and trawling fish catch across regions.
  - For set net options, the industry output decreases by $0.09 million (Option 2) to $0.14 million (Option 4).
  - For trawl options, the industry output decreases by $0.08 million (Option 2) to $0.21 million (Option3).

Downstream industries, which use and/or process the output of the set net and trawl fishing industries into finished or different products that reach consumers, are also likely to be negatively affected

- Air transport output decreases by $0.04 million per year (Option 2) to 0.05 million (Option 4) for the set net options. For trawling options, air transport output is also expected to decrease by an annual $0.05 million (Option 2) to $0.10 million (Option 3). Given that fish caught under these two fishing methods is primarily for domestic use, the reduction in regional trade of fish by air transport leads to the decrease of this industry output.
- Communication services (such as radio, internet, mobile and satellite communication services) decrease by $0.04 million (Option 2) to $0.07 million (Option 4) for the set net options. This industry output decreases by $0.05 million (Option 2) to $0.11 million (Option 3) for the trawling options.

Industries where households spend their income are also likely to be affected from decreased income that comes through employment and wages, and decreased returns to capital from a reduced trawl and set net fishing industries. Such industries include consumption goods like the food and beverage services, grocery and other goods wholesaling, or retail trade. Such industries also include housing and real estate (which takes a large share of households' budgets).

Competing industries would gain from the decrease in trawl and set net fishing industries as they compete for resources (labour and capital)…

These industries are the labour intensive and/or export industries, such as services and manufacturing industries.

- Annual output of business services grows by $0.34 million (Option 2) to $0.46 million (Option 4) for the set net options. For the trawling options, industry output is expected to rise by $0.5 million (Option 2) to $1.18 million (Option 3). This industry includes a variety of services such as environmental consulting, agricultural, legal and accounting. With the contraction of the set net and trawl fishing industries, as well as their supporting industries, workers move to other industries, which are expanding, such as other fishing[2] and metal product manufacturing. This implies a greater requirement for business services in these industries, which in turn increases the output of business services.
- Other fishing[3] annual output increases by $0.03 million (Option 2) to $0.07 million (Option 4) for the set net options. Output of this industry increases by $0.05 million (Option 2) to $0.09 million (Option 3) for trawling options. Labour in other fishing industry segments could have similar skills to those currently engaged in set net and trawl fishing industries. This would allow for worker displacement from set net and trawl fishing industries towards the other segments within the fishing industry.
- Seafood processing output increases by $0.14 million (Option 2) to $0.27 million per year for the set net options. For trawling options, this industry output is expected to rise by $0.36 million (Option 2) to $ 1.01 million (Option 3). Seafood processing industry is considered as a downstream industry but also a competitive industry as it also processes other fish species (e.g. other wild fish, aquaculture and crustaceans) resulting from the "other fishing" industry, whose output expands with the contraction of the set net and trawl fishing industries.

  Even though catch is likely to be reduced from set net and trawl options, data from Statistics NZ[4] suggests that some fishers will want to continue to fish rather than move to other occupations. When the catch from set net and trawl fishing reduces, it requires:

  - Fishers to move towards fishing less valuable fish.[5] To maintain profit margins, fishers will need to catch slightly larger quantities of less valuable fish. This causes the catch of the less valuable fish to increase, raising demand for fish processing
  - A diversion of fish typically caught for export into the domestic market. With catch from set net and trawling traded mostly on the domestic market, we expect a slight increase in domestic demand for fish that are exported. This could also slightly increase the demand for fish processing.

  We expect both impacts to drive the slight increase in fish processing, although which impact will dominate is unclear. What happens will depend on the behaviour of

[2] Other fishing includes other wild fish species, aquaculture and crustaceans.

[3] Other fishing includes other wild fish species, aquaculture and crustaceans.

[4] Set out in the Input – Output Tables that drives the economy-wide modelling.

[5] Included in other fishing.

fishers. It could be that local factors drive behaviour that reduces catches and processing.[6]

- Annual output for metal product manufacturing (iron, steel, and aluminium) increases by $0.06 million (Option 2) to $0.08 million (Option 4) for the set net options. Industry output increases by $0.09 million (Option 2) to $0.22 million (Option 3) for trawling options. The growth in this industry could be due to less metal products required to build and maintain fewer fishing vessels. Instead, capital and labour substitute towards other industries that require metal products.

…but overall, national output decreases annually

New Zealand industry output decreases annually by $8.47 million (Option 2) to $12.66 million (Option 4) for the set net options and it decreases by $9.42 million (Option 2) to $22.75 million (Option 3) for trawling options.

Closure of set net and trawling fishing is forecast to decrease GDP in the fishing industry by between $3.0 million and $13.0 million by 2040[7]

- Fishing industry GDP is forecast to grow by 2040 between $431 million to $671 million at 2040 market prices.[8]
- In 2018 market prices, the fishing industry GDP is forecast to be between $400 million and $450 million in the next 20 years.
- Canterbury, Northland and Auckland experience the greatest impacts on GDP from the proposed set net restriction options with real GDP being lowered by between $1.74 million and $2.68 million in 2040.
- Under the proposed trawling restriction options, Canterbury, Auckland, Waikato-Taranaki and Bay of Plenty feel the greatest impacts on GDP in 2040 with real GDP decreasing by between $1.71 million and $6.28 million.

6 However, confirming this will take time and resources that are outside the scope of this work.

7 The forecasts are in contrast with a scenario where there is no closure.

8 In this report, nominal GDP is the GDP evaluated at current market prices, without adjusting for inflation while real GDP is measured at 2018 market prices

Contents

Appendices

Figures

Tables

1 Scope and outline

1.1 Scope

Fisheries New Zealand (FNZ) has asked NZIER to provide economic impact assessments to estimate the impacts of three closure options for both set net and trawling under the Hector's & Māui dolphin Threat Management Plan (TMP).

This work follows the NZIER's peer-review of the methodology used to estimate forgone economic value of commercial fishing arising from proposals to implement spatial closures.

As a result of our peer review, NZIER advised FNZ to use computable general equilibrium (CGE) analysis to provide economic impact assessments of the proposed spatial closures as CGE models are considered more reliable than multiplier analysis.[9] FNZ followed NZIER's recommendations.

We understand the issue that FNZ is grappling with is the tightening of restrictions on fishing activities in certain locations, to reduce the risk of fishing-related dolphin deaths. The impacts on fishing activity will vary in significance for the local economies in affected regions.

Fishing restrictions may divert fishing activity to other less dolphin-risky methods or species, which are not the fishers' most profitable first choice under current conditions; or it may cause contraction of fishing, freeing up resources like labour for redeployment to other industries, so that impacts on fishing will be offset to some extent by effects on other sectors.

There could be quite different impacts across the regions according to their economic structures, which is why economic impact analysis tailored to the regions, as proposed here, will increase the information base on which to make decisions.

1.2 Outline

We used NZIER's regional CGE model of the New Zealand economy to provide economic impact assessments of the proposed closure Options 2, 3 and 4 for trawl and set net fishing industries.

We provide estimates for the proposed closure Options 2, 3 and 4 to show the impacts on trawl and set net fishing. We also provide forecasts on set net and trawl fishing industry's GDP.

For further detail on the methodology, refer to Appendix B for the CGE modelling and Appendix D for the forecasting models.

[9] See Appendix **Error! Reference source not found.** for further explanations as to why CGE are considered more reliable than multiplier analysis.

2 Economic effects of the closure options for set net and trawl fishing

Set net and trawling fishing industries interact with other parts of New Zealand by employing labour and capital, using intermediate inputs supplied by other industries, and by supplying inputs to seafood processing and other industries.

We used NZIER's regional CGE (hereafter, TERM-NZ) model of the New Zealand economy to approximate the economic contributions that set net and trawling fishing industries make to other regions and New Zealand.

Regional CGE modelling captures the various inter-linkages between sectors and regions, as well as their links to households (via the labour market), the government sector, capital markets and the global economy (via imports and exports). It is therefore useful for understanding the likely economic impact of closure options for both set net and trawling under the Hector's & Māui dolphin TMP.

The key benefit of using our TERM-NZ model is that each New Zealand region is modelled as a separate economy, but linked to each other through inter-regional trade in goods and factors. TERM-NZ is therefore a useful tool for examining how closure options for both set net and trawling might impact both the regional and New Zealand economies.

A technical description of TERM-NZ is provided in Appendix B.

2.1 CGE modelling and scenario design

We use our static TERM-NZ model, which looks at 'before' (i.e. current situation) and 'after'. We therefore do not explicitly model the timing of the proposed closure options. Instead, we analyse a static scenario that estimates the overall economic effects of a closure option for trawl and set net fishing.

For our scenario design, we implement three policy options to represent what the regional and national economies would look like if closure options for trawl and/or set net fishing were to occur. Based on discussions with FNZ officials, we considered three policy options associated with different levels of revenue decrease for trawl and set net catch, and hence lower outputs in the trawl and set net fishing industries. These three policy options are: Option 2, Option 3 and Option 4 (Table 9).

Table 9 Regional policy options for set net and trawl fishing under TMP

In percentage change

Regions	Set net fishing			Trawl fishing		
	Option 2	Option 3	Option 4	Option 2	Option 3	Option 4
Northland	-4.8%	-8.1%	-66.3%	0.0%	-1.6%	-1.6%
Auckland	0.0%	-3.1%	-58.7%	-1.5%	-11.3%	-18.4%
Taranaki-Waikato	-17.9%	-20.5%	-30.7%	-19.9%	-64.1%	-79.4%
Bay of Plenty	0.0%	0.0%	0.0%	0.0%	-4.1%	-6.6%
Gisborne	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Regions	Set net fishing			Trawl fishing		
	Option 2	Option 3	Option 4	Option 2	Option 3	Option 4
Hawke's Bay	-0.3%	-0.3%	-0.3%	0.0%	-0.1%	-0.1%
Whanganui-Manawatu	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wellington	-14.7%	-14.7%	-14.7%	0.0%	-7.1%	-7.0%
Tasman-nelson	-38.9%	-38.9%	-14.2%	-0.2%	-1.6%	-0.2%
Marlborough	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
West Coast	0.0%	0.0%	0.0%	0.0%	-0.7%	-0.3%
Canterbury	-66.6%	-81.9%	0.0%	-14.2%	-20.5%	0.0%
Otago	-2.8%	-2.8%	0.0%	-15.5%	-18.3%	0.0%
Southland	-2.4%	-4.8%	0.0%	-7.1%	-10.2%	0.0%

Source: NZIER, FNZ

2.2 Headline macroeconomic impacts for the North and South Islands

New Zealand-wide results flow from the direct and indirect impacts at the regional levels as a result of the closure of fishing areas for set net and trawling under Options 2, 3 and 4.

Overall, the economic impacts are expected to be higher for trawling options as the catch value of trawl fishing ($115 million) is about 9 times bigger than the catch value of set net fishing ($13 million).[10]

The following sections present the economy-wide effects for North Island and South Island. The overall national effects can be found in Appendix C.

Economic impacts in the North Island

Amongst the set net and trawling options, the overall economic impacts are expected to be higher under Option 4 compared with Options 2 and 3 in the North Island. This is because Option 4 is more restrictive.

- For set netting, it represents a full closure of the harbours on the west coast of the North Island, in contrast to the other options which are more partial.
- For the trawling, it represents a larger restriction area on the central west coast of the North Island (Maunganui to New Plymouth).

Table 10 and Table 11 show the annual macroeconomic impacts of each option for set net fishing and trawl fishing, respectively, in the North Island.

[10] See Table 7 in appendix A.2 for the detailed composition of the trawl and set net fishing industries.

Table 10 Macroeconomic impacts from the set net options in the North Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.001%	-2.1	-0.001%	-2.9	-0.004%	-8.3
Household consumption	-0.001%	-1.6	-0.002%	-2.1	-0.003%	-4.2
Export volumes	-0.003%	-1.8	-0.004%	-2.2	-0.007%	-4.2
National output	-0.001%	-2.5	-0.001%	-3.5	-0.003%	-11.5
Employment	-0.001%	-0.6	-0.001%	-0.8	-0.002%	-1.6

3 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

4 Figures in percent changes differ at the four-digit level.

Source: NZIER

Table 11 Macroeconomic impacts from the trawling options in the North Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.001%	-2.0	-0.004%	-8.3	-0.005%	-9.9
Household consumption	-0.002%	-2.1	-0.005%	-6.0	-0.004%	-4.9
Export volumes	-0.003%	-1.9	-0.010%	-5.9	-0.009%	-5.2
National output	-0.001%	-2.4	-0.003%	-10.7	-0.003%	-13.4
Employment	-0.001%	-0.6	-0.002%	-1.9	-0.002%	-1.7

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

With the closure options, trawling and set net fishing industries are contracting, which has a negative impact on supporting (downstream and upstream industries) and leads to a decrease of the industry output in the North Island:

- For the set net options (Table 10), annual industry output is likely to decrease by between $2.5 million (Option 2) and $11.5 million (Option 4).
- For trawling options (Table 11), annual industry output is likely to decrease by between $2.4 million (Option 2) and $13.4 million (Option 4).
- Annual GDP is expected to decrease with the contraction of the output in the North Island:
  - For set netting options (Table 10), GDP is expected to fall by between $2.1 million (Option 2) and $8.3 million (Option 4) per year.
  - For trawling options (Table 11), national GDP is expected to fall by between $2.0 million (Option 2) and $9.9 million (Option 4) per year.

- In the North Island, household spending (the best measure of economic wellbeing and discretionary income) is driven by regional household consumption which is, in turn, negatively affected by the decrease in employment and lower wages at the regional level derived from the closure of trawling and/or set netting areas:
  - For the set net options (Table 10), annual household spending may be reduced by $1.6 million (Option 2) to $4.2 million (Option 4).
  - For trawling options (Table 11), annual household spending may be reduced by $2.1 million (Option 2) to $6.0 million (Option 3).
- Employment is likely to be reduced in the North Island. In our modelling we assume wages are typically inflexible in the short term, so that most of the impact on labour is felt through job losses rather than wage reductions. We understand that some industries might respond differently, by reducing hours or wages but maintaining jobs. However, the negative impacts of the closure options will still be felt either through job losses, wage reductions or a combination of both. We also stress that the reductions are temporary and not lasting job losses. Employment returns to its baseline as the economy adjusts to the policy change:
  - For the set net options (Table 10), annual employment in the North Island may be reduced by between $0.6 million (Option 2) to $1.6 million (Option 4).
  - For the trawling options (Table 11), New Zealand annual employment may be reduced by between $0.6 million (Option 2) to $1.9 million (Option 3).
- Annual export revenue in the North Island may reduce by between $1.7 million (Option 2) to $4.2 million (Option 4) when closure options apply to set net fishing (Table 10). For the trawling options, annual exports are expected to decrease by $1.9 million (Option 2) to $5.9 million (Option 3) as shown in Table 11.

  The decrease in national exports is mostly due to the overall decrease in national output and to the appreciation of the New Zealand dollar exchange rate following the contraction of real GDP. With the appreciation of the New Zealand dollar exchange rate, the relative price of domestic goods and services increases while the relative price of imported goods and services decreases. This leads to a decrease in aggregate demand (assuming the aggregate demand is relatively inelastic) and to a contraction in New Zealand exports as they become relatively more expensive.

Economic impacts in the South Island

Amongst the set net and trawling options, the overall economic impacts in the South Island are expected to be higher under Option 3 compared with Options 2 and 4. This is because the restrictions under Option 3 are higher than under Option 2, while for Option 4, there is no trawling or set net restrictions in the South Island.

Similarly to the section above, Table 12 and Table 13 overleaf show the annual macroeconomic impacts of each option for set net fishing and trawl fishing, respectively, in the South Island.

Table 12 Macroeconomic impacts from the set net options in the South Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.006%	-4.1	-0.007%	-4.9	-0.002%	-1.1
Household consumption	-0.004%	-1.4	-0.004%	-1.7	-0.001%	-0.5
Export volumes	-0.008%	-1.8	-0.010%	-2.2	-0.004%	-1.0
National output	-0.005%	-5.9	-0.006%	-7.5	-0.001%	-1.2
Employment	-0.002%	-0.5	-0.002%	-0.7	-0.001%	-0.2

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

Table 13 Macroeconomic impacts from the trawling options in the South Island

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.009%	-5.8	-0.015%	-10.1	-0.002%	-1.3
Household consumption	-0.004%	-1.7	-0.008%	-3.0	-0.001%	-0.6
Export volumes	-0.011%	-2.5	-0.019%	-4.3	-0.005%	-1.1
National output	-0.006%	-7.0	-0.010%	-12.0	-0.001%	-1.2
Employment	-0.002%	-0.6	-0.004%	-1.0	0.000%	-0.1

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

2.3 Regional impacts on annual GDP and household spending

Overall, the annual GDP and household impacts are expected to vary across regions depending on:

- The size of set net fishing and/or trawling for each region.
- The expected revenue loss within each region from the closure of areas for set net and/or trawling.
- The geographic location of the closure areas for the different options.

Annual impacts on regional GDP

Table 14, Table 15, and Figure 1 describe the annual regional impacts on GDP, from the set net and trawling options, respectively. All the regional economies of New Zealand are expected to contract due to the direct and flow-on effects associated with the closure of set net and/or trawl fishing areas.

- For the set net options (Table 14), annual regional GDP in dollar value is expected to decrease the most in Northland, Auckland, Waikato-Taranaki, Nelson-Tasman and Canterbury. This is because set net fishing is mostly located in these regions, which also represent the main base ports for set net fishing, and therefore, are expected to be more affected by the closure options.
- For the trawling options (Table 15), annual regional GDP in dollar value is expected to decrease the most in Auckland, Waikato-Taranaki, Nelson-Tasman and Canterbury. This is because trawl fishing is mostly located in these regions, which are also the main base ports for trawl fishing.

Table 14 Impacts on regional GDP from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2	Option 3	Option 4
Northland	-0.39	-0.61	-3.25
Auckland	-0.45	-0.72	-2.88
Waikato-Taranaki	-0.84	-1.01	-1.50
Bay of Plenty	-0.08	-0.10	-0.15
Gisborne	-0.01	-0.01	-0.01
Hawke's Bay	-0.04	-0.05	-0.07
Whanganui-Manawatu	-0.05	-0.07	-0.07
Wellington	-0.27	-0.32	-0.35
Nelson-Tasman	-0.76	-0.79	-0.40
Marlborough	-0.03	-0.04	-0.04
West Coast	-0.02	-0.03	-0.02
Canterbury	-2.88	-3.41	-0.35
Otago	-0.16	-0.20	-0.13
Southland	-0.25	-0.41	-0.19
North Island	**-2.12**	**-2.89**	**-8.28**
South Island	**-4.10**	**-4.88**	**-1.13**
National	**-6.22**	**-7.76**	**-9.41**

1 The sum of figures given in dollar value for the South Island and North Island might not be equal to figures for New Zealand due to rounding.

Source: NZIER

Table 15 Impacts on regional GDP from the trawling options

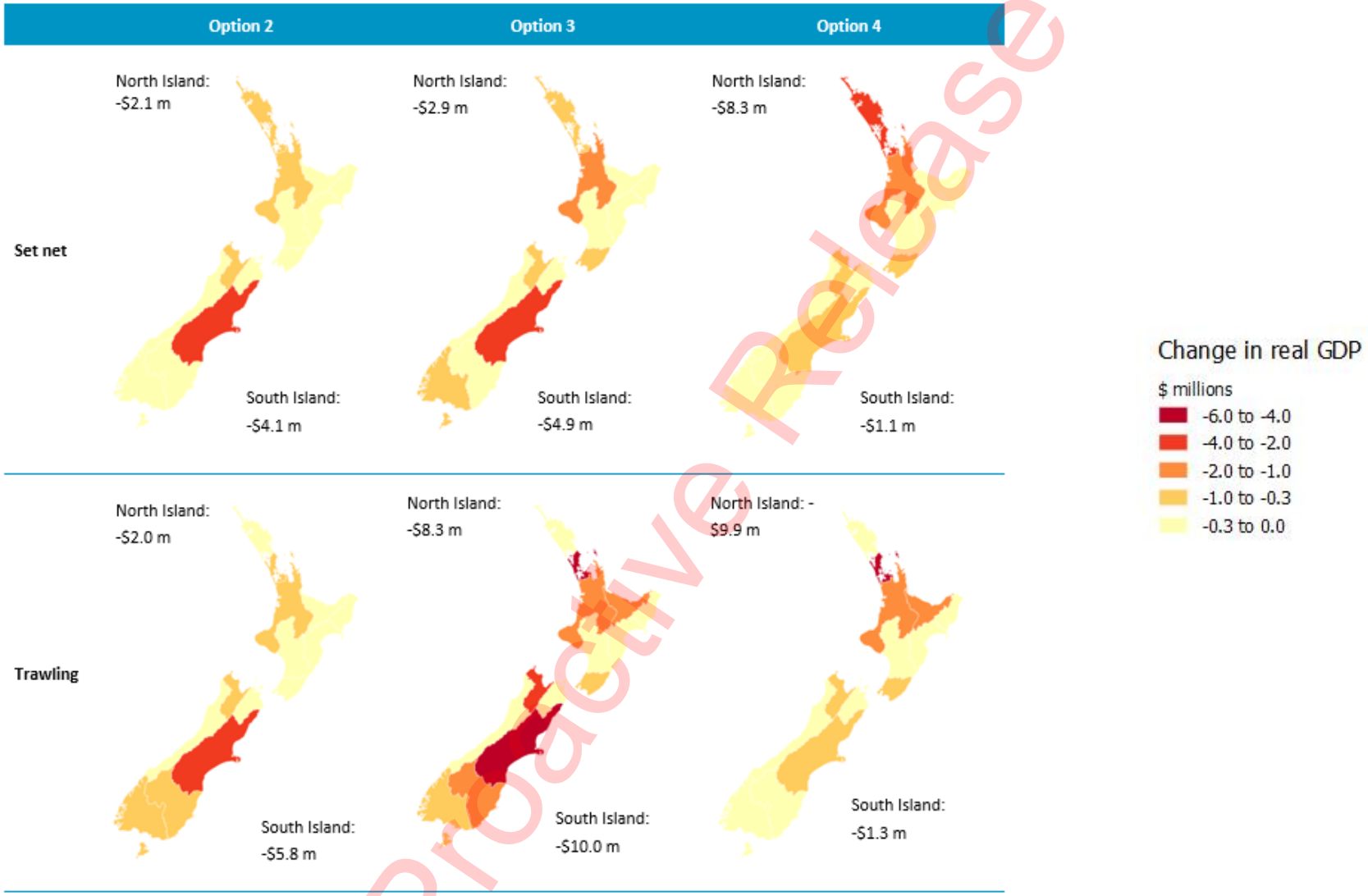
Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2	Option 3	Option 4
Northland	-0.04	-0.19	-0.16
Auckland	-0.90	-4.34	-5.75
Waikato-Taranaki	-0.63	-1.55	-1.53
Bay of Plenty	-0.13	-1.31	-1.82
Gisborne	-0.02	-0.06	-0.04
Hawke's Bay	-0.07	-0.19	-0.14
Whanganui-Manawatu	-0.05	-0.13	-0.07
Wellington	-0.16	-0.52	-0.36
Nelson-Tasman	-0.43	-2.05	-0.61
Marlborough	-0.03	-0.07	-0.04
West Coast	-0.07	-0.27	-0.13
Canterbury	-3.85	-5.70	-0.34
Otago	-0.79	-1.02	-0.09
Southland	-0.63	-0.95	-0.07
North Island	**-2.00**	**-8.28**	**-9.86**
South Island	**-5.80**	**-10.06**	**-1.28**
National	**-7.80**	**-18.33**	**-11.14**

1 The sum of figures given in dollar value for the South Island and North Island might not be equal to figures for New Zealand due to rounding.

Source: NZIER

Figure 1 Regional GDP impact of fishing restrictions



Source: NZIER

Effects on regional household spending

Table 16, Table 17, and Figure 2 describe the annual regional impacts on household spending, from the set net options and trawling options, respectively. Our measure of economic welfare (i.e. consumption) indicates that regional households would be 'worse-off' overall. This is because of the reduction in incomes from wages and capital returns as set net and trawl fishing industries see their outputs decrease with the closure of set net and/or trawling fishing areas.

For both the set net and trawling options (Table 16 and Table 17, respectively), annual regional household spending in dollar value is expected to decrease the most in Auckland, Waikato-Taranaki, Wellington and Canterbury for Options 2, 3, and 4. This is because household spending is higher in regions that are more populated and wealthier. Therefore, even a small percentage decrease will have a larger monetary impact than less populated and wealthy regions.

Household spending is expected to slightly increase in Southland for all three set net options. This is because set net fishing only accounts for a very small portion of the regional economy and there is near full employment in the region.

In our modelling we assume wages are typically inflexible in the short term, so that most of the impact on labour is felt through job losses rather than wage reductions. We understand that some industries might respond differently, by reducing hours or wages but maintaining jobs. However, the negative impacts of the closure options will still be felt either through job losses, wage reductions or a combination of both.

Therefore, with the set net closures, some labour is freed up from the set net industry as well as from its supporting industries and moves toward competing industries such as agriculture and construction. Increasing employment in these competing industries causes total employment and income wages to slightly increase, which leads to a rise in household consumption.

We acknowledge, however, that the reallocation of workers across industries within the region will lead to transition costs in the short to medium term. These transition costs are not captured within our modelling framework. Potentially the transition costs for those workers exiting the set net fishing industry could offset the slight gains in household consumption in the short to medium term.

Table 16 Impacts on regional household consumption from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2	Option 3	Option 4
Northland	-0.03	-0.06	-0.83
Auckland	-0.67	-0.89	-1.89
Waikato-Taranaki	-0.32	-0.38	-0.54
Bay of Plenty	-0.14	-0.18	-0.25
Gisborne	-0.02	-0.03	-0.04
Hawke's Bay	-0.06	-0.08	-0.09
Whanganui-Manawatu	-0.11	-0.15	-0.16
Wellington	-0.29	-0.37	-0.40
Nelson-Tasman	-0.25	-0.27	-0.13
Marlborough	-0.05	-0.07	-0.06
West Coast	-0.04	-0.05	-0.04
Canterbury	-0.99	-1.24	-0.29
Otago	-0.10	-0.12	-0.10
Southland	0.02	0.02	0.08
North Island	**-1.64**	**-2.12**	**-4.21**

Region	Option 2	Option 3	Option 4
South Island	**-1.41**	**-1.73**	**-0.54**
National	**-3.05**	**-3.84**	**-4.75**

Source: NZIER

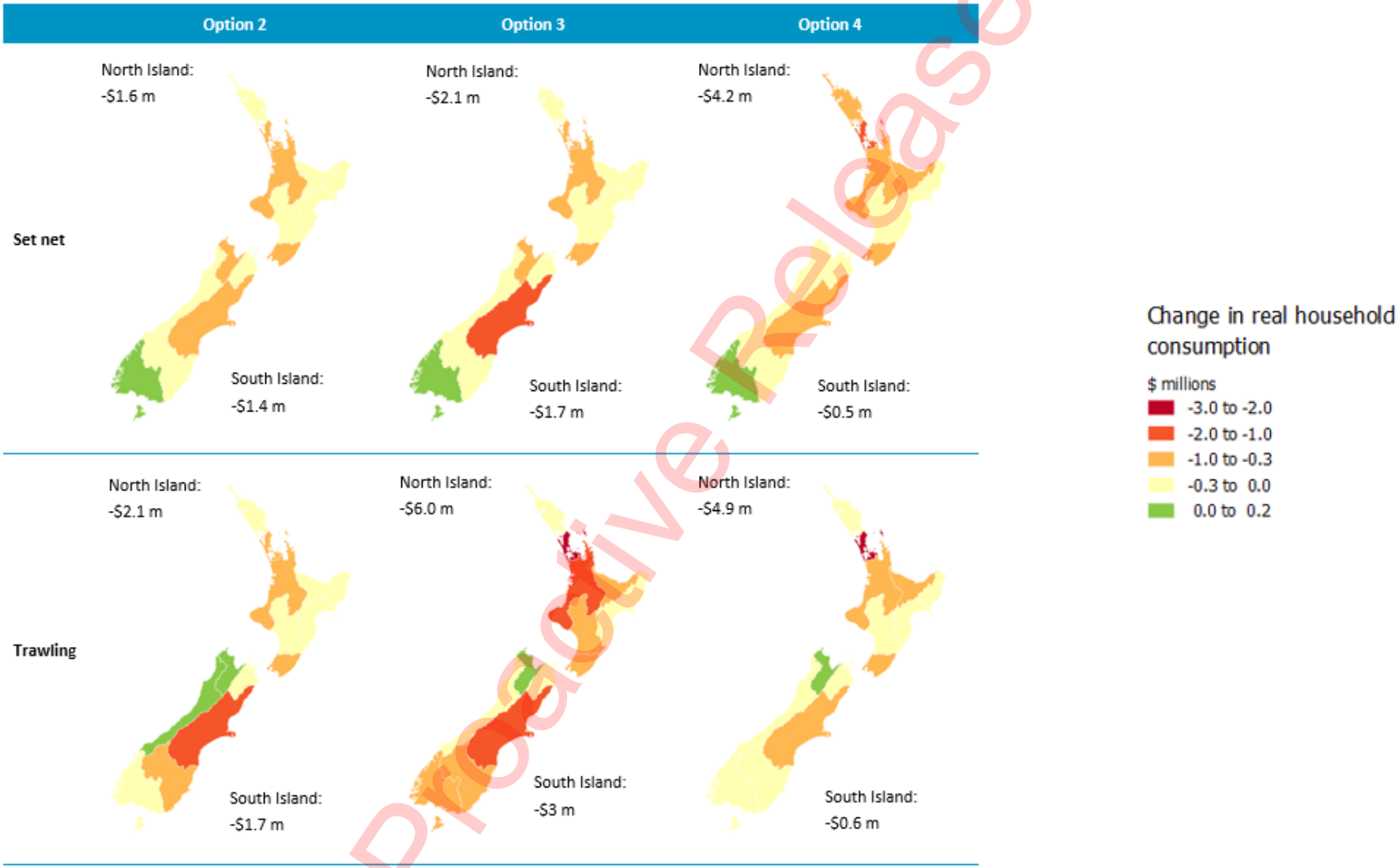
Table 17 Impacts on regional household consumption from the trawling options

Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2	Option 3	Option 4
Northland	-0.07	-0.20	-0.14
Auckland	-0.99	-2.90	-2.61
Waikato-Taranaki	-0.41	-1.08	-0.86
Bay of Plenty	-0.11	-0.48	-0.53
Gisborne	-0.01	-0.02	-0.01
Hawke's Bay	-0.06	-0.13	-0.08
Whanganui-Manawatu	-0.14	-0.33	-0.19
Wellington	-0.34	-0.83	-0.50
Nelson-Tasman	0.11	0.03	0.18
Marlborough	-0.06	-0.13	-0.07
West Coast	0.01	0.00	0.00
Canterbury	-1.16	-1.99	-0.46
Otago	-0.34	-0.55	-0.17
Southland	-0.22	-0.36	-0.07
North Island	**-2.13**	**-5.97**	**-4.93**
South Island	**-1.66**	**-3.01**	**-0.58**
National	**-3.79**	**-8.98**	**-5.50**

Source: NZIER

Figure 2 Regional impact on household consumption of fishing restrictions



Source: NZIER

2.4 Flow-on effects

Table 18 and Table 19 show the annual indirect impacts of closure options for set net and trawl fishing across other industries[11] within the New Zealand economy.

Partly offsetting the losses from set net and trawl fishing industries, as well as their supporting industries, is the expansion of competing industries. These industries gain from the decrease in the set net and trawl fishing industry outputs as they compete for resources (labour and capital), which become less expensive. Typically, these competitive industries are the labour-intensive and/or export industries, such as business services, other fishing and manufacturing industries.

Upstream industries – Industries that supply the trawl and set net fishing industries with intermediate inputs are likely to be negatively affected. Such industries include construction, finance and insurance, or industries of transport. For example:

- Transport equipment manufacturing, which includes boatbuilding, shipbuilding and repair services, is negatively affected from fewer operating fishing vessels and fewer vehicles transporting fish across regions.
  - For the set net options, industry output decreases by $0.08 million (Option 2) to $0.11 million (Option 3).
  - For the trawling options, industry output decreases by $0.06 million (Option 2) to $0.15 million (Option 3).
- Construction services (such as electricity and plumbing services) output is also likely to decrease due to less repair needed from vessels used for set net and trawl fishing.
  - For the set net options, industry output decreases by $0.09 million (Option 2) to $0.17 million (Option 4).
  - For the trawling options, industry output decreases by $0.08 million (Option 2) to $0.21 million (Option 3).
- Petroleum and coal product manufacturing also decreases with the reduction in petroleum fuel products (i.e. diesel, petrol and light fuel oil) required from fewer fishing trips and fewer vehicles transporting set net and trawling fish catch across regions.
  - For the set net options, industry output decreases by $0.09 million (Option 2) to $0.14 million (Option 4).
  - For the trawling options, industry output decreases by $0.08 million (Option 2) to $0.21 million (Option3).
- **Downstream industries** – which use and/or process the output of the set net and trawl fishing industries into finished or different products that reach consumers, are also likely to be negatively affected.
  - Air transport output decreases by $0.04 million per year (Option 2) to 0.05 million (Option 4) for the set net options. Air transport output is also expected to decrease by an annual $0.05 million (Option 2) to $0.10 million (Option 3) for the trawling options. Given that fish caught under these two fishing methods are primarily for domestic use, the reduction in regional trade of fish by air transport leads to the decrease of this industry output.
  - Communication services (such as radio, internet, mobile and satellite communication services) decrease by $0.04 million (Option 2) to $0.07 million (Option 4) for the set net options. The

[11] These are industries classified under the ANZSIC classification system: http://archive.stats.govt.nz/methods/classifications-and-standards/classification-related-stats-standards/industrial-classification.aspx

industry output decreases by $0.05 million (Option 2) to $0.11 million (Option 3) for the trawling options.

- **Household expenditure industries** – Industries where households spend their income are also likely to be affected from decreased income that comes through employment and wages, and decreased returns to capital from a smaller trawl and set net fishing industries. Such industries include consumption goods like the food and beverage services, grocery and other goods wholesaling, or retail trade. Such industries also include housing and real estate (which takes a large share of households' budgets).
- **Competing industries** – These industries gain from the decrease in the trawl and set net fishing industry as they compete for resources (labour and capital). These industries are labour-intensive and/or export industries, such as services and manufacturing industries.
  - Annual output of business services grows by $0.34 million (Option 2) to $0.46 million (Option 4) for the set net options. Industry output is expected to rise by $0.5 million (Option 2) to $1.18 million (Option 3) for the trawling options. This industry includes a variety of services such as environmental consulting, agricultural, legal and accounting. With the contraction of the set net and trawl fishing industries, as well as their supporting industries, workers move to other industries which are expanding, such as other fishing[12] and metal product manufacturing. This implies a greater requirement for business services in these industries, which in turn increases the output of business services.
  - Other fishing[13] annual output increases by $0.03 million (Option 2) to $0.07 million (Option 4) for the set net options. Output of this industry are increasing by $0.05 million (Option 2) to $0.09 million (Option 3) for the trawling options. Labour in other fishing industry could have similar skills to those currently engaged in the set net and trawl fishing industries. This would allow for worker displacement from the set net and trawl fishing industries towards the other segments within the fishing industry.
  - Seafood processing output increases by $0.14 million (Option 2) to $0.27 million per year for set net options. The output of the industry increases by $0.36 million (Option 2) to $ 1.01 million (Option 3) for the trawling options. Seafood processing industry is considered as a downstream industry but also a competitive industry as it also processes other fish species (e.g. other wild fish, aquaculture and crustaceans) resulting from the other fishing industry, whose output expands with the contraction of the set net and trawl fishing industries.

    Even though catch is likely to be reduced from set net and trawl options, data from Statistics NZ[14] suggests that some fishers will want to continue to fish rather than move to other occupations. When the catch from set net and trawl fishing reduces, it requires:

    - Fishers to move towards fishing less valuable fish.[15] To maintain profit margins, fishers will need to catch slightly larger quantities of less valuable fish. This causes the catch of the less valuable fish to increase, raising demand for fish processing.
    - A diversion of fish typically caught for export into the domestic market. With catch from set net and trawling traded mostly on the domestic market, we expect a slight increase in domestic demand for fish that are exported. This could also slightly increase the demand for fish processing.

[12] Other fishing includes other wild fish species, aquaculture and crustaceans.

[13] Other fishing includes other wild fish species, aquaculture and crustaceans.

[14] Set out in the Input – Output Tables that drives the economy-wide modelling.

[15] Included in other fishing.

- We expect both impacts to drive the slight increase in fish processing, although which impact will dominate is unclear. What happens will depend on the behaviour of fishers. It could be that local factors drive behaviour that reduces catches and processing.[16]

– Annual output for metal product manufacturing (iron, steel, aluminium) increases by $0.06 million (Option 2) to $0.0.08 million (Option 4) for set net options. Industry output increases by $0.09 million (Option 2) to $0.22 million (Option 3) for the trawling options. The growth in this industry could be due to less metal products required to build and maintain fewer fishing vessels. Instead, capital and labour substitute towards other industries that require metal products.

Overall, national output decreases annually by $8.47 million (Option 2) to $12.66 million (Option 4) for the set net options (Table 18). The national output decreases by $9.42 million (Option 2) to $22.75 million (Option 3) for the trawling options (Table 19).

Table 18 Flow-on effects on selected industries at the national level from the set net options

Annual changes in $ millions, in real terms in 2018 prices

Industry	Industry type	Option 2	Option 3	Option 4
Food and beverage services	Household expenditure industries	-0.32	-0.43	-0.58
Grocery and other goods wholesaling		-0.32	-0.41	-0.51
Retail		-0.27	-0.34	-0.39
Education and health services		-0.16	-0.21	-0.30
Accommodation		-0.15	-0.20	-0.24
Other personal services		-0.09	-0.13	-0.15
Sport and recreation services		-0.07	-0.09	-0.11
Property services and dwelling		-0.07	-0.08	-0.10
Recreational, clothing, footwear, and personal accessory retailing		-0.06	-0.08	-0.08
Construction	Supporting industries (supplying & downstream industries)	-0.09	-0.12	-0.17
Finance and insurance		-0.10	-0.13	-0.15
Petroleum and coal product manufacturing		-0.09	-0.13	-0.14
Transport equipment manufacturing		-0.08	-0.11	-0.10
Road and rail transport		-0.05	-0.07	-0.08
Electricity generation and transmission		-0.04	-0.06	-0.07
Communication services		-0.04	-0.05	-0.07
Air and other transport		-0.04	-0.04	-0.05
Meat and meat product manufacturing	Competing industries	0.03	0.04	0.01
Dairy product manufacturing		0.03	0.03	0.02
Horticulture and fruit growing		0.02	0.03	0.02
Fruit, oil, cereal, and other food product manufacturing		0.04	0.05	0.04
Wood product manufacturing		0.03	0.04	0.04
Other fishing (including aquaculture and crustaceans)		0.03	0.02	0.07
Metal product manufacturing		0.06	0.07	0.08
Agriculture, forestry, and fishing support services		0.06	0.07	0.09
Scientific, architectural, and engineering services		0.12	0.15	0.15
Business services		0.34	0.40	0.46
Seafood processing	Supporting & competing industry	0.14	0.16	0.27
Total New Zealand output		**-8.47**	**-10.93**	**-12.66**

1 Results for the three options reflect the changes compared to our 2018 CGE database (based on the Stats NZ IO table),

Source: NZIER

[16] However, confirming this will take time and resources that are outside the scope of this work.

Table 19 Flow-on effects on selected industries at the national level from the trawling options

Annual changes in $ millions, in real terms in 2018 prices

Industry	Industry type	Option 2	Option 3	Option 4
Food and beverage services	Household expenditure industries	-0.34	-0.87	-0.58
Grocery and other goods wholesaling		-0.36	-0.91	-0.64
Retail		-0.29	-0.71	-0.46
Education and health services		-0.12	-0.29	-0.19
Accommodation		-0.16	-0.39	-0.25
Other personal services		-0.09	-0.23	-0.16
Sport and recreation services		-0.09	-0.20	-0.12
Property services and dwelling		-0.08	-0.19	-0.12
Recreational, clothing, footwear, and personal accessory retailing		-0.07	-0.16	-0.10
Construction	Supporting industries (supplying & downstream industries)	-0.08	-0.21	-0.15
Finance and insurance		-0.10	-0.25	-0.15
Petroleum and coal product manufacturing		-0.08	-0.21	-0.15
Transport equipment manufacturing		-0.06	-0.15	-0.11
Road and rail transport		-0.05	-0.13	-0.10
Electricity generation and transmission		-0.05	-0.12	-0.07
Communication services		-0.05	-0.11	-0.07
Air and other transport		-0.05	-0.10	-0.03
Meat and meat product manufacturing	Competing industries	0.05	0.10	0.04
Dairy product manufacturing		0.05	0.09	0.04
Horticulture and fruit growing		0.02	0.05	0.02
Fruit, oil, cereal, and other food product manufacturing		0.04	0.09	0.05
Wood product manufacturing		0.03	0.08	0.05
Other fishing (including aquaculture and crustaceans)		0.05	0.09	0.01
Metal product manufacturing		0.09	0.22	0.15
Agriculture, forestry, and fishing support services		0.05	0.11	0.06
Scientific, architectural, and engineering services		0.17	0.38	0.21
Business services		0.50	1.18	0.74
Seafood processing		0.36	1.01	0.97
Total New Zealand output		**-9.42**	**-22.75**	**-14.52**

1 Results for the three Options reflect the changes compared to our 2018 CGE database (based on the Stats NZ IO table)

Source: NZIER

3 Impacts of the fishing industry in 2040

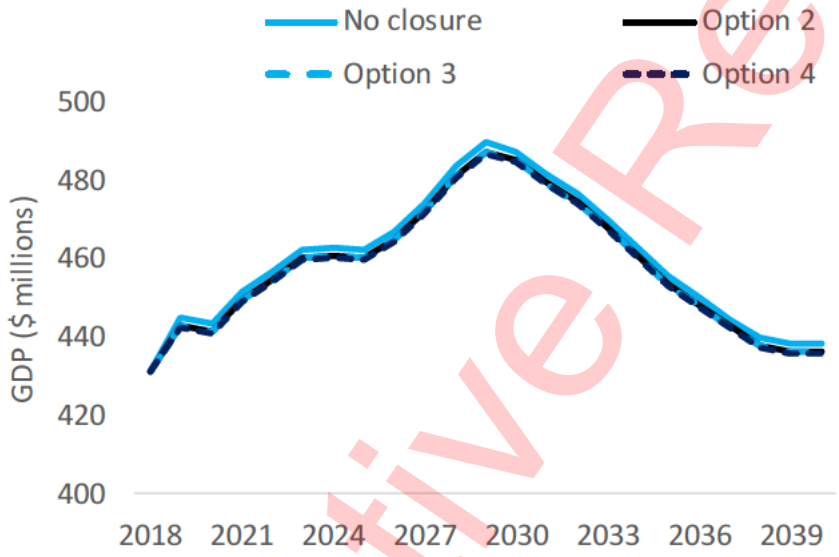
In 2018 market prices, the fishing industry GDP (no closure option) is forecast to grow from $431.1 million to $671.1 million in nominal terms by 2040. These forecasts were estimated using NZIER's GDP simulation model. More detail on the methodology can be found in Appendix D.

In real terms[17], the fishing industry GDP (no closure option) is forecast to be between $400 million and $450 million in the next 20 years (Figure 3 and Figure 4), a decrease in volume of fish caught. Another reason for static growth is that from 2030, the New Zealand economy is forecast to move more towards services, as more capital is attracted towards services and zero carbon initiatives than primary industries.

3.1 Set net restrictions' impact on fishing GDP

Option 4's set net restrictions have the largest impact on real GDP. By 2040 real GDP will be $3.74 million lower than if there were no closures. This is followed by Option 3 ($3.21 million lower in 2040) and Option 2 ($2.97 million lower in 2040).

Figure 3 Forecast fishing GDP for the set net fishing restriction options



Source: NZIER

Table 20 shows the regional impact of Options 2, 3 and 4 for set net fishing.

- Option 2 impacts the South Island ($2.74 million lower) more than the North Island ($0.24 million lower) in 2040, with the greatest impact felt in Canterbury ($2.47 million lower).
- Option 3 impacts the South Island ($2.83 million lower) more than the North Island ($0.37 million lower) in 2040, with the greatest impact felt in Canterbury ($2.68 million lower).
- Option 4 impacts the North Island ($3.30 million lower) more than the South Island ($1.23 million lower) in 2040, with the greatest impacts felt in Northland ($2.47 million lower) and Auckland (1.74 million lower). Under this option, the South Island has no increase in fishing restrictions. Additionally, the price of fish increases due to the closures in the North Island, which leads to an increase in South Island fishing GDP.

Other regions will see real GDP decreases of less than $1 million for all options.

[17] Nominal GDP represent the unadjusted value added (in $) that the industry makes to the New Zealand economy. This compares to real GDP which adjusted to take into consideration changes in price levels and therefore excludes the effects of inflation.

Table 20 Forecast fall in fishing GDP from the set net options

Changes in $ millions per year (in 2018 prices)

Region	Option 2		Option 3		Option 4	
	2019	2040	2019	2040	2019	2040
Northland	0.05	0.07	-0.01	-0.01	-1.64	-2.47
Auckland	0.17	0.26	0.13	0.20	-1.15	-1.74
Waikato-Taranaki	-0.37	-0.56	-0.39	-0.59	-0.58	-0.88
Bay of Plenty	0.02	0.04	0.03	0.05	0.06	0.09
Gisborne	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Hawke's Bay	0.02	0.03	0.03	0.04	0.04	0.06
Whanganui-Manawatu	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Wellington	-0.05	-0.07	-0.04	-0.05	-0.02	-0.04
Nelson-Tasman	-0.45	-0.68	-0.44	-0.67	-0.09	-0.14
Marlborough	0.01	0.01	0.01	0.01	0.01	0.01
West Coast	0.01	0.01	0.01	0.01	0.01	0.01
Canterbury	-1.64	-2.47	-1.78	-2.68	0.33	0.50
Otago	0.07	0.11	0.12	0.18	0.15	0.23
Southland	0.19	0.29	0.21	0.32	0.41	0.62
North Island	**-0.16**	**-0.24**	**-0.25**	**-0.37**	**-3.30**	**-4.97**
South Island	**-1.81**	**-2.74**	**-1.88**	**-2.83**	**0.82**	**1.23**
National	**-1.97**	**-2.97**	**-2.12**	**-3.21**	**-2.48**	**-3.74**

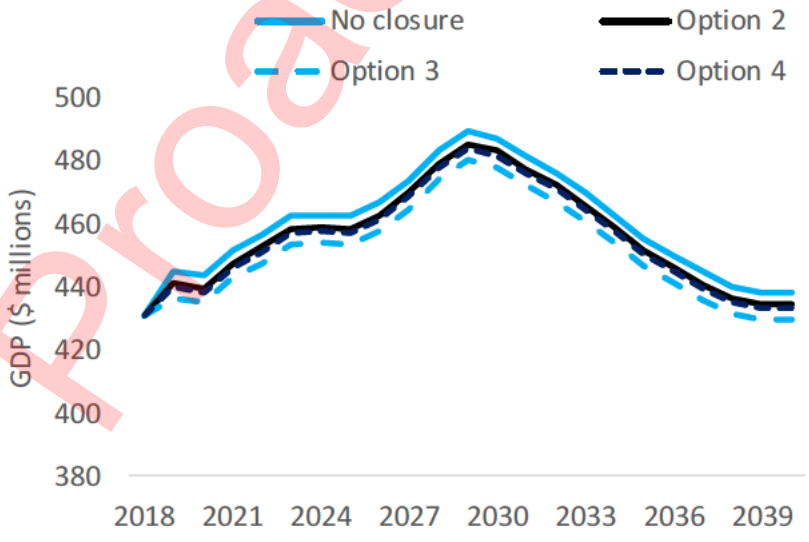
1 Figures in this table are for the annual fall in fishing GDP in 2019 and 2040. They are larger in 2040 than in 2019 because they include the loss in growth potential of the fishing industry than the restriction by each option.

Source: NZIER

3.2 Trawling restrictions' impact on fishing GDP

Option 3's trawling restrictions have the largest impact on real GDP (Figure 4). By 2040 real GDP will be $12.99 million lower than if there were no closures. This is followed by Option 4 ($7.64 million lower in 2040) and Option 2 ($5.76 million lower in 2040).

Figure 4 Forecast fishing GDP for the trawling restriction options



Source: NZIER

Table 21 shows the regional impact of Options 2, 3 and 4 for trawling.

- Option 2 impacts the South Island ($5.18 million lower) more than the North Island ($0.58 million lower) in 2040, with the greatest impact felt in Canterbury ($4.58 million lower).
- Option 3 impacts the South Island ($7.37 million lower) more than the North Island ($5.62 million lower) in 2040, with the greatest impacts felt in Canterbury ($6.28 million lower), Auckland ($3.55 million lower) and Waikato-Taranaki ($1.62 million lower).
- Option 4 impacts the North Island ($6.28 million lower) more than the South Island ($1.22 million lower) in 2040, with the greatest impacts felt in Auckland ($6.18 million lower), Waikato-Taranaki ($1.74 million lower) and Bay of Plenty ($1.71 million lower). In this option the South Island has no increase in fishing restrictions, since the price of fish increases due to the closures in the North Island. The South Island's fishing GDP increase; Tasman-Nelson is forecast to increase by GDP $1.14 million in 2040.

Other regions will see real GDP decreases of less than $1 million for all options.

Table 21 Forecast fall in fishing GDP from the trawling options

Changes in $ million per year (in 2018 prices)

Region	Option 2		Option 3		Option 4	
	2019	2040	2019	2040	2019	2040
Northland	-0.04	-0.06	-0.19	-0.28	-0.16	-0.24
Auckland	-0.90	-1.36	-4.34	-6.55	-5.75	-8.67
Waikato-Taranaki	-0.63	-0.95	-1.55	-2.34	-1.53	-2.30
Bay of Plenty	-0.13	-0.19	-1.31	-1.97	-1.82	-2.74
Gisborne	-0.02	-0.03	-0.06	-0.08	-0.04	-0.06
Hawke's Bay	-0.07	-0.10	-0.19	-0.29	-0.14	-0.21
Whanganui-Manawatu	-0.05	-0.08	-0.13	-0.19	-0.07	-0.11
Wellington	-0.16	-0.24	-0.52	-0.79	-0.36	-0.54
Nelson-Tasman	-0.43	-0.65	-2.05	-3.09	-0.61	-0.93
Marlborough	-0.03	-0.05	-0.07	-0.11	-0.04	-0.06
West Coast	-0.07	-0.10	-0.27	-0.40	-0.13	-0.20
Canterbury	-3.85	-5.80	-5.70	-8.60	-0.34	-0.51
Otago	-0.79	-1.20	-1.02	-1.55	-0.09	-0.14
Southland	-0.63	-0.95	-0.95	-1.43	-0.07	-0.10
North Island	**-2.00**	**-3.02**	**-8.28**	**-12.49**	**-9.86**	**-14.87**
South Island	**-5.80**	**-8.75**	**-10.06**	**-15.18**	**-1.28**	**-1.94**
National	**-7.80**	**-11.77**	**-18.33**	**-27.66**	**-11.14**	**-16.81**

1 Figures in this table are for the annual fall in fishing GDP in 2019 and 2040. They are larger in 2040 than in 2019 because they include the loss in growth potential of the fishing industry than the restriction by each option.

Source: NZIER

Appendix A Data and assumptions

A.1 Data

FNZ provided us with the following data:

- Fish catch dataset (greenweight catch volume and price for each fish species) by:
  - set net and trawling fishing method.
  - inside / outside fishing boundaries.
  - base port.

A.2 Assumptions and caveats

Below is a list of caveats and assumptions we made for our modelling and forecasting exercise.

- The model runs we have made depend on assumptions about values and other factors that may change over time.
- We use our static TERM-NZ model, which can only look at 'before' (i.e. current situation) and 'after' (with closure option). We therefore do not explicitly model the timing of the proposed closure options for the set net and trawl fishing methods. We simply compare the regional and national economies without and with the closure options. Typically, such reductions have specific costs and revenues, each incurred at different periods. A more sophisticated, dynamic modelling approach would be required to capture these timing effects. We analyse a static scenario that estimates the overall annual economic effects of proposed closure options for set net and trawl fishing.
- There are no comprehensive data sources for all aspects of the economic effects for the proposed spatial closure options, so modelling depends on a mix of Stats NZ's official data supplemented by information from FNZ.
- Estimates from the CGE modelling are not forecasts because we do not know precisely how the proposed spatial closure options might play out in the set net and trawl fishing industries, at the regional and national levels. However, they do quantify the potential economic impacts of such closure options. As more information and data becomes available, we will be able to carry out further economic modelling as required.
- As catch from set net and trawling decrease, fishers move to fishing other fish at similar depths using the fishing methods for which they are currently resourced.
- Our CGE database is based on Stats NZ's 2013 Input-Output tables. We then updated this data to 2018 levels using Stats NZ's latest national accounts (November 2018).
- We only modelled changes in catch for commercially caught fish from set net and trawling methods. We have not looked at the economic impacts of changes in catch or abundance relating to the recreational and customary non-commercial fishing sectors.

Appendix B CGE modelling

B.1 Why do we prefer CGE over multipliers?

Multiplier studies[18] are popular for economic impact analysis as they are relatively cheap and produce appealing big figures. However, they are based on several assumptions which requires them to be interpreted and considered with considerably care.

Key caveats to remember about multiplier studies include they:

- Do not consider the impacts of policy changes on the price of goods, services, intermediate inputs, labour (wages) and capital.
- Assume that land, labour and capital are available in unlimited quantities, and at no additional cost to firms.
- Cannot consider the opportunity cost of using additional resources in one industry on the rest of the economy – there are almost never any losers (i.e. contracting industries) in multiplier studies.

Because of these assumptions, multipliers overestimate the impacts of a change in a particular industry on the rest of the economy. Both the Ministry of Business, Innovation and Employment (MBIE) and Treasury have highlighted the inherent flaws in using multiplier studies for serious economic analysis.[19]

For all these reasons, we prefer to use CGE models.

A CGE model provides an estimation of opportunity costs (between action and inaction), winners and losers. Resources are limited. It also considers price impacts of shocks and can capture regional linkages between industries as well as spill-over effects.

NZIER's CGE models are highly regarded amongst government agencies with whom we have worked for to conduct policy analysis or sectoral impact studies. This includes MBIE, Treasury, the Ministry of Foreign Affairs and Trade, the Ministry for Primary Industries and the Ministry for the Environment.

B.2 Our CGE model: TERM-NZ

We use the static version of our regional CGE model, TERM-NZ, so that we compare the economy before and after a policy option is applied. There is no time dimension in the static model, so we do not look at how the economy adjusts to a new equilibrium.[20]

The policy option applied disturbs the equilibrium in the economy, and the model calculates changes in demand, supply and prices of inputs (like labour and capital) then reallocates them across sectors according to where they get greatest returns, establishing a new equilibrium after a policy has been implemented.

[18] Also known as 'input-output studies'.

[19] For an overview of these weaknesses, see the New Zealand Treasury and MBIE. Both documents, and Gretton (2013), clearly state that multipliers over-state economic impacts and thus lack credibility for economic analysis. Or in Treasury's words: "Unless there is significant unemployment of people with the requisite skills, **it is therefore likely that multiplier effects do not exist**".

[20] These fluctuations may have significant impacts in their own right and could be captured in future research by using our more sophisticated, dynamic CGE model.

NZIER's TERM-NZ[21] model is a bottom-up CGE model of the New Zealand economy and its 15 regions. TERM-NZ is based on a Stats NZ's Input-Output table that identifies the structure of the industries involved. It contains information on 106 industries, 201 commodities and 15 regions.

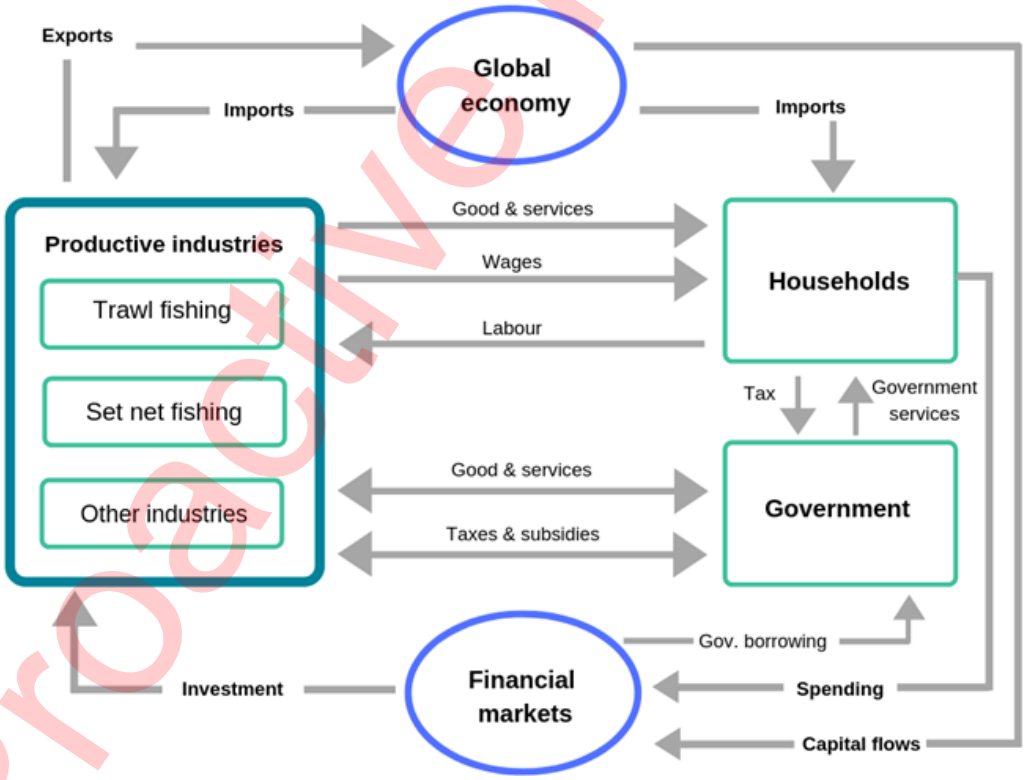
For this study, we have aggregated the model's database to 53 industries and 74 commodities, which include separate sectors for trawl fishing and set net fishing.

TERM-NZ treats New Zealand's regions as separate economies. This means that we are able to account for region-specific inter-linkages between industries, as well as their links to households (via the labour market), local and central government, capital markets, the rest of New Zealand (via inter-regional trade) and the global economy (via imports and exports).

The model shows how the reduced area for trawling and set net fishing might affect the regional and national economies.

A visual representation of our CGE model is shown in Figure 5. It highlights how the model captures the complex and multidirectional flows between the various actors of the national economy and how they interact with the rest of the world. More technical details on the model are available upon request.

Figure 5 Our CGE model represents the circular flows between all the agents and activities in the economy



Source: NZIER

[21] TERM-NZ stands for "The Enormous Regional Model" of the New Zealand economy. It was developed at NZIER based on the original Australian TERM model created by Professor Mark Horridge of the Centre of Policy Studies, Victoria University-Melbourne, Australia. http://www.copsmodels.com/term.htm. NZIER maintains close connections with the Centre, ensuring that our modelling techniques reflect international best-practice.

Key features of the model are:

- Each industry can produce a number of different commodities.
- Production inputs are intermediate commodities (domestic and imported) and primary factors (labour, land and capital).
- The demand for primary factors and the choice between imported and domestic commodities are determined by Constant Elasticity of Substitution (CES) production nests. This means an increase in price of one input shifts sourcing towards another input.
- Intermediate goods, primary factors and other costs are combined using a Leontief production function. This means the proportion of production inputs is held constant for all levels of output.
- The production mix of each industry is dependent on the relative prices of each commodity. The proportion of output exported or consumed domestically is also dependent on relative prices.
- Policy impacts are often unevenly spread across industries and regions. To capture these heterogeneous effects, the model uses a 'bottom-up' approach in which the national impacts are the sum of the regional impacts.

B.3 Tailoring the model's database

The model's database has been sourced initially from Stats NZ's 2013 Input-Output tables. We then updated this data to 2018 levels using Stats NZ's latest national accounts (November 2018).

We have expanded our standard CGE database by separately identifying trawl fishing, set net fishing and other fishing from Stats NZ's initial Input-Output table, which only has an aggregated fishing industry. Other fishing industry includes aquaculture, crustaceans and any other wild fish not caught by set net or trawling fishing. It is calculated as the difference between the original fishing industry and the sum of trawl and set net fishing industries.

To do so, we used catch volumes (greenweight kg) by fish species and corresponding port prices provided by FNZ. We estimated the value of trawled fish at $115 million and set-netted fish at $13 million for 2018. When port prices were missing, we applied the weighted average price (by greenweight) for the corresponding fish species volume. When we had no price using this method, we used the weighted average price across all fish species.

We then used the composition of the fishing industry (from Stats NZ Input-Output table) to build the trawl and set-net fishing industries. We estimated the value of the trawl fishing industry at $331 million and the value of the set net fishing industry at $37 million (Table 22).

Table 22 Composition of the trawl and set net fishing industries

2018, $ millions

Intermediate consumption	Fishing industry*		Trawl fishing	Set net fishing
	Share	$m	$m	$m
Fish	18%	240	115	13
Crustaceans	16%	216	0	0.0
Fishing Services	2%	22	6	1
Fish preparation	47%	615	155	17
Machine & equipment	17%	216	55	6
Commercial property services	1%	1	0.3	0
Research & development	0.1%	2	0.4	0
Total	**100%**	**1312**	**331**	**37**

Note*: Fishing industry composition is based on Stats NZ IO table.

Source: NZIER

We then applied regional revenue shares to split the trawling and set net fishing industries geographically (shown in Table 23). These shares were calculated using fishing revenue by base port. We then mapped the base ports and their corresponding regional councils to calculate the share of fishing revenue attributed to each region.

Table 23 Main base ports for set net and trawl fishing

Shares are based on revenue by base port for 2017/18

Regions	Set net fishing	Trawl fishing
Northland	19.3%	2.1%
Auckland	13.5%	12.7%
Waikato	7.8%	0.4%
Bay of Plenty	1.7%	11.1%
Gisborne	0.0%	2.3%
Hawke's Bay	1.4%	5.8%
Taranaki	5.9%	0.9%
Whanganui-Manawatu	0.0%	0.0%
Wellington	2.5%	0.9%
Tasman	2.5%	1.1%
Marlborough	0.7%	0.9%
West Coast	0.2%	7.1%
Canterbury	17.5%	12.0%
Otago	6.6%	2.2%
Southland	16.0%	3.6%

Source: NZIER, FNZ

B.4 Scenario design and assumptions

To design the scenarios, we made the following assumptions:

- Fishers do not switch fishing method and will either remain or leave the fishing industry.
- The fishing industry is at capacity and therefore fishers are unable to start catching other fish species.
- The loss in fish revenue is attributed to a region by base port. Fishers who will lose revenue do not make it up by fishing more in another region.
- Aquaculture industry is at capacity; therefore, it is unable to expand to meet the fall in quantity of fish produced.
- At the national level, capital is fixed in the short term (see Section B.5 for closures) and cannot move to other industries. However, capital is mobile between industries within each region.

To calculate the size of the policy option impacts for each scenario, we used data provided by FNZ for the three policy options for set net and trawling (6 scenarios in total). This data allowed us to calculate the current fishing revenue earned inside and outside of each of the set net and trawling closures options. From there, we estimated the annual decrease in fishing revenue for each policy option within each regional council area (Table 24).

We then modelled each policy option for set net and trawling. Each policy option disturbs the equilibrium in the economy, and the model calculates changes in demand, supply and prices of inputs (like labour and capital) then reallocates them across sectors according to where they get greatest returns, establishing a new equilibrium after the policy has been implemented.

Table 24 Regional policy options for set net and trawl fishing under TMP

In percentage change

Regions	Set net fishing			Trawl fishing		
	Option 2	Option 3	Option 4	Option 2	Option 3	Option 4
Northland	-4.8%	-8.1%	-66.3%	0.0%	-1.6%	-1.6%
Auckland	0.0%	-3.1%	-58.7%	-1.5%	-11.3%	-18.4%
Taranaki-Waikato	-17.9%	-20.5%	-30.7%	-19.9%	-64.1%	-79.4%
Bay of Plenty	0.0%	0.0%	0.0%	0.0%	-4.1%	-6.6%
Gisborne	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hawke's Bay	-0.3%	-0.3%	-0.3%	0.0%	-0.1%	-0.1%
Whanganui-Manawatu	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wellington	-14.7%	-14.7%	-14.7%	0.0%	-7.1%	-7.0%
Tasman-nelson	-38.9%	-38.9%	-14.2%	-0.2%	-1.6%	-0.2%
Marlborough	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%
West Coast	0.0%	0.0%	0.0%	0.0%	-0.7%	-0.3%
Canterbury	-66.6%	-81.9%	0.0%	-14.2%	-20.5%	0.0%

Regions	Set net fishing			Trawl fishing		
	Option 2	Option 3	Option 4	Option 2	Option 3	Option 4
Otago	-2.8%	-2.8%	0.0%	-15.5%	-18.3%	0.0%
Southland	-2.4%	-4.8%	0.0%	-7.1%	-10.2%	0.0%

Source: NZIER, FNZ

B.5 Closure

Given that a closure in set net and trawl fishing areas has an immediate effect, we assume a short run model closure in which the following assumptions are made:

- National real wage is rigid, and the national employment adjusts.
- Labour is completely mobile between industries and partially mobile across regions.
- The short-run rates of return to capital adjust to maintain fixed national investment However, capital is mobile between industries and regions.
- Regional household consumption follows regional wage income. National household propensity to consume is fixed.
- Foreign currency prices of imports are naturally exogenous.
- Real government consumption is also exogenous.

Results are reported as dollar values and percentage changes from the counterfactual, in which no policy change has occurred.

B.6 Interpreting the results

The CGE technique calculates impacts as changes relative to the baseline level. Results are then reported as percentage changes from the baseline forecast.

In analysing the modelling results we track the impacts as they flow through the economy, beginning with the direct impacts from the closure options on the set net and trawling industries. We then analyse the flow-on or indirect impacts. It can aid understanding to split indirect impacts into the following categories:

- **Supporting industries** – industries that support or supply the trawl and set net fishing industries with intermediate inputs are likely to be negatively affected. Such industries include seafood processing, transports, etc.
- **Household expenditure industries** – industries that households spend money on are likely to be negatively affected from decreased income that comes through employment and wages, and decreased returns to capital from closure under the TMP. Such industries include housing and real estate (which takes a large share of households' budgets), and those for consumption goods like the retail trade.
- **Competing export industries** – industries that benefit from the decrease in trawl and set net fishing industries as they compete for resources.

The national results flow logically from the regional direct and indirect impacts. We focus on key macroeconomic variables such as employment, GDP, exports and household consumption, which we use as a measure of national economic welfare (how 'well off' we are).

Appendix C Additional results from our CGE analysis

C.1 Macroeconomic impacts on the New Zealand economy

Table 25 Macroeconomic impacts from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.002%	-6.2	-0.003%	-7.8	-0.003%	-9.4
Household consumption	-0.002%	-3.1	-0.002%	-3.8	-0.003%	-4.7
Export volumes	-0.005%	-3.5	-0.006%	-4.5	-0.007%	-5.2
National output	-0.002%	-8.5	-0.002%	-10.9	-0.002%	-12.7
Employment	-0.001%	-1.14	-0.001%	-1.5	-0.002%	-1.8

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

Table 26 Macroeconomic impacts from the trawling options

Annual changes from 2018 baseline, in $ millions (real terms)

Variables	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	-0.003%	-7.8	-0.006%	-18.3	-0.004%	-11.1
Household consumption	-0.002%	-3.8	-0.006%	-9.0	-0.003%	-5.5
Export volumes	-0.006%	-4.3	-0.013%	-10.1	-0.008%	-6.2
National output	-0.002%	-9.4	-0.004%	-22.7	-0.003%	-14.5
Employment	-0.001%	-1.2	-0.002%	-2.9	-0.002%	-1.8

1 Each row represents a distinct indicator about the New Zealand economy. These rows are not additive.

2 Figures in percent changes differ at the four-digit level.

Source: NZIER

C.2 Summary of real GDP impacts from the set net and trawling options

Table 27 Real GDP impacts from the set net options

Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
North Island	-0.001%	-2.1	-0.001%	-2.9	-0.004%	-8.3
South Island	-0.006%	-4.1	-0.007%	-4.9	-0.002%	-1.1
New Zealand	-0.002%	-6.2	-0.003%	-7.8	-0.003%	-9.4

1 Figures in percent changes differ at the four-digit level.

2 The sum of figures given in dollar value for the South Island and North Island might not be equal to figures for New Zealand due to rounding.

Source: NZIER

Table 28 Real GDP impacts from the trawling options

Annual changes from 2018 baseline, in $ millions (real terms)

Region	Option 2		Option 3		Option 4	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
North Island	-0.001%	-2.0	-0.004%	-8.3	-0.005%	-9.9
South Island	-0.009%	-5.8	-0.015%	-10.1	-0.002%	-1.3
New Zealand	-0.003%	-7.8	-0.006%	-18.3	-0.004%	-11.1

1 Figures in percent changes differ at the four-digit level.

2 The sum of figures given in dollar value for the South Island and North Island might not be equal to figures for New Zealand due to rounding.

Source: NZIER

Appendix D Forecasting methodology

D.1 Fishing industry GDP

To estimate regional GDPs, we apply a bottom-up approach by first determining GDP at the area unit level then summing up the corresponding area units under each region to get the regional level GDPs.

To estimate GDP, we use two sub models:

- Population simulation.
- Economic growth and labour simulation sub models.

Both sub models use a wide range of inputs such as annual inputs from Stats NZ, and Census data to simulate results at the area unit level.

For population simulation, in addition to input data from Stats NZ, we use a sub model for migration between regions. Outputs for the population model are population (by age and sex), households by type, average age of households, number of people per household, labour force and long-run employment.

Economic and income sub model inputs are regional GDP, national and industry multifactor productivity growth, trend growth in industry GDP, historical covariance between industries in economic activity (using a Vector Auto Regressive (VAR) model), relationship between GDP per capita and household (HH) incomes. Output of the model is:

- GDP by industry and region.
- Household incomes by type and region.

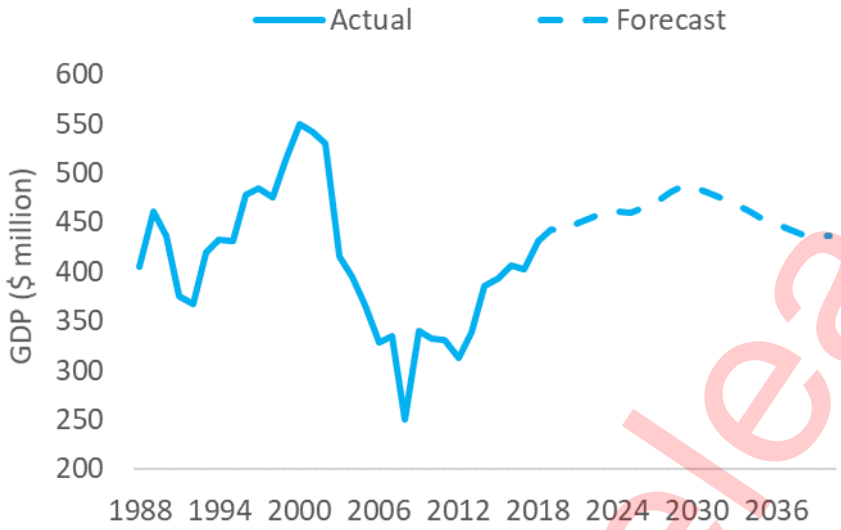
Model forecasts results

NZIER's model forecasts nominal GDP increasing, when we remove the impact of prices and real GDP is forecast to stay steady, this means that volume of fish is forecast to fall. Fishing volumes are likely to be lower in the future because of:

- Higher cost of carbon, which will add cost pressure to many fishing operators.
- Uncertainty of size of the wild fish stock, with the possibility of reduced volumes.
- Changing mix of fish species from wild fish to farmed fish, likely due to consumer preferences around sustainability.

Figure 6 shows forecasted GDP compared to historic trends, our forecasts fit comfortably within the historical volatility since the 1980s.

Figure 6 Forecast fishing GDP



Source: NZIER