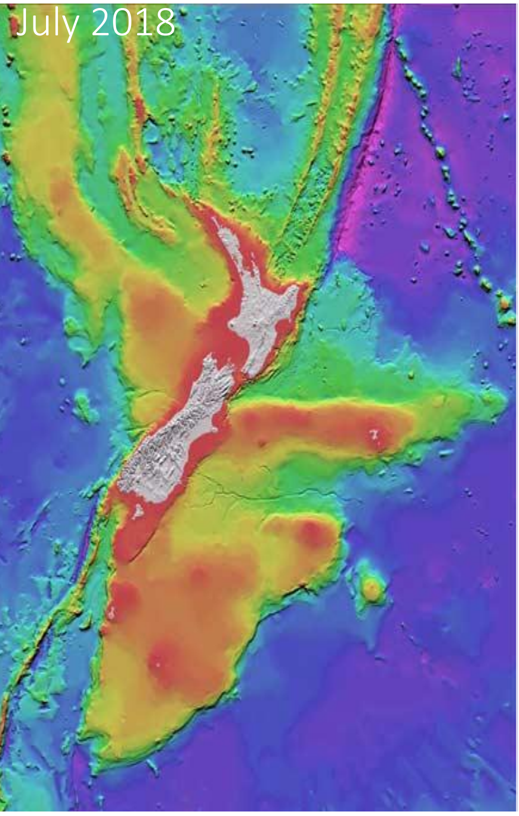
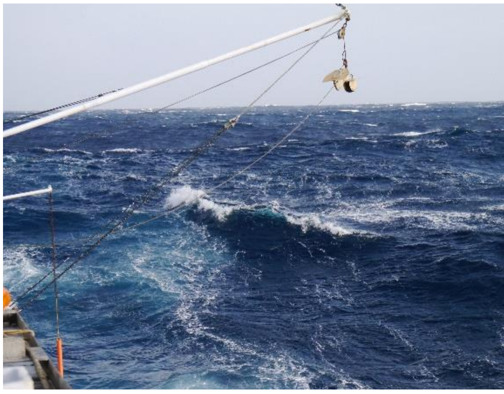
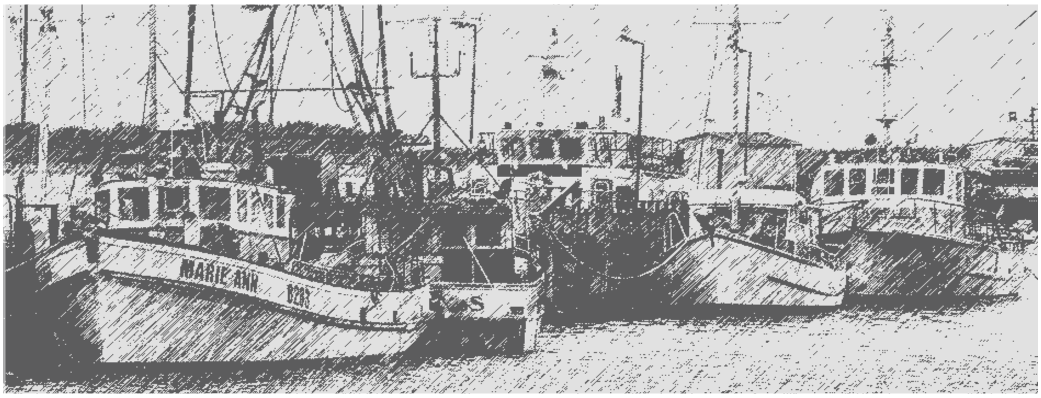
July 2018





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# Ministry for Primary Industries

## Tarakihi Total Allowable Catch Reduction Scenarios

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www.berl.co.nz

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# Making sense of the numbers

The New Zealand east coast stock of tarakihi is below the soft limit (20 percent of Virgin biomass ($B_0$)) as indicated by the 2018 stock assessment (Langley 2018). Consistent with the Ministry for Primary Industries Harvest Strategy Standard and associated Operational Guidelines (HSS), a rebuild strategy is now required to build the tarakihi stock back to target over an appropriate timeframe.

## Rebuild strategies explored through five scenarios

To explore different potential tarakihi rebuild strategies, BERL has, with input from the Ministry for Primary Industries, developed five different rebuild scenarios to project the impact on stock over a 20 year period . The following assumptions were key to the five scenarios:

- That if the tarakihi catch was 10 percent or more of the catch of a targeted species in the 2016-17 base year that species would be affected by the reduction in tarakihi Total Allowable Commercial Catch (TACC).
- That the percentage share of bycatch per species seen in each Fishing Management Area (FMA) in the 2016-17 base year will continue across the 20 year period.
- That for any year across the 20 year period, fishers will catch the maximum allowed amount of tarakihi.
- That for those scenarios which see an end of TACC reduction prior to the 20 year period, that fishers will catch the total of 4,175 tonnes of tarakihi split across the three FMAs.
- That tarakihi TACC reduction only effect fishing in fishing management area (FMAs) one, two and three.

Given the assumptions used in our projections, the largest uncertainty is around the catch volumes, and our assumption that over the 20 year period fishers will catch the maximum allowable amount of tarakihi. Looking at historic tarakihi catches in FMA1, FMA2 and FMA3, tarakihi catch volume can change year to year by up to 10 to 15 percent. BERL assumes that given the value of tarakihi, fishers will catch a similar amount to the TACC each year.

## Scenario five – 20 percent reduction in tarakihi catch - provides smallest relative decline

Out of the five scenarios projected:

- Scenario five (20 percent reduction in tarakihi catch in perpetually) provides the smallest relative decline in assessed metrics over the 20 year period examined.
- This is followed by scenarios one (55 percent reduction in tarakihi catch over 10 years) and scenario two (staggered reduction in tarakihi catch over 10 years), which provide the next smallest relative decline in the assessed metrics over the 20 year period.
- Scenario three (40 percent reduction in tarakihi catch over 15 years) showed a relative performance that measured just behind scenario one and two.
- Scenario four (35 percent reduction in tarakihi catch over 20 years) showed the worst relative performance of the five scenario's.

The benefits of scenario one and two is that they have a defined tarakihi reduction end year that is within the 20 year period examined. The relative impacts of scenario one would surpass scenario five if the time period explored was at least one year longer.

The metrics used to measure the relative impact of each scenario cover the commercial industry through changes in catch and fish revenue, the region's through total GDP and total employment impacts, and the retail sector through potential changes in price for tarakihi.

The relative average annual catch volume and value for each scenario compared to the 2016-17 base year is shown in the following table:

| Scenarios | Average annual catch over 20 years (% of base year) | | Average fish revenue over 20 years (% of base year) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 98.3% | 62.7% | 97.1% | 62.7% |
| Scenario 2 | 98.3% | 62.7% | 97.1% | 62.7% |
| Scenario 3 | 97.7% | 57.9% | 96.0% | 57.9% |
| Scenario 4 | 97.2% | 51.2% | 95.4% | 51.2% |
| Scenario 5 | 98.3% | 63.3% | 97.2% | 63.3% |

Under scenario five the average annual catch and revenue of tarakihi fish remains at 63.3 percent of the base year across the 20 year period. Scenario one, the next best scenario, has an average annual tarakihi catch and revenue of 62.7 percent of the base year across the 20 year period.

The average annual economic impact of the tarakihi catch reduction in terms of total output, total GDP, and total employment for each scenario compared to scenario one is shown in the following table:

| Scenarios | Total Output (%) | Total GDP (%) | Total Employment (%) |
|---|---|---|---|
| Scenario 1 | 0% | 0% | 0% |
| Scenario 2 | 0% | 0% | 0% |
| Scenario 3 | -25% | -24% | -25% |
| Scenario 4 | -60% | -59% | -60% |
| Scenario 5 | 30% | 31% | 30% |

Compared to scenario one, scenario three (around -25 percent) and scenario four (around -60 percent) will all have weaker economic impacts than scenario one, while scenario five will have an economic impact of around 30 percent higher than scenario one, across the 20 year period.

## Across the scenarios the price of tarakihi could potentially increase between 16 and 59 percent

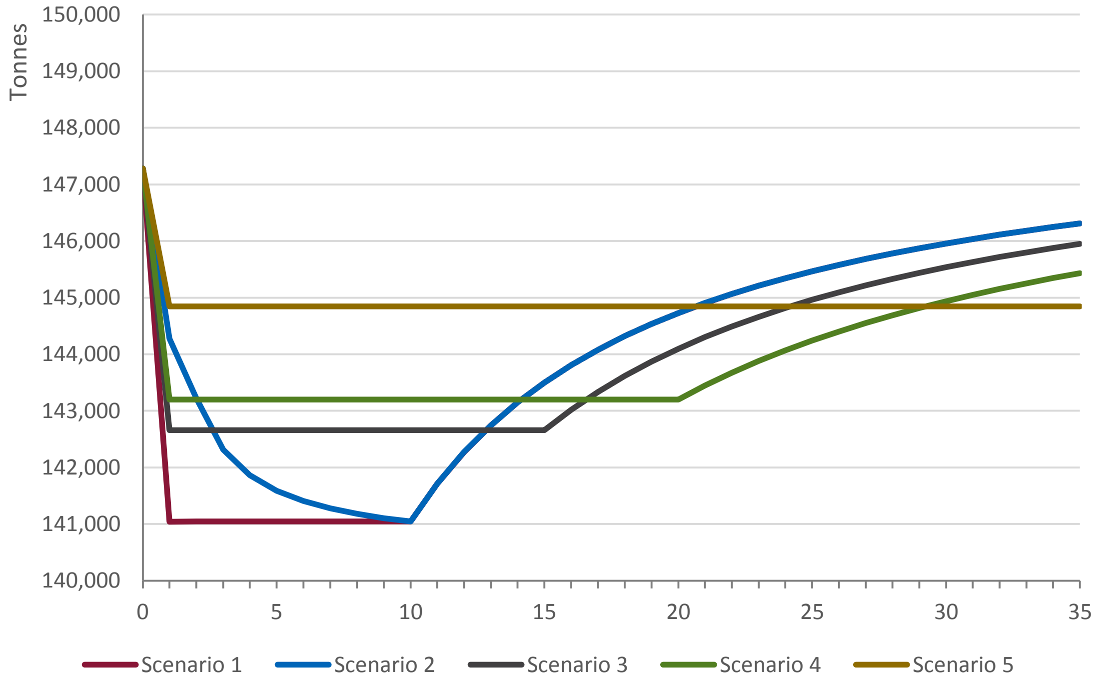
The relative price peak for tarakihi under each scenario compared to the price per kg as at June 2018 in retail shops is shown in the following table:

| Scenarios | Potential peak price of tarakihi |
|---|---|
| Scenario 1 | 39% |
| Scenario 2 | 59% |
| Scenario 3 | 34% |
| Scenario 4 | 30% |
| Scenario 5 | 16% |

Under scenario five there is the potential for 16 percent increase in the retail price in tarakihi, while under scenario two there will be a potential peak increase of 59 percent.

## Extending time period leaves scenario five trailing

The figure below demonstrates that by year 40, scenario one, two, three and four will have higher annual average catches of tarakihi. This is a result of the extended time period when these four scenarios have been able to catch tarakihi at a higher level than scenario five after their reduction and rebuild periods ended. Also as shown in the figure, scenario one and two will surpass scenario five by year 21, while scenario three will surpass scenario five by year 25, and scenario four will surpass scenario five by year 30.




## Stock rebuild taking twice as long could cost up to 2.5 times as much

BERL projected scenario one over a 20 year period rather than its current 10 year period to demonstrate the potential opportunity costs of the tarakihi reduction taking longer than expected to bring the stock back to the target level. The following table shows the relative performance of the longer scenario 1A compared to scenario one:

| Scenarios | Average annual catch over 20 years (% of base year) | | Average fish revenue over 20 years (% of base year) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 100% | 100% | 100% | 100% |
| Scenario 1A | 244% | 182% | 242% | 182% |

The table shows that if the reductions for scenario one was over 20 years rather than 10 years, the reduction would be 2.4 times that of scenario one in average annual total catch and fish revenue, and 1.8 times that of scenario one in average annual tarakihi catch and fish revenue.

# Contents

## Figures

## Tables

# 1 Introduction

The Ministry for Primary Industries is concerned about the sustainability of the east coast New Zealand tarakihi biological stock (which spans the quota management areas TAR 2, TAR 3 and parts of TAR 1 and TAR 7). The Ministry for Primary Industries therefore considers it important that a review of the Total Allowable Catch limits for these quota management areas is undertaken.

When considering adjustments to Total Allowable Catch limits the Minister of Fisheries is required to ensure that the settings are consistent with maintaining, restoring, or moving a stock towards a biomass that is at or above the level that can produce the maximum sustainable yield ($B_{MSY}$). However, there is also significant discretion regarding the manner and rate that this objective is pursued, allowing for the Minister to consider the social, cultural and economic implications of various approaches.

Guidance for the development of the Ministry for Primary Industries advice on what approaches to consider is provided by the Harvest Strategy Standard and associated Operational Guidelines ("the HSS").

For example, the HSS includes advice on the use of a proxy in instances where a robust estimate of $B_{MSY}$ is not available. In the case of tarakihi, a Science Working Group comprising of suitable experts recently applied criteria in the HSS guidelines to recommend a proxy of 40 percent $B_0$[1] be used as a reference point for $B_{MSY}$.

The HSS also guides the setting of a "soft" and "hard" limit. If the stock is below the soft limit, it is considered to be overfished or depleted and a time-constrained rebuild plan is recommended. The HSS specifies that where the probability that a stock is at or below the soft limit is greater than 50 percent, the stock should be rebuilt to the target within a time period between Tmin and 2*Tmin (where Tmin is the theoretical number of years required to rebuild a stock to the target with zero fishing mortality).

If the stock is below the hard limit, it is considered to have collapsed and fisheries may need to be closed to rebuild the stock at the fastest possible rate.

Specifying these reference points is recognised as international best practice and provides a degree of certainty to fishers and other stakeholders about the Ministry for Primary Industries policy position on when and why they propose changes to catch limits, and how they define sustainability for the purposes of the Fisheries Act (1996).

The 2018 stock assessment for the New Zealand east coast stock of tarakihi indicates that the stock is below the soft limit (20 percent $B_0$) (Langley 2018). Consistent with the HSS, a rebuild strategy is required to build the stock to target over an appropriate timeframe.

Tmin has been calculated at five years for a target of 40 percent $B_0$ (and therefore 2*Tmin is 10 years).

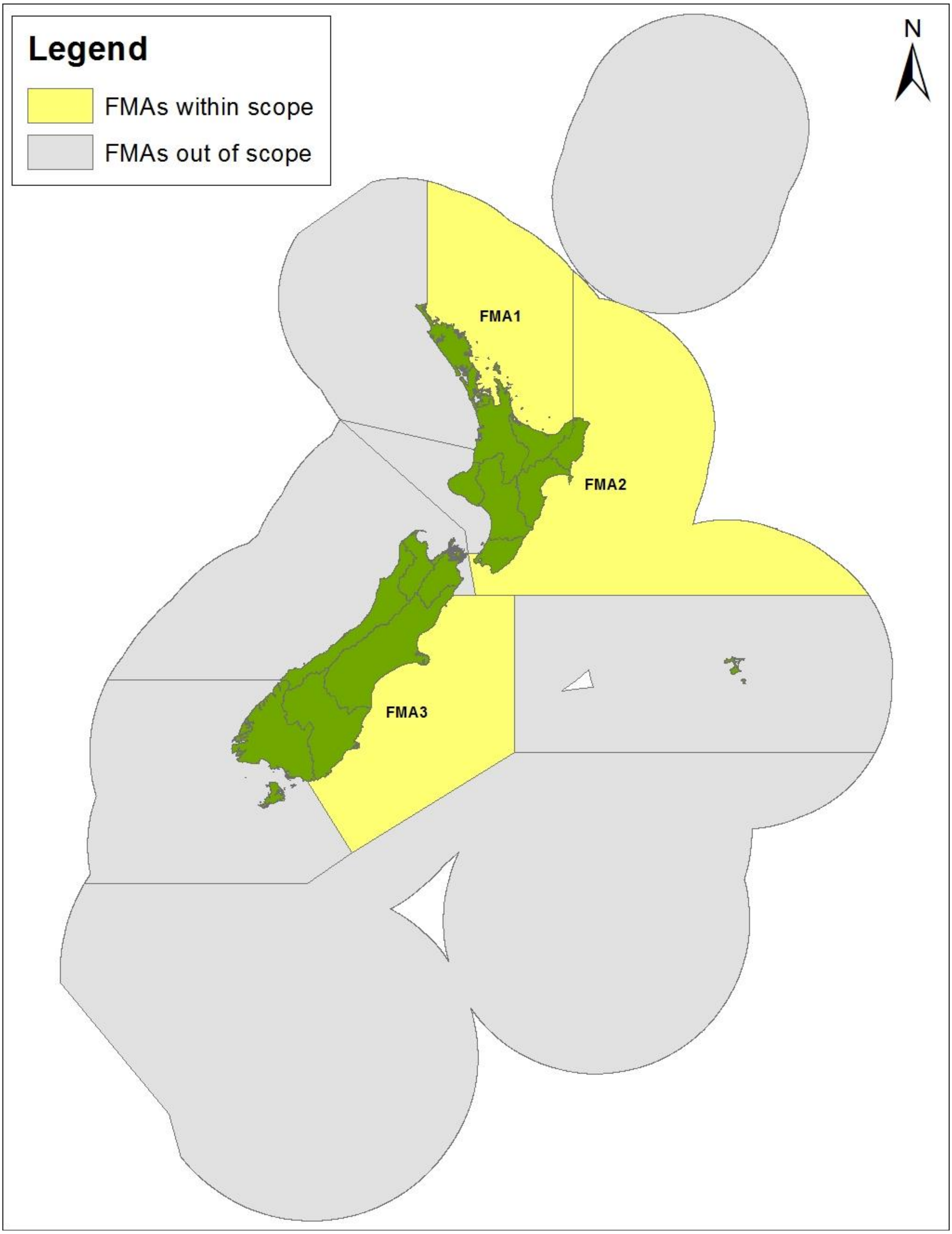
Biomass projections indicate that significant catch reductions across the quota management areas (QMA's) covered by the stock assessment are required to achieve stock recovery within this timeframe (i.e. 60 percent reductions to achieve 2*Tmin).

Tarakihi is primarily caught for commercial sale (primarily domestic market) and is one of a limited number of inshore finfish species that holds considerable value (BERL 2018). The Ministry for Primary Industries has commissioned BERL to model and analyse five scenarios with varied impacts on tarakihi and other fisheries. This is because tarakihi is taken as target and bycatch, it is not only the direct impact of tarakihi harvest reductions that is required to be assessed but also consideration of the value lost/increased costs to harvest other species taken in association with tarakihi; noting the availability of tarakihi annual catch entitlements (ACE) might become a limiting factor.

[1] $B_0$ stands for virgin biomass

BERL's analysis will cover the change in fish catch volumes and fish revenue. In addition our analysis will cover the impact of changes in these two variables on the fishers who catch tarakihi in targeted fishing management areas (FMA1, FMA2 and FMA3) as shown in Figure 1.1; the impact on quota holders who use or sell their ACE; the impact on the six identified key fisheries within the area covered by the assessment, which are the Canterbury Bight trawl, Kaikoura setnet, Cook Strait (East) trawl, Hawke's Bay trawl, Bay of Plenty trawl, East Northland trawl (Langley 2017); and the impact on the regions who benefit from the catch with the assessment area, in terms of GDP and employment.

Figure 1.1 Fishing Management Areas (FMAs) within project scope



# 2 Scenario overview

BERL has developed five scenarios. In this section the scenarios are described. For all five scenarios there is a reduction in the Total Allowable Commercial Catch (TACC) for tarakihi (TAR) compared to the 2016-17 base year, in Fishing Management Areas (FMA) one, two and three. All five scenarios have been run over a 20 year period to enable an examination of both short-term and longer-term impacts.

## 2.1 Scenario one

Scenario one is focussed on rebuilding the tarakihi stock to a target of 40 percent of optimal biomass over 10 years with at least 50 percent probability of being at or above the target. For this scenario this target will be met by a 55 percent reduction in total tarakihi catch over a period of 10 years, with reductions in both commercial and recreation catch. To model the reduction in commercial catch, BERL have used a reduction in TACC in FMA1 to 330 tonnes, in FMA2 to 735 tonnes, and in FMA3 to 579 tonnes, for the 2018-19 fishing year.

This reduction in TACC will occur in year one (2018-19 fishing year) and will last until year 10 (2027-28 fishing year) is reached, after which the TACC in the three FMAs will move to 4,175 tonnes per annum. This total comes from table 13 on page 1575 of volume three of the Fisheries New Zealand May 2018 Fishers Assessment Plenary.[2]

## 2.2 Scenario two

Scenario two is also focussed on rebuilding the tarakihi stock to a target of 40 percent of optimal biomass over 10 years with at least 50 percent probability of being at or above the target. But for this scenario the reduction in tarakihi catch across both commercial and recreational catches, will occur across a three year period, rather than a single year as seen in scenario one.

To model the reduction in commercial catch, BERL have used a reduction in TACC in FMA1 to 555 tonnes, in FMA2 to 1,225 tonnes, and in FMA3 to 965 tonnes, for the 2018-19 fishing year. This will be followed by a reduction in TACC in FMA1 to 410 tonnes, in FMA2 to 906 tonnes, and in FMA3 to 714 tonnes, for the 2019-20 fishing year, and then finally there will be a reduction in TACC in FMA1 to 296 tonnes, in FMA2 to 652 tonnes, and in FMA3 to 514 tonnes, for the 2020-21 fishing year.

This reduction in TACC will occur over three years and last until year 10 (2027-28 fishing year) is reached, after which the TACC in the three FMAs will move to 4,175 tonnes per annum. This total comes from table 13 on page 1575 of volume three of the Fisheries New Zealand May 2018 Fishers Assessment Plenary.

## 2.3 Scenario three

Scenario three is focussed on rebuilding the tarakihi stock to a target of 40 percent of optimal biomass over 15 years with at least 50 percent probability of being at or above the target. For this scenario this target will be met by a 40 percent reduction in total tarakihi catch over a period of 15 years, with reductions in both commercial and recreation catch. To model the reduction in commercial catch, BERL have used a reduction in TACC in FMA1 to 444 tonnes, in FMA2 to 980 tonnes, and in FMA3 to 772 tonnes, for the 2018-19 fishing year.

This reduction in TACC will occur in year one (2018-19 fishing year) and will last until year 15 (2032-33 fishing year) is reached, after which the TACC in the three FMAs will move to 4,175 tonnes per annum. This total comes from table 13 on page 1575 of volume three of the Fisheries New Zealand May 2018 Fishers Assessment Plenary.

[2] Ministry for Primary Industries (2018) May Plenary 2018 – Volume 3. Accessed at https://fs.fish.govt.nz/Page.aspx?pk=61&tk=212

## 2.4 Scenario four

Scenario four is focussed on rebuilding the tarakihi stock to a target of 40 percent of optimal biomass over 20 years with at least 50 percent probability of being at or above the target. For this scenario this target will be met by a 35 percent reduction in total tarakihi catch over a period of 20 years, with reductions in both commercial and recreation catch. To model the reduction in commercial catch, BERL have used a reduction in TACC in FMA1 to 481 tonnes, in FMA2 to 1,061 tonnes, and in FMA3 to 837 tonnes, for the 2018-19 fishing year.

This reduction in TACC will occur in year one (2018-19 fishing year) and will last until year 20 (2037-38 fishing year) is reached. As each scenario is run for a 20 year period, this scenario will not see an increase in the TACC for tarakihi in any of the three FMAs.

## 2.5 Scenario five

Scenario five is focussed on reducing the total tarakihi catch in FMA1, FMA2, and FMA3 by 20 percent, with this reduction occurring across both commercial and recreation catches. To model the reduction in commercial catch, BERL have used a reduction in TACC in FMA1 to 592 tonnes, in FMA2 to 1,306 tonnes, and in FMA3 to 1,040 tonnes, for the 2018-19 fishing year.

This reduction in TACC will occur in year one (2018-19 fishing year). As each scenario is run for a 20 year period, this scenario will not see an increase in the TACC for tarakihi in any of the three FMAs within the run period of the model.

## 2.6 Summary of scenarios

Table 2.1 shows the reduction in tarakihi TACC across the three FMAs that have been modelled for each scenario, as well as the length of time the reduction will continue for. For the three scenarios where the reduction in TACC finishes prior to the end of the 20 year period, the table shows the tarakihi TACC levels across the three FMAs that these scenarios will use for the remaining period.

Table 2.1 Scenario summary

| Fishing years | | Scenario 1 (tonnes) | | | Scenario 2 (tonnes) | | | Scenario 3 (tonnes) | | | Scenario 4 (tonnes) | | | Scenario 5 (tonnes) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FMA1 | FMA2 | FMA3 | FMA1 | FMA2 | FMA3 | FMA1 | FMA2 | FMA3 | FMA1 | FMA2 | FMA3 | FMA1 | FMA2 | FMA3 |
| 2016/17 | Base year | 757 | 1,967 | 1,287 | 757 | 1,967 | 1,287 | 757 | 1,967 | 1,287 | 757 | 1,967 | 1,287 | 757 | 1,967 | 1,287 |
| 2018/19 | 1 | 333 | 735 | 579 | 555 | 1,225 | 965 | 444 | 980 | 772 | 481 | 1,061 | 937 | 592 | 1,306 | 1,040 |
| 2019/20 | 2 | " | " | " | 410 | 906 | 714 | " | " | " | " | " | " | " | " | " |
| 2020/21 | 3 | " | " | " | 296 | 652 | 514 | " | " | " | " | " | " | " | " | " |
| 2021/22 | 4 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2022/23 | 5 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2023/24 | 6 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2024/25 | 7 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2025/26 | 8 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2026/27 | 9 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2027/28 | 10 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2028/29 | 11 | 798 | 2,061 | 1,316 | 798 | 2,061 | 1,316 | " | " | " | " | " | " | " | " | " |
| 2029/30 | 12 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2030/31 | 13 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2031/32 | 14 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2032/33 | 15 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2033/34 | 16 | " | " | " | " | " | " | 798 | 2,061 | 1,316 | " | " | " | " | " | " |
| 2034/35 | 17 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2035/36 | 18 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2036/37 | 19 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |
| 2037/38 | 20 | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " |

# 3 Methodology

In this section, the methodology for the model used to run each scenario is detailed. The method followed to calculate projected volumes, values, changes to ACE, changes to the retail market, and the regional economic impact of each scenario is detailed separately. In addition BERL has detailed the assumptions that have been used in the construction of the model.

## 3.1 Assumptions

In the construction of the scenario model the following assumptions were used:

- That fishing outside FMA1, FMA2 and FMA3 would be unaffected by the reduction in tarakihi TACC, and no change in volume would occur.
- That fishing of fishing species within FMA1, FMA2 and FMA3 that did not result in any tarahiki being caught in the 2016-17 base year would be unaffected by the reduction in tarakihi TACC, and no change in the volume of catch would occur for these fish species.
- That the price any fish species caught by a fisher in FMA1, FMA2, or FMA3 would not change across the 20 year time period. This assumption has been made to ensure that all values are in current dollar, and therefore enable values calculated in future years to be compared to earlier values.
- That for any year in which there is a reduction in tarakihi TACC, fishers will catch the maximum allowed amount of tarakihi.
- That for those scenarios which see an end of TACC reduction prior to the end of the 20 year period, that fishers will catch the total of 4,175 tonnes of tarakihi split across the three FMAs. This total of 4,175 tonnes comes from table 13 on page 1575 of volume three of the Fisheries New Zealand May 2018 Fishers Assessment Plenary, and is the estimated total of tarakihi yield once target stock numbers have been reached.[3] For FMA1 this is 798 tonnes, for FMA3 this is 1,316 tonnes, while for FMA2 this is 2,061 tonnes.
- That if the tarakihi catch was 10 percent or more of the catch of a targeted species in the 2016-17 base year, in each FMA, the targeted species catch in future years would be affected by the reduction in tarakihi catch. For example in FMA1 in 2016-17 fishing year fishers targeting red snapper caught 13 tonnes of red snapper, as a bycatch of this fishing 4 tonnes of tarakihi was caught by the fishers. This means that tarakihi represents more than 10 percent of the volume of red snapper when fishers target red snapper, and therefore the red snapper catch in FMA1, in future years will be affected by the reduction in tarakihi.
- That the method of fishing in each FMA seen in the 2016-17 base year will continue across the 20 year period. This is that the percentage share of fish caught by different fishing methods will remain constant. For example in FMA2 98 percent of barracouta was caught in 2016-17 using Bottom Trawl (BT), under this assumption 98 percent of barracouta in FMA2 will be caught using Bottom Trawl for each of the 20 projected years going forward.
- That the pattern of fishing in each FMA seen in the 2016-17 base year will continue across the 20 year period. That is the percentage share of fish caught when targeting a particular fish in an FMA will hold constant. For example in FMA3 112.5 tonnes of gurnard was caught in 2016-17, at the same time the fishers targeting gurnard also caught 28 tonnes of elephant fish, therefore under this assumption for every 10 tonnes of gurnard caught by fishers targeting gurnard, 2.5 tonnes of elephant fish will also be caught.

[3] Ministry for Primary Industries (2018) May Plenary 2018 – Volume 3. Accessed at https://fs.fish.govt.nz/Page.aspx?pk=61&tk=212

- That tarakihi will no longer be exported once the TACC is reduced and therefore all tarakihi caught will be allocated for consumption within the domestic market.
- That there will be no change in the domestic retail price for gurnard and trevally despite extra demand. This is based on the assumptions that there was in 2016-17 1.7 thousand tonnes of gurnard TACC unfished, along with 0.4 thousand tonnes of trevally. In addition it was assumed that the extra demand for gurnard and trevally occurring in the domestic market could be supplied out of the volume of fish currently being exported, of which around 10 percent of gurnard is exported and around 60 percent of trevally is exported.
- That there was zero waste throughout the New Zealand supply chain for tarakihi. This enables BERL to multiple the catch volume of tarakihi by the retail prices and estimate the highest possible value for total domestic consumer spend of tarakihi.
- That in determining total full-time equivalent (FTE) counts for the fishing industry within each region (Northland, Auckland, Bay of Plenty, Hawke's Bay-Gisborne, Wellington, Canterbury, and Otago), BERL have assumed that people working full-time count as 1 FTE and those working part-time count as 0.33 FTE.
- In using a standard multiplier analysis which is only a "partial equilibrium" analysis, BERL have assessed the direct and indirect effects of a change in revenue being considered. This has been done though without analysing the effects of the resources used on the wider national and regional economy, using regional multiplier table produced by Geoff Butcher from Butcher and Associates. In particular, this standard approach assumes that the supply of capital, productive inputs and labour can expand to meet the additional demand called forth by the initial injection and the flow on multiplier effects, without leading to resource constraints in other industries. These constraints would lead to price rises and resulting changes in overall patterns of production between industries.
- That for BERL's analysis of an extended 40 year time period, that the total tarakihi catch for scenarios one, two, three and four will remain at 4,175 tonnes of tarakihi from the end of their reduction period to the end of the 40 year period. At the same time for scenario five the total tarakihi catch will remain at 2,938 tonnes from year one to year 40.

## 3.2 Projecting catch volumes

In order to project the catch volumes for each individual fish species across the 20 year period, for each scenario, BERL undertook the following steps:

1) The Ministry for Primary Industries provided a fish catch dataset that contained the green weight catch volume for each fish species, along with the fish species being targeted, the FMA and statistical area the fish were caught in, for the time period running from October 2015 to September 2017 (the 2015-16 and 2016-17 fishing years). This fish catch dataset had been limited to catch in FMA1, FMA2 and FMA3, and to reported fish catch where tarakihi was reported to be caught as part of the catch, either as the targeted species or as bycatch. Throughout this report this catch volume is referred to as total catch volume.
2) The dataset was split into the FMAs and then for each FMA a matrix was constructed which reported the volume of fish caught in the 2016-17 base year by each fish species, by the fish species being targeted. This matrix provides the co-efficient for the amount of each fish species caught when a particular fish species was targeted.
3) For each targeted species the volume of tarakihi caught was determined and percentage share of tarakihi compared to the targeted fish was calculated for the base year, for each FMA. If the percentage share of tarakihi was 10 percent or higher compared to the targeted species, then the targeted species was deemed to be affected by the tarakihi reduction.

4) Then for each scenario for each of the 20 projected years, and for each FMA, the reduced catch of tarakihi was calculated.

5) For all targeted fish species where the tarakihi catch was less than 10 percent, the volume of tarakihi caught in each projected year will remain constant. Then the remaining volume of tarakihi in each FMA was assigned to the affected target species based the volume of tarakihi caught in the 2016-17 base year. This process establishes under each scenario for each of the 20 years for each FMA, the new volume of tarakihi catch for each of the targeted species of fish.

6) Using the co-efficient from the matrix setup in step two, BERL was able to calculate for each FMA and each year across the 20 year period the new volume of the targeted fish affected by the tarakihi reduction that will be caught. For example it was established that tarakihi catch (3.3 tonnes) was around 56 percent of the red cod catch (5.9 tonnes) in FMA2 in the base year. Therefore as an affected fishing species it was calculated under scenario one that the red cod fishery could only catch 1.3 tonnes of tarakihi as bycatch in year one and therefore the red cod catch would be reduced to 2.3 tonnes as a result in year one.

7) Continuing the use of the co-efficient from the matrix, BERL was able to calculate the change in volume for all fish species across the three FMAs from any changes in the amount of the targeted species caught.

8) This process provided BERL with the total catch volumes for each fish species, for each scenario, for each year of the 20 year period, across each of the three FMAs. This enabled BERL to determine for each scenario what the total catch volumes would be across the 20 year period, as detailed in section 4 of this report.

## 3.3 Projecting changes to annual catch entitlements (ACE)

In order to determine how the change in projected fish catch volumes would affect quota holders and fishers, BERL needed to determine the change in annual catch entitlements (ACE) that would result from the change in fish volumes.

In order to do this BERL undertook the following steps:

1) Using ACE transactions provided by the Ministry for Primary Industries for the 2016-17 year, BERL calculated the total amount of ACE allocation for each individual fish species in each FMA.

2) Using the change in fish catch volumes by species for each year under each scenario, BERL calculated the reduction in ACE for each species within each FMA. For example in FMA3 it was determined under scenario one that bluenose would see a reduction of 409 kgs of fish catch in year one, therefore the total ACE held in FMA for bluenose in year one would be reduced by the same amount. If there was no reduction in a fish species catch, then there was no reduction in ACE for that species.

3) The change in projected ACE under each scenario was then split across each ACE client using the amount of ACE held by each client as a percentage of total ACE allocated to that species within that FMA. This projected change in ACE for each ACE client was then used to determine the change in revenue for each fisher profile, and to determine the change in volume of ACE allocated to quota holders, as detailed below.

## 3.4 Projecting fish revenue

At this point the BERL model could determine the total catch by fish species, by year and FMA for each of the five scenarios. But to determine how the change in the volume of fish catches would affect the fisher revenue, and how the change in volume of fish catches would affect the regional economies, BERL needed to translate the fish catch volumes into revenue.

In order to do this BERL undertook the following steps:

1) The Ministry for Primary Industries provided BERL with the 2016-17 port prices for each fish species. The port price is obtained via a survey of licenced fish receivers and is the average price per kg paid by licenced fish receiver for that specific fish species.

2) Earlier work for Fisheries Inshore New Zealand (FINZ) BERL (2017)[4] had calculated a new price per kg for each fish species that took into account the export price of fish for any fish species that exported more than 10 percent of total fish catch volumes, and took into account the industries reported revenue for 2015-16 as reported by Statistics New Zealand. For this earlier report, the export volume for each fish species was determined, and for any fish species with over 10 percent of fish volume being exported, the export price per kg was assigned to it. For those fish species with less than 10 percent being exported the 2015-16 port price per kg was assigned to it. Then the volume of each fish species caught in the 2015-16 year was multiplied by its assigned price. This total revenue of all fish caught in New Zealand in the 2015-16 year was measured against the reported fishing industry revenue for 2015-16, and then each fish price was adjusted by the same amount to eliminate any difference in the two revenue figures.

3) For this project BERL compared the fish price per kg from its earlier work to the 2016-17 port prices provided by the Ministry for Primary Industries and used the higher of the two prices per kg, as the price for each fish species. The final price per kg used for each fish species for this project is reported in appendix A of this report.

4) For each projected year the fish price per kg was held constant to ensure that all reported revenue numbers would be in current dollar terms.

5) By multiplying our projected fish volumes for each scenario, by the price per kg for each fish species, BERL could determine the change in revenue resulting from the change in fish catch volumes.

6) Using ACE transactions provided by the Ministry for Primary Industries for the 2016-17 year, BERL was able to analyse the ACE packages held by fishers and determined for each FMA five different profiles of fishers based the percentage of tarakihi ACE they held, and the total volume of ACE they held. These profiles were:

    a. Over 30 for those fishers who held at least 30 percent tarakihi ACE as part of their total ACE package.

    b. 15 to 30 for those fishers who held between 15 and 30 percent tarakihi ACE as part of their total ACE package.

    c. 5 to 15 for those fishers who held between 5 and 15 percent tarakihi ACE as part of their total ACE package.

    d. Under 5 high volume for those fishers who held less than 5 percent tarakihi ACE as part of their total ACE package, and held at least 100 tonnes of ACE.

    e. Under 5 low volume for those fishers who held less than 5 percent tarakihi ACE as part of their total ACE package, and held less than 100 tonnes of ACE.

7) Using the projected change in ACE held by each ACE client and assuming that all ACE held represented fish actually caught, BERL were able to determine the total amount of fish caught by individual species by fishers within each profile.

[4] BERL (2017). *The economic contribution of commercial fishing to the New Zealand economy.*

8) By then multiplying the fish catch volumes for each individual fish species by our price per kg, BERL were able to calculate for each fisher profile the revenue amount for each year and each FMA, under each scenario. The results of this calculation for each scenario can be seen in section 5 of this report.

## 3.5 Projecting catch volumes by fishing method

BERL at this point had a model that for each scenario could determine the total catch by fish species, by year and FMA. But to determine how the change in fishing catch volumes would affect different fishing sectors, BERL needed to be able to split the projected catch volumes by fishing method.

In order to do this BERL undertook the following steps:

1) For each fish species in the Ministry for Primary Industries dataset provided, the volume of fish caught in the 2016-17 base year by each fishing method was calculated. This calculation provided the share for each fish species caught by each fishing method.
2) Assuming that the fishing method used to catch each fish species would not change over the 20 year period, BERL multiplied the projected catch volumes for each fish species, for each year, within each FMA, by the percentage share of catch for each fishing method.
3) This resulted in a projected catch volume for each fishing method, within each FMA, across each year of the 20 year period, for each scenario. The results of this calculation for each scenario can be seen in section 6 of this report.

## 3.6 Projecting changes to the retail market

To determine how the reduction in the tarakihi TACC could potentially affect the New Zealand retail market, BERL ran three retail models for each of the five scenarios to determine the possible impacts on the price of tarakihi and the volume of demand on close substitutes gurnard and trevally. We assume that there is low substitutability of other non-fish products for fish, if fish supply is reduced. The three retail models are as follows:

- Retail model one is one in which tarakihi consumers continue to spend the same total amount on tarakihi, and will not substitute away from tarakihi to another fish.
- Retail model two is one in which tarakihi consumers continue to spend the same total amount on fish, but will substitute away from tarakihi once the price has increased to a substantial degree (halfway between current average price and the price determined in retail scenario one).
- Retail model three is one in which tarakihi consumers continue to spend the same total amount on fish, but will substitute away from tarakihi once the price has increased by more than five percent.

Overall these three retail models represent three possible reactions to the reduced amount of tarakihi available in the New Zealand domestic market once TACC reduction commence. These three possible reactions are associated with different demand elasticities to price changes where:

- Demand will continue for tarakihi with no substitution (low elasticity), so price increases until all tarakihi is sold.
- Demand will continue until price has increased substantially (medium elasticity) and consumers will substitute to the nearest priced fish alternative.
- Demand will cease when prices rise by more than five percent and consumers will substitute to the nearest priced fish alternative.

In order to determine the outcomes of each of the three retail models, BERL undertook the following steps:

1) Collected retail prices from supermarkets and fishmongers located within Wellington City for gurnard, trevally and tarakihi in June 2018.
2) Arranged for the Ministry for Primary Industries to collect retail prices from supermarkets and fishmongers located within Auckland, for gurnard, trevally and tarakihi in June 2018.
3) Utilising the retail prices collected in Wellington and Auckland, BERL determined an average retail price for June 2018 for tarakihi, gurnard and trevally.
4) Utilising the total tarakihi catch volume for New Zealand in 2016-17, the volume of tarakihi exported, and the average retail price, BERL calculated the total domestic consumer spend on tarakihi at $191 million. In calculating this total domestic consumer spend, BERL have assumed zero waste throughout the supply chain. Therefore the calculated total domestic consumer spend is the maximum possible given the volume of tarakihi.
5) For retail model one, BERL divided the total domestic consumer spend on tarakihi by the new volume of tarakihi for each scenario, to determine the new price equilibrium for tarakihi given the reduction in volume.
6) For retail model two, BERL determined the average price between the June 2018 retail prices and the new equilibrium price calculated in retail model one for each scenario. This average price was multiplied by the new volume of tarakihi for each scenario to determine the total consumer spend on tarakihi. This spend was subtracted from the $191 million previously calculated. The remaining spend was then divided into two, and then each half was divided by the current retail price for gurnard and trevally. This enabled us to determine the extra demand for these two fish species resulting from consumer substitution away from tarakihi once the price had risen substantially. BERL have assumed that the retail price of gurnard and trevally will not be altered by the change in demand for these fish species, as additional fish could be caught to feed the demand or fish could be moved from the export market to the domestic market to fill the gap.
7) For retail model three, BERL increased the June 2018 retail price for tarakihi by a five percent margin and then multiplied this marginal price by the new volume of tarakihi for each scenario to determine the total consumer spend on tarakihi. This spend was subtracted from the $191 million previously calculated. The remaining spend was then divided into two and then each half was divided by the current retail price for gurnard and trevally to determine the extra demand for these two fish species resulting from consumer substitution away from tarakihi once the price had risen marginally.

## 3.7 Determining the economic impact of changes

Overall the three FMA used in this project cover a substantial portion of New Zealand as they run down the east coast of New Zealand from Cape Reinga in the North to Catlins on the border between Southland Region and Otago Region. To determine the economic impact the change in tarakihi TACC will have, BERL have split the catch across the three FMAs into the eight different regions that border the three FMAs, as shown in the map in Figure 3.1.

BERL have then used a standard multiplier approach to show the total GDP and total employment impacts generated from change in revenue occurring in the fishing industry. This standard multiplier approach is relatively straightforward. An initial expenditure (**direct impact**) in an industry creates flows of expenditures that are magnified, or "multiplied", as they flow through to the wider economy. This occurs in two ways:

- The industry purchases materials and services from supplier firms, who in turn make further purchases from their suppliers. This generates an **indirect impact**.

- People employed in the direct development and in firms supplying services earn income (mostly from wages and salaries, but also from profits) which, after tax is deducted, is spent on consumption. There is also an allowance for some savings. These are the **induced impact**.

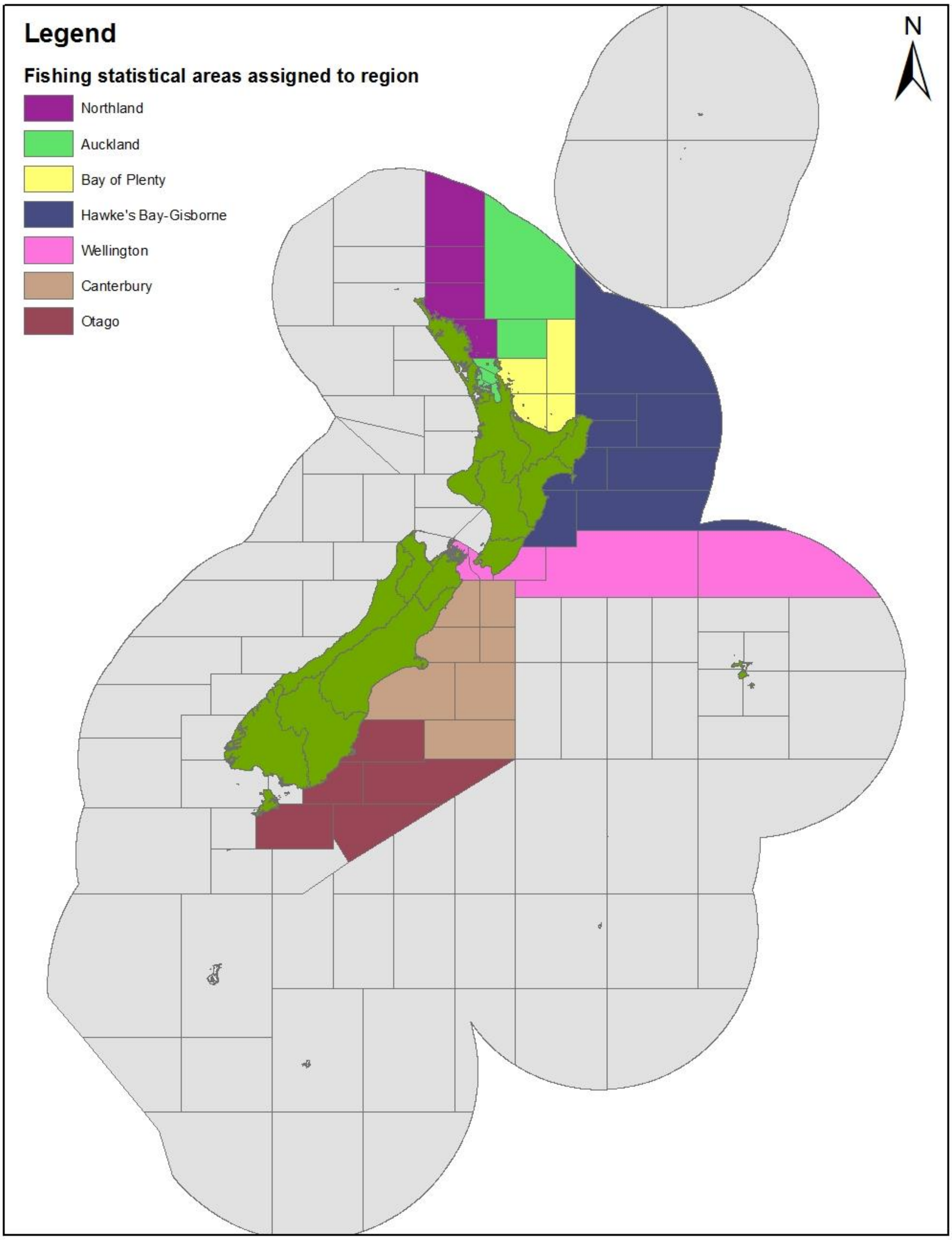
Hence, for any amount spent in an area (direct effect), the actual output generated from that spend is greater once the flow on activity (indirect and induced effects) is taken into account.

To determine the economic impact on each of the affected regions in terms of GDP ($millions) and employment (FTEs)[5], BERL undertook the following steps:

1) Assigned each statistical area within each FMA to a particular region as shown in Figure 3.1.
2) Calculated for each fish species the total catch volume in the 2016-17 base year for each region.
3) Calculate for each fish species the change in total catch volume in each FMA, for each year and scenario, and pro rata the changed volume across each region based on its share of the total catch of that fish in the FMA.
4) Multiply the fish volumes for each region by the assigned price for each fish species to determine the revenue for each region for each year.
5) For each scenario determine the change in revenue for each scenario and each projected year compared to the 2016-17 base year.
6) Using 106 industry input-output multiplier tables for each region provided by leading New Zealand input-output table expert Geoff Butcher from Butcher and Associates, BERL determined the annual change in GDP and employment generated by the change in revenue to the fishing industry for each region. For this calculation BERL used the multiplier industry fishing and aquaculture.
7) The results of these calculations are detailed in section 9 of this report.

[5] 1 full-time equivalent (FTE) is equal to one person working for 30 hours a week for the entire year.

Figure 3.1 Regional allocation of fishing statistical areas



## 3.8 Projecting change on quota holders

To determine the projected change for quota holders from the reduction in the tarakihi TACC, BERL used the calculated change per year in the amount of ACE required to cover the total catch associated with tarakihi in FMA1, FMA2 and FMA3, as detailed in section 3.3, along with the Ministry for Primary Industries supplied ACE transactions dataset. With these two datasets BERL were able to calculate the projected change in required ACE to cover total catch for each of the five scenarios, and therefore the effective changes to amount ACE quota holders can use or sell in the 20 year period.

To determine the change in ACE required and the effective impact on quota holders, BERL undertook the following steps:

1) From the Ministry for Primary Industries ACE transactions dataset, BERL determined the total ACE allocated to each quota holders at the start of the 2016-17 fishing year, by individual fish species.
2) For each individual quota holder, BERL determined their share of total ACE for each fish species.
3) For each year across the 20 year period, BERL used the calculated change in each fish species ACE for each scenario and subtracted that from total ACE provided to the quota holders in the 2016-17 base year.
4) BERL multiplied the new total of ACE for each fish species by each individual quota holder's share of total ACE for that fish species to determine the change in each year for each individual quota holder.
5) BERL then summed together the quota holders ACE for each individual fish species for each year, over the 20 year period.
6) Using this information BERL could determine the ACE holding of quota holders in TAR1, TAR2, TAR3 and total ACE, for the base year and two other snapshot years, year three and year 20.
7) BERL, as detailed in section 8, was then able for each scenario to examine the change in ACE across the snapshot years, and show in year three the array of impacts on individual quota holders.

# 4 Change in projected catch volumes

In this section BERL examines the change in projected catch volumes across the 20 year period for the five scenarios undertaken. BERL examines the change in not only tarakihi catch which will be reduced following the TACC reduction implemented in each scenario, but the wider impact on catch volumes from a reduction in fishing for species where tarakihi is a major bycatch.

The main findings of our analysis of catch volumes across the five scenarios is as follows:

- Scenario five sees the smallest average reduction across all FMAs in total catch across the 20 year period, with a reduction of 2.43 thousand tonnes (Table 4.1).
- Scenario five sees the smallest average reduction across all FMAs in tarakihi catch across the 20 year period, with a reduction of 1.71 thousand tonne (Table 4.1).
- Scenario four sees the largest average reduction across all FMAs in tarakihi catch across the 20 year period, with a reduction of 2.27 thousand tonne (Table 4.1).
- FMA2 will see the largest reduction in annual average catch volume with an average annual loss of 1.48 thousand tonne across all scenarios (Table 4.3), this is on the back of FMA2 having the largest annual average loss of tarakihi catch across all scenarios, with an average annual loss of around 700 tonnes (Table 4.3).
- For scenario **one** there is projected to be a decline of 1.73 thousand tonnes in average annual tarakihi catch (Table 4.1), and a decline of 2.55 thousand tonnes in the total average annual catch (Table 4.1). This decline in total annual average catch will come from a drop in FMA1 of 0.55 thousand tonnes (Table 4.2), in FMA2 of 1.16 thousand tonnes (Table 4.3), and in FMA3 of 0.84 thousand tonnes.
- For scenario **two** there is projected to be a decline of 1.73 thousand tonnes in average annual tarakihi catch (Table 4.1), and a decline of 2.55 thousand tonnes in the total average annual catch (Table 4.1). This decline in total annual average catch will come from a drop in FMA1 of 0.55 thousand tonnes (Table 4.2), in FMA2 of 1.16 thousand tonnes (Table 4.3), and in FMA3 of 0.84 thousand tonnes (Table 4.4).
- For scenario **three** there is projected to be a decline of 1.95 thousand tonnes in average annual tarakihi catch (Table 4.1), and a decline of 3.44 thousand tonnes in the total average annual catch (Table 4.1). This decline in total annual average catch will come from a drop in FMA1 of 0.91 thousand tonnes (Table 4.2), in FMA2 of 1.57 thousand tonnes (Table 4.3), and in FMA3 of 0.96 thousand tonnes (Table 4.4).
- For scenario **four** there is projected to be a decline of 2.27 thousand tonnes in average annual tarakihi catch (Table 4.1), and a decline of 4.08 thousand tonnes in the total average annual catch (Table 4.1). This decline in total annual average catch will come from a drop in FMA1 of 0.8 thousand tonnes (Table 4.2), in FMA2 of 2.09 thousand tonnes (Table 4.3), and in FMA3 of 1.19 thousand tonnes (Table 4.4).
- For scenario **five** there is projected to be a decline of 1.71 thousand tonnes in average annual tarakihi catch (Table 4.1), and a decline of 2.43 thousand tonnes in the total average annual catch (Table 4.1). This decline in total annual average catch will come from a drop in FMA1 of 0.48 thousand tonnes (Table 4.2), in FMA2 of 1.41 thousand tonnes (Table 4.3), and in FMA3 of 0.54 thousand tonnes (Table 4.4).

## 4.1 Total

Across the 20 year period there was a total difference across the three FMAs of 32.95 thousand tonne between all the scenarios, with scenario five having the largest catch with 2,897 thousand tonne of fish being caught. At the same time scenario four had the lowest total catch with 2,864 thousand tonne of fish being caught across the 20 years.

Scenario five across the three FMAs saw the largest volume of tarakihi caught, with 58.76 thousand tonnes caught across the 20 years, or an annual average of 2.94 thousand tonne being caught per year. At 2.38 thousand tonne per year being caught scenario four had the smallest catch of tarakihi, while the other three scenarios averaged around 2.84 thousand tonnes of tarakihi being caught each year.

On average across the 20 years there was just 1.65 thousand tonne difference in the total fish catch between the five scenarios, with all scenarios catching around 3.01 thousand tonne less than in the base year (2016-17).

Table 4.1 Total catch of all fish and tarakihi across first 20 years along with average annual catch

| Scenarios | Total summed catch over 20 years (thousand tonnes) | | Average annual catch over 20 years (thousand tonnes) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 2,894.59 | 58.22 | 144.73 | 2.91 |
| Scenario 2 | 2,894.59 | 58.22 | 144.73 | 2.91 |
| Scenario 3 | 2,876.70 | 53.82 | 143.84 | 2.69 |
| Scenario 4 | 2,863.99 | 47.58 | 143.20 | 2.38 |
| Scenario 5 | 2,896.94 | 58.76 | 144.85 | 2.94 |
| Base Year | | | 147.28 | 4.64 |

## 4.2 FMA1

For FMA1 the average annual catch of tarakihi across the 20 year period was around 0.21 thousand tonnes, down from the base year catch of 0.76 thousand tonnes. On average the total catch across all five scenarios is around 57.62 thousand tonnes, which is just 0.66 thousand tonnes less than the base year.

For FMA1 scenario five will see the largest catch of tarakihi across the 20 years with around 11.84 thousand tonnes caught.

Table 4.2 Total catch of all fish and tarakihi across first 20 years along with average annual catch, FMA1

| Scenarios | Total summed catch over 20 years (thousand tonnes) | | Average annual catch over 20 years (thousand tonnes) | |
|---|---|---|---|---|
| FMA1 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 1,154.50 | 11.32 | 57.73 | 0.57 |
| Scenario 2 | 1,154.51 | 11.32 | 57.73 | 0.57 |
| Scenario 3 | 1,147.31 | 10.65 | 57.37 | 0.53 |
| Scenario 4 | 1,149.59 | 9.62 | 57.48 | 0.48 |
| Scenario 5 | 1,156.02 | 11.84 | 57.80 | 0.59 |
| Base Year | | | 58.28 | 0.76 |

## 4.3 FMA2

In FMA2 the average annual catch of tarakihi across the 20 year period was around 1.28 thousand tonnes, down from the base year catch of 1.97 thousand tonnes. On average the total catch across all five scenarios is around 23.46 thousand tonnes, which is 1.48 thousand tonnes below the base year catch. For FMA2 scenario one will see the largest catch of tarakihi across the 20 years with around 27.96 thousand tonnes caught, which is 0.01 thousand tonnes more than any of the other scenarios.

Table 4.3 Total catch of all fish and tarakihi across first 20 years along with average annual catch, FMA2

| Scenarios | Total summed catch over 20 years (thousand tonnes) | | Average annual catch over 20 years (thousand tonnes) | |
|---|---|---|---|---|
| FMA2 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 475.63 | 27.96 | 23.78 | 1.40 |
| Scenario 2 | 475.62 | 27.95 | 23.78 | 1.40 |
| Scenario 3 | 467.46 | 25.00 | 23.37 | 1.25 |
| Scenario 4 | 457.00 | 21.22 | 22.85 | 1.06 |
| Scenario 5 | 470.55 | 26.12 | 23.53 | 1.31 |
| Base Year | | | 24.94 | 1.97 |

## 4.4 FMA3

In FMA3 the average annual catch of tarakihi across the 20 year period was around 0.94 thousand tonnes, down from the base year catch of 1.29 thousand tonnes. On average the total catch across all five scenarios is around 63.19 thousand tonnes, which is 0.87 thousand tonnes below the base year catch. FMA3 has the largest total catch related to tarakihi across the three FMAs despite having only the second largest tarakihi catch behind FMA2.

For FMA3 scenario five will see the largest catch of tarakihi across the 20 years with around 20.80 thousand tonnes caught, which is 1.85 thousand tonnes more than any of the other scenarios.

Table 4.4 Total catch of all fish and tarakihi across first 20 years along with average annual catch, FMA3

| Scenarios | Total summed catch over 20 years (thousand tonnes) | | Average annual catch over 20 years (thousand tonnes) | |
|---|---|---|---|---|
| FMA3 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 1,264.45 | 18.95 | 63.22 | 0.95 |
| Scenario 2 | 1,264.46 | 18.95 | 63.22 | 0.95 |
| Scenario 3 | 1,261.94 | 18.16 | 63.10 | 0.91 |
| Scenario 4 | 1,257.41 | 16.74 | 62.87 | 0.84 |
| Scenario 5 | 1,270.37 | 20.80 | 63.52 | 1.04 |
| Base Year | | | 64.06 | 1.29 |

# 5 Change in projected catch revenues

In this section BERL examines the change in projected catch revenues across the 20 year period for the five scenarios undertaken. BERL examines the change in not only tarakihi revenue which will be reduced following the TACC reduction implemented in each scenario, but the wider impact on catch revenues from a reduction in fishing for species where tarakihi is a major bycatch.

The main findings of our analysis of catch revenues across the five scenarios is as follows:

- Across all FMAs scenario five sees the smallest average reduction in total revenue across the 20 year period, with a reduction of $8.14 million (Table 5.1) compared to the base year.
- Across all FMAs scenario four sees the largest average reduction in total revenue across the 20 year period, with a reduction of $13.34 million (Table 5.1) compared to the base year.
- Across all FMAs scenario five see the smallest average reduction in total tarakihi revenue across the 20 year period, with a reduction of $6.77 million (Table 5.1) compared to the base year.
- FMA2 will see the largest reduction in annual average revenue with an average annual loss of $4.81 million across all scenarios (Table 5.3), this is on the back of FMA2 having the largest annual average revenue loss of $2.72 million of tarakihi catch across all scenarios (Table 5.3), based on an average annual loss of around 700 tonnes of tarakihi (Table 4.3).
- For scenario **one** there is projected to be a decline of $6.88 million in average annual tarakihi revenue (Table 5.1), and a decline of $8.33 million in the total average annual revenue (Table 5.1). This decline in total annual average revenue will come from a drop in FMA1 of $2.73 million (Table 5.2), in FMA2 of $3.77 million (Table 5.3), and in FMA3 of $1.82 million (Table 5.4).
- For scenario **two** there is projected to be a decline of $6.88 million in average annual tarakihi revenue (Table 5.1), and a decline of $8.33 million in the total average annual revenue (Table 5.1). This decline in total annual average revenue will come from a drop in FMA1 of $2.73 million (Table 5.2), in FMA2 of $3.77 million (Table 5.3), and in FMA3 of $1.82 million (Table 5.4).
- For scenario **three** there is projected to be a decline of $7.75 million in average annual tarakihi revenue (Table 5.1), and a decline of $11.71 million in the total average annual revenue (Table 5.1). This decline in total annual average revenue will come from a drop in FMA1 of $4.51 million (Table 5.2), in FMA2 of $5.10 million (Table 5.3), and in FMA3 of $2.10 million (Table 5.4).
- For scenario **four** there is projected to be a decline of $8.99 million in average annual tarakihi revenue (Table 5.1), and a decline of $13.34 million in the total average annual revenue (Table 5.1). This decline in total annual average revenue will come from a drop in FMA1 of $3.95 million (Table 5.2), in FMA2 of $6.81 million (Table 5.3), and in FMA3 of $2.59 million (Table 5.4).
- For scenario **five** there is projected to be a decline of $6.77 million in average annual tarakihi revenue (Table 5.1), and a decline of $8.14 million in the total average annual revenue (Table 5.1). This decline in total annual average revenue will come from a drop in FMA1 of $2.36 million (Table 5.2), in FMA2 of $4.60 million (Table 5.3), and in FMA3 of $1.18 million (Table 5.4).

## 5.1 Total

In total across the three FMAs and across the 20 year period there was a difference of $104.1 million in total between all the scenarios, with scenario five having the largest catch revenue with $5,679.8 million worth of fish being caught across the 20 years. At the same time scenario four had the lowest total catch revenue with $5,575.7 million worth of fish being caught across the 20 years.

Scenario five across the three FMAs saw the largest revenue gained from tarakihi caught, with $233.13 million across the 20 years, or an annual average of $11.66 million worth of tarakihi being caught every year. At $9.44 million revenue generated from tarakihi being caught scenario four had the smallest revenue of tarakihi, while the other three scenarios averaged around $11.26 million worth of tarakihi being caught each year.

On average across the 20 years there was just $5.21 million difference in the value of total fish catch between the five scenarios, with all scenarios catching around $9.97 million less than in the base year (2016-17).

Table 5.1 Total revenue of all fish and tarakihi across first 20 years along with average annual revenue

| Scenarios | Total summed Fish revenue over 20 years ($millions) | | Average Fish revenue over 20 years ($millions) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 5,676.01 | 230.99 | 283.80 | 11.55 |
| Scenario 2 | 5,676.03 | 230.99 | 283.80 | 11.55 |
| Scenario 3 | 5,608.43 | 213.51 | 280.42 | 10.68 |
| Scenario 4 | 5,575.71 | 188.77 | 278.79 | 9.44 |
| Scenario 5 | 5,679.82 | 233.13 | 283.99 | 11.66 |
| Base Year | | | 292.13 | 18.43 |

## 5.2 FMA1

FMA1 sees the second largest drop in average revenue with all scenarios reporting around $152.56 million in total revenue compared to the base year of $155.81 million. This is a drop of around $3.25 million, but it comes from the smallest declines ($0.83 million) in revenue earned from tarakihi, indicating that the decline in associated fishing is of quite valuable fish compared to the other FMAs. Overall the average decline in total fish revenue is 3.9 times the decline in tarakihi revenue, which is much higher than in FMA2 (1.77) and FMA3 (1.37).

In addition average fish revenue in FMA1 is almost twice the average annual revenue of FMA3 and almost three times the revenue of FMA2.

Table 5.2 Total revenue of all fish and tarakihi across first 20 years along with average annual revenue, FMA1

| Scenarios | Total summed Fish revenue over 20 years ($millions) | | Average Fish revenue over 20 years ($millions) | |
|---|---|---|---|---|
| FMA1 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 3,061.60 | 44.90 | 153.08 | 2.24 |
| Scenario 2 | 3,061.64 | 44.91 | 153.08 | 2.25 |
| Scenario 3 | 3,026.12 | 42.27 | 151.31 | 2.11 |
| Scenario 4 | 3,037.35 | 38.17 | 151.87 | 1.91 |
| Scenario 5 | 3,069.08 | 46.98 | 153.45 | 2.35 |
| Base Year | | | 155.81 | 3.00 |

## 5.3 FMA2

FMA2 sees the largest decline in average fish revenue across the 20 years, with average annual revenue of $51 million down $4.81 million from the base year of $55.81 million in the base year. For FMA2 tarakihi catch represents the largest percentage of total revenue, for scenario five total tarakihi revenue comprises 10.1 percent of total catch revenue compared to 5.2 percent in FMA3, and 0.8 percent in FMA1, for the same scenario.

Table 5.3 Total revenue of all fish and tarakihi across first 20 years along with average annual revenue, FMA2

| Scenarios | Total summed Fish revenue over 20 years ($millions) | | Average Fish revenue over 20 years ($millions) | |
|---|---|---|---|---|
| FMA2 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 1,040.75 | 110.92 | 52.04 | 5.55 |
| Scenario 2 | 1,040.72 | 110.91 | 52.04 | 5.55 |
| Scenario 3 | 1,014.13 | 99.20 | 50.71 | 4.96 |
| Scenario 4 | 980.04 | 84.19 | 49.00 | 4.21 |
| Scenario 5 | 1,024.19 | 103.63 | 51.21 | 5.18 |
| Base Year | | | 55.81 | 7.81 |

## 5.4 FMA3

In FMA3 there is a difference of just $28.21 million between scenario four and five in total revenue earned over the 20 year period. For each scenario, FMA3 has the highest percentage of total revenue decline coming from the loss of tarakihi revenue. On average across the five scenarios there was a loss of $1.4 million for tarakihi and a further $0.5 million coming from the loss of other fish catch.

Table 5.4 Total revenue of all fish and tarakihi across first 20 years along with average annual revenue, FMA3

| Scenarios | Total summed Fish revenue over 20 years ($millions) | | Average Fish revenue over 20 years ($millions) | |
|---|---|---|---|---|
| FMA3 | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 1,573.66 | 75.17 | 78.68 | 3.76 |
| Scenario 2 | 1,573.67 | 75.17 | 78.68 | 3.76 |
| Scenario 3 | 1,568.19 | 72.04 | 78.41 | 3.60 |
| Scenario 4 | 1,558.33 | 66.42 | 77.92 | 3.32 |
| Scenario 5 | 1,586.54 | 82.52 | 79.33 | 4.13 |
| Base Year | | | 80.51 | 5.11 |

# 6 Change in projected total catch volumes by fishing method

In this section BERL examines the change in projected total catch volume by fishing method across three snapshot years across the 20 year period, the five scenarios have been run over. This three snapshot years are the base year of 2016-17; year three (2020-21) by which time all scenarios have reached their peak reduction in tarakihi catch; and year 20 (2037-38) by which time all scenarios will see an increase in tarakihi catch and will have had their increase in catch implemented. This means that for each scenario across the three snapshot years we see the base year, the year of maximum tarakihi reduction, and a year in which scenarios one, two and three will show an increase in tarakihi catch compared to scenario four and five where the TACC reduction is still in effect.

For each FMA, we have included the main fishing methods that are used to target tarakihi or catch tarakihi as a bycatch.

The main findings of our analysis of catch volumes by fishing method across the five scenarios is as follows:

- Within FMA1 Bottom Trawl (BT) sees the largest absolute and percentage change between the base year and year three. With scenario five seeing a 5.4 percent decline in BT catch (Table 6.5), while scenario two sees an 9.1 percent decline in BT catch in year three (Table 6.2).
- Within the FMA1 by year 20, scenarios one, two and three see a return for BT to its projected catch of 7.3 thousand tonnes (Table 6.1, Table 6.2, Table 6.3), while for scenario four BT is still catching 6.8 thousand tonnes (Table 6.4), and for scenario five BT is catching 7 thousand tonnes (Table 6.5).
- In FMA2 there has been a decline in total catch in year three for Bottom Trawling (BT) of between 16.6 percent for scenario five (Table 6.10) and 37.9 percent for scenario two (Table 6.7).
- In FMA3 under all scenarios there has been a decline in total catch in year three for BT of between 0.8 percent for scenario five (Table 6.15) and 3.4 percent for scenario two (Table 6.12). At the same time there has been a decline in Set Netting (SN) of between 3.9 percent for scenario five (Table 6.15) and 16 percent for scenario two (Table 6.12).
- Under scenario **one** the East Northland trawl and Bay of Plenty trawl in FMA1 will see a reduction in total catch volume compared to the base year (9.8 thousand tonnes) to 9 thousand tonnes in year three, before improving in year 11 to 20 to be 9.9 thousand tonnes (Table 6.1). The Hawke's Bay trawl and Cook Strait (East) trawl in FMA2 will see a reduction in total catch volume compared to the base year (22.2 thousand tonnes) to 19.4 thousand tonnes in year three, before improving in year 11 to 20 to be 22.8 thousand tonnes (Table 6.6). The Canterbury Bight trawl in FMA3 will see a reduction in total catch volume compared to the base year (61.6 thousand tonnes) to 59.8 thousand tonnes in year three, before improving in year 11 to 20 to be 61.9 thousand tonnes. While the Kaikoura setnet also in FMA3 will see a reduction in total catch volume compared to the base year (1.2 thousand tonnes) to one thousand tonnes in year three, before improving in year 11 to 20 to be 1.2 thousand tonnes (Table 6.11).
- Under scenario **two** the East Northland trawl and Bay of Plenty trawl in FMA1 will see a reduction in total catch volume compared to the base year (9.8 thousand tonnes) to nine thousand tonnes in year three, before improving in year 11 to 20 to be 9.9 thousand tonnes (Table 6.2). The Hawke's Bay trawl and Cook Strait (East) trawl in FMA2 will see a reduction in total catch volume compared to the base year (22.2 thousand tonnes) to 19.2 thousand tonnes in year three, before improving in year 11 to 20 to be 22.8 thousand tonnes (Table 6.7). The Canterbury Bight trawl in FMA3 will see a reduction in total catch volume compared to the base year (61.6 thousand tonnes) to 59.6 thousand tonnes in year three, before improving in year 11 to 20 to be 61.9 thousand tonnes. While the Kaikoura setnet also in FMA3 will see a reduction in

total catch volume compared to the base year (1.2 thousand tonnes) to one thousand tonnes in year three, before improving in year 11 to 20 to be 1.2 thousand tonnes (Table 6.11).

- Under scenario **three** the East Northland trawl and Bay of Plenty trawl in FMA1 will see a reduction in total catch volume compared to the base year (9.8 thousand tonnes) to 9.2 thousand tonnes in year three, before improving in year 16 to 20 to be 9.9 thousand tonnes (Table 6.3). The Hawke's Bay trawl and Cook Strait (East) trawl in FMA2 will see a reduction in total catch volume compared to the base year (22.2 thousand tonnes) to 20 thousand tonnes in year three, before improving in year 16 to 20 to be 22.8 thousand tonnes (Table 6.8). The Canterbury Bight trawl in FMA3 will see a reduction in total catch volume compared to the base year (61.6 thousand tonnes) to 60.4 thousand tonnes in year three, before improving in year 16 to 20 to be 61.9 thousand tonnes. While the Kaikoura setnet also in FMA3 will see a reduction in total catch volume compared to the base year (1.2 thousand tonnes) to 1.1 thousand tonnes in year three, before improving in year 16 to 20 to be 1.2 thousand tonnes (Table 6.13).
- Under scenario **four** the East Northland trawl and Bay of Plenty trawl in FMA1 will see a reduction in total catch volume compared to the base year (9.8 thousand tonnes) to 9.3 thousand tonnes in year three through to year 20 (Table 6.4). The Hawke's Bay trawl and Cook Strait (East) trawl in FMA2 will see a reduction in total catch volume compared to the base year (22.2 thousand tonnes) to 20.2 thousand tonnes in year three through to year 20 (Table 6.9). The Canterbury Bight trawl in FMA3 will see a reduction in total catch volume compared to the base year (61.6 thousand tonnes) to 60.6 thousand tonnes in year three through to year 20. While the Kaikoura setnet also in FMA3 will see a reduction in total catch volume compared to the base year (1.2 thousand tonnes) to 1.1 thousand tonnes in year three through to year 20 (Table 6.14).
- Under scenario **five** the East Northland trawl and Bay of Plenty trawl in FMA1 will see a reduction in total catch volume compared to the base year (9.8 thousand tonnes) to 9.5 thousand tonnes in year three through to year 20 (Table 6.5). The Hawke's Bay trawl and Cook Strait (East) trawl in FMA2 will see a reduction in total catch volume compared to the base year (22.2 thousand tonnes) to 20.9 thousand tonnes in year three through to year 20 (Table 6.10). The Canterbury Bight trawl in FMA3 will see a reduction in total catch volume compared to the base year (61.6 thousand tonnes) to 61.1 thousand tonnes in year three through to year 20. While the Kaikoura setnet also in FMA3 will see a reduction in total catch volume compared to the base year (1.2 thousand tonnes) to 1.1 thousand tonnes in year three through to year 20 (Table 6.15).

## 6.1 FMA1

In FMA1 under all scenarios the largest fishing method affected is Bottom Trawling (BT) with a 5.4 percent to 9.1 percent decline in fish catch by year three. Purse seining (PS) which has the largest catch in terms of volumes in FMA1 will only see a tiny impact on its volumes in any of the scenarios.

Table 6.1 Catch by fishing method, FMA1, scenario one

| FMA1 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 5.7 | 5.4 | 5.7 | -4.9% | 5.6% |
| BT | 7.2 | 6.6 | 7.3 | -8.3% | 10.0% |
| DS | 2.0 | 1.9 | 2.0 | -5.8% | 6.8% |
| MW | 0.3 | 0.3 | 0.3 | -3.5% | 4.0% |
| PRB | 2.3 | 2.1 | 2.3 | -6.7% | 7.9% |
| PS | 37.8 | 37.8 | 37.8 | -0.1% | 0.1% |
| SLL | 2.3 | 2.3 | 2.3 | 0.0% | 0.0% |
| SN | 0.4 | 0.4 | 0.4 | -3.1% | 3.5% |

Table 6.2 Catch by fishing method, FMA1, scenario two

| FMA1 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 5.7 | 5.4 | 5.7 | -5.3% | 6.1% |
| BT | 7.2 | 6.6 | 7.3 | -9.1% | 10.9% |
| DS | 2.0 | 1.9 | 2.0 | -6.3% | 7.3% |
| MW | 0.3 | 0.3 | 0.3 | -3.8% | 4.4% |
| PRB | 2.3 | 2.1 | 2.3 | -7.3% | 8.6% |
| PS | 37.8 | 37.8 | 37.8 | -0.1% | 0.1% |
| SLL | 2.3 | 2.3 | 2.3 | 0.0% | 0.1% |
| SN | 0.4 | 0.4 | 0.4 | -3.4% | 3.8% |

Table 6.3 Catch by fishing method, FMA1, scenario three

| FMA1 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 5.7 | 5.5 | 5.7 | -3.6% | 4.2% |
| BT | 7.2 | 6.8 | 7.3 | -6.2% | 7.4% |
| DS | 2.0 | 1.9 | 2.0 | -4.3% | 5.1% |
| MW | 0.3 | 0.3 | 0.3 | -2.6% | 3.0% |
| PRB | 2.3 | 2.2 | 2.3 | -5.0% | 5.9% |
| PS | 37.8 | 37.8 | 37.8 | -0.1% | 0.1% |
| SLL | 2.3 | 2.3 | 2.3 | 0.0% | 0.0% |
| SN | 0.4 | 0.4 | 0.4 | -2.3% | 2.7% |

Table 6.4 Catch by fishing method, FMA1, scenario four

| FMA1 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 5.7 | 5.5 | 5.5 | -3.2% | 0.0% |
| BT | 7.2 | 6.8 | 6.8 | -5.4% | 0.0% |
| DS | 2.0 | 1.9 | 1.9 | -3.8% | 0.0% |
| MW | 0.3 | 0.3 | 0.3 | -2.3% | 0.0% |
| PRB | 2.3 | 2.2 | 2.2 | -4.4% | 0.0% |
| PS | 37.8 | 37.8 | 37.8 | -0.1% | 0.0% |
| SLL | 2.3 | 2.3 | 2.3 | 0.0% | 0.0% |
| SN | 0.4 | 0.4 | 0.4 | -2.0% | 0.0% |

Table 6.5 Catch by fishing method, FMA1, scenario five

| FMA1 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 5.7 | 5.6 | 5.6 | -1.9% | 0.0% |
| BT | 7.2 | 7.0 | 7.0 | -3.2% | 0.0% |
| DS | 2.0 | 2.0 | 2.0 | -2.3% | 0.0% |
| MW | 0.3 | 0.3 | 0.3 | -1.4% | 0.0% |
| PRB | 2.3 | 2.2 | 2.2 | -2.6% | 0.0% |
| PS | 37.8 | 37.8 | 37.8 | 0.0% | 0.0% |
| SLL | 2.3 | 2.3 | 2.3 | 0.0% | 0.0% |
| SN | 0.4 | 0.4 | 0.4 | -1.2% | 0.0% |

## 6.2 FMA2

In FMA2 under all scenarios there has been a decline in total catch in year three for BT of between 16.6 percent and 37.9 percent. In addition, Set Netting (SN) and Precision Bottom Trawl (PRB), have seen the largest percentage declines in fish volumes associated with tarakihi across all scenarios, but these declines are off very small base catches.

Across all scenario Mid-Water Trawl (MW) which has the largest volume of catch saw only a small decrease in volume in year three, based on the small amount of tarakihi caught using this method.

Table 6.6 Catch by fishing method, FMA2, scenario one

| FMA2 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.3 | 1.2 | 1.3 | -3.8% | 4.9% |
| BT | 7.5 | 4.9 | 8.1 | -35.2% | 66.7% |
| MW | 11.3 | 11.2 | 11.3 | -0.6% | 0.8% |
| PRB | 0.1 | 0.1 | 0.2 | -51.5% | 130.4% |
| PRM | 3.3 | 3.2 | 3.3 | -1.0% | 1.2% |
| PS | 0.6 | 0.5 | 0.6 | -9.0% | 12.1% |
| SLL | 0.7 | 0.7 | 0.7 | -0.3% | 0.4% |
| SN | 0.2 | 0.1 | 0.2 | -35.5% | 67.6% |

Table 6.7 Catch by fishing method, FMA2, scenario two

| FMA2 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.3 | 1.2 | 1.3 | -4.1% | 5.2% |
| BT | 7.5 | 4.6 | 8.1 | -37.9% | 73.9% |
| MW | 11.3 | 11.2 | 11.3 | -0.7% | 0.8% |
| PRB | 0.1 | 0.1 | 0.2 | -55.5% | 150.9% |
| PRM | 3.3 | 3.2 | 3.3 | -1.0% | 1.3% |
| PS | 0.6 | 0.5 | 0.6 | -9.7% | 12.9% |
| SLL | 0.7 | 0.7 | 0.7 | -0.3% | 0.4% |
| SN | 0.2 | 0.1 | 0.2 | -38.3% | 75.0% |

Table 6.8 Catch by fishing method, FMA2, scenario three

| FMA2 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.3 | 1.2 | 1.3 | -2.9% | 3.9% |
| BT | 7.5 | 5.4 | 8.1 | -27.2% | 48.4% |
| MW | 11.3 | 11.3 | 11.3 | -0.5% | 0.6% |
| PRB | 0.1 | 0.1 | 0.2 | -39.9% | 85.7% |
| PRM | 3.3 | 3.2 | 3.3 | -0.7% | 1.0% |
| PS | 0.6 | 0.5 | 0.6 | -6.9% | 9.6% |
| SLL | 0.7 | 0.7 | 0.7 | -0.2% | 0.3% |
| SN | 0.2 | 0.1 | 0.2 | -27.5% | 49.0% |

Table 6.9 Catch by fishing method, FMA2, scenario four

| FMA2 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.3 | 1.2 | 1.2 | -2.7% | 0.0% |
| BT | 7.5 | 5.6 | 5.6 | -24.6% | 0.0% |
| MW | 11.3 | 11.3 | 11.3 | -0.4% | 0.0% |
| PRB | 0.1 | 0.1 | 0.1 | -36.0% | 0.0% |
| PRM | 3.3 | 3.2 | 3.2 | -0.7% | 0.0% |
| PS | 0.6 | 0.5 | 0.5 | -6.3% | 0.0% |
| SLL | 0.7 | 0.7 | 0.7 | -0.2% | 0.0% |
| SN | 0.2 | 0.1 | 0.1 | -24.8% | 0.0% |

Table 6.10 Catch by fishing method, FMA2, scenario five

| FMA2 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.3 | 1.2 | 1.2 | -1.8% | 0.0% |
| BT | 7.5 | 6.2 | 6.2 | -16.6% | 0.0% |
| MW | 11.3 | 11.3 | 11.3 | -0.3% | 0.0% |
| PRB | 0.1 | 0.1 | 0.1 | -24.3% | 0.0% |
| PRM | 3.3 | 3.2 | 3.2 | -0.5% | 0.0% |
| PS | 0.6 | 0.5 | 0.5 | -4.2% | 0.0% |
| SLL | 0.7 | 0.7 | 0.7 | -0.1% | 0.0% |
| SN | 0.2 | 0.1 | 0.1 | -16.8% | 0.0% |

## 6.3 FMA3

In FMA3 under all scenarios there has been a decline in total catch in year three for BT of between 0.8 percent for scenario five and 3.4 percent for scenarios one and two. At the same time there has been a decline in SN of between 3.9 percent for scenario five and 16 percent for scenarios one and two.

In total SN has seen a decline of up 200 tonnes in year three in tarakihi and associated fish catch (scenario one and two), while BT has seen a decline of 1.7 thousand tonnes in scenarios one and two in year three.

Table 6.11 Catch by fishing method, FMA3, scenario one

| FMA3 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.2 | 1.1 | 1.2 | -4.7% | 5.6% |
| BT | 51.2 | 49.5 | 51.5 | -3.4% | 4.0% |
| MW | 10.1 | 9.9 | 10.2 | -2.4% | 2.9% |
| PRB | 0.3 | 0.3 | 0.3 | -0.3% | 0.4% |
| SN | 1.2 | 1.0 | 1.2 | -16.0% | 22.0% |

Table 6.12 Catch by fishing method, FMA3, scenario two

| FMA3 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.2 | 1.1 | 1.2 | -4.7% | 5.6% |
| BT | 51.2 | 49.5 | 51.5 | -3.4% | 4.0% |
| MW | 10.1 | 9.9 | 10.2 | -2.4% | 2.9% |
| PRB | 0.3 | 0.3 | 0.3 | -0.3% | 0.4% |
| SN | 1.2 | 1.0 | 1.2 | -16.0% | 22.0% |

Table 6.13 Catch by fishing method, FMA3, scenario three

| FMA3 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.2 | 1.1 | 1.2 | -2.9% | 3.7% |
| BT | 51.2 | 50.1 | 51.5 | -2.1% | 2.7% |
| MW | 10.1 | 10.0 | 10.2 | -1.5% | 1.9% |
| PRB | 0.3 | 0.3 | 0.3 | -0.2% | 0.2% |
| SN | 1.2 | 1.1 | 1.2 | -10.1% | 13.9% |

Table 6.14 Catch by fishing method, FMA3, scenario four

| FMA3 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.2 | 1.1 | 1.1 | -2.5% | 0.0% |
| BT | 51.2 | 50.3 | 50.3 | -1.8% | 0.0% |
| MW | 10.1 | 10.0 | 10.0 | -1.3% | 0.0% |
| PRB | 0.3 | 0.3 | 0.3 | -0.2% | 0.0% |
| SN | 1.2 | 1.1 | 1.1 | -8.6% | 0.0% |

Table 6.15 Catch by fishing method, FMA3, scenario five

| FMA3 | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|
| BLL | 1.2 | 1.2 | 1.2 | -1.1% | 0.0% |
| BT | 51.2 | 50.8 | 50.8 | -0.8% | 0.0% |
| MW | 10.1 | 10.1 | 10.1 | -0.6% | 0.0% |
| PRB | 0.3 | 0.3 | 0.3 | -0.1% | 0.0% |
| SN | 1.2 | 1.1 | 1.1 | -3.9% | 0.0% |

# 7 Projected impact on fishers

In this section BERL examines the change in projected catch revenue by fishing profile across three snapshot years over the 20 year period, based on the five scenarios. This three snapshot years are the base year 2016-17; year three (2020-21) by which time all scenarios have reached their peak reduction in tarakihi catch; and year 20 (2037-38) by which time all scenarios which will see an increase in tarakihi catch will have had their increase in catch implemented. This means that for each scenario across the three snapshot years we will see the base year; the year of maximum tarakihi reduction; and a year in which scenarios one, two and three will show an increase in tarakihi catch compared to scenario four and five where the TACC reduction is still in effect.

In each FMA fishers have been split into one of five profiles based on their tarakihi ACE and total ACE held at the end of the 2016-17 fishing year. Due to the nature of fishing and the size of some of the fishers, a number of fishers hold ACE in multiple FMAs in 2016-17. This means that some of the fishers have been counted in multiple FMAs. In total there were around 190 fishers holding tarakihi ACE across the three FMAs, of these around 17 held tarakihi ACE in multiple FMAs, with most fitting into the under 5 high volume fisher profile in each FMA.

In addition fishers in the under 5 high volume profile also were allocated a considerable amount of TAR1, TAR2 and TAR3 ACE in the base year. In total they were allocated around 500 tonnes of TAR1 ACE, around 140 tonnes of TAR2 ACE, and around 545 tonnes of TAR3 ACE. Outside this under 5 high volume profile, fishers were allocated 10.5 tonnes of TAR1 ACE, and 137 tonnes of TAR3 ACE in the base year.

This indicates that the larger high volume fishers will not be affected in the same way as other fishers as they are allocated a substantial portion of TAR ACE, which could mean either they can sell the TAR ACE to the other fishers who need to buy ACE during the year to cover their catch, or they can hold their TAR ACE and continue to catch the same amount of tarakihi as in the base year.

The fishing profiles are:

- Over 30 – Fishers in this profile have at least 30 percent of their total ACE in tarakihi.
- 15 to 30 – Fishers in this profile have between 15 and 30 percent of their total ACE in tarakihi.
- 5 to 15 – Fishers in this profile have between 5 and 15 percent of their total ACE in tarakihi.
- Under 5 high volume – Fishers in this profile have under 5 percent of their total ACE in tarakihi, and hold at least 100,000 kgs in ACE.
- Under 5 low volume – Fishers in this profile have under 5 percent of their total ACE in tarakihi, and hold less than 100,000 kgs in ACE.

The main findings of our analysis of fishing profiles across the five scenarios is as follows:

- In all scenarios those fishers who hold more than 5 percent of their ACE as tarakihi ACE will be substantially more affected by the reduction in tarakihi ACE, than those fishers who hold less than 5 percent tarakihi ACE.
- Across all scenarios fishers in FMA2 who hold at 5 percent of their ACE as tarakihi ACE will be the most affected out of the three FMAs, while those fishers in FMA1 will be the least affected.
- Under scenario **one** fishers with at least 5 percent TAR1 ACE in FMA1 will see their total revenue decline by around 11.2 percent by year three, before rebounding from year 11 to 20 to around just above base year revenue levels (Table 7.1). In FMA2 those fishers who hold 5 to 15 percent TAR2 ACE will see their total revenue decline by around 16.1 percent by year three, while those that hold at least 15 percent will decline by around 35.8 percent by year three. Though both groups will see their revenue rebound from year 11 to 20 to just above base year revenue levels (Table 7.6). In FMA3 those fishers with at least 5 percent TAR3

ACE will see their total revenue decline by around 13.6 percent by year three, before rebounding from year 11 to 20 to around base year revenue levels (Table 7.11).

- Under scenario **two** fishers with at least 5 percent TAR1 ACE in FMA1 will see their total revenue decline by around 12.1 percent by year three, before rebounding from year 11 to 20 to just above base year revenue levels (Table 7.2). In FMA2 those fishers who hold 5 to 15 percent TAR2 ACE will see their total revenue decline by around 17.4 percent by year three, while those that hold at least 15 percent will decline by around 38.6 percent by year three. Though both groups will see their revenue rebound from year 11 to 20 to just above base year revenue levels (Table 7.7). In FMA3 those fishers with at least 5 percent TAR3 ACE will see their total revenue decline by around 15 percent by year three, before rebounding from year 11 to 20 to around base year revenue levels (Table 7.12).
- Under scenario **three** fishers with at least 5 percent TAR1 ACE in FMA1 will see their total revenue decline by around 8.4 percent by year three, before rebounding from year 16 to 20 to just above base year revenue levels (Table 7.3). In FMA2 those fishers who hold 5 to 15 percent TAR2 ACE will see their total revenue decline by around 12.4 percent by year three, while those that hold at least 15 percent will decline by around 27.7 percent by year three. Though both groups will see their revenue rebound from year 16 to 20 to just above base year revenue levels (Table 7.8). In FMA3 those fishers with at least 5 percent TAR3 ACE will see their total revenue decline by around 9.5 percent by year three, before rebounding from year 16 to 20 to around base year revenue levels (Table 7.13).
- Under scenario **four** fishers with at least 5 percent TAR1 ACE in FMA1 will see their total revenue decline by around 7.5 percent by year three and hold at this level for the 20 year period (Table 7.4). In FMA2 those fishers who hold 5 to 15 percent TAR2 ACE will see their total revenue decline by around 11.1 percent by year three. While those that hold at least 15 percent will decline by around 25 percent by year three, these declines will hold at this level for the 20 year period (Table 7.9). In FMA3 those fishers with at least 5 percent TAR3 ACE will see their total revenue decline by around 8.2 percent by year three and hold at this level for the 20 year period (Table 7.14).
- Under scenario **five** fishers with at least 5 percent TAR1 ACE in FMA1 will see their total revenue decline by around 4.7 percent by year three and hold at this level for the 20 year period (Table 7.5). In FMA2 those fishers who hold 5 to 15 percent TAR2 ACE will see their total revenue decline by around 7.4 percent by year three. While those that hold at least 15 percent will decline by around 16.8 percent by year three, these declines will hold at this level for the 20 year period (Table 7.10). In FMA3 those fishers with at least 5 percent TAR3 ACE will see their total revenue decline by around 3.9 percent by year three and hold at this level for the 20 year period (Table 7.15).

## 7.1 FMA1

Table 7.1 Impact on fisher profiles, FMA1, scenario one

| FMA1 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 41 | 14.1 | 13.8 | 14.2 | -2.3% | 2.7% |
| Under 5 High volume | 26 | 262.0 | 256.9 | 262.9 | -1.9% | 2.3% |
| 5 to 15 | 18 | 27.9 | 25.0 | 28.4 | -10.3% | 13.5% |
| 15 to 30 | 6 | 8.0 | 7.1 | 8.1 | -11.4% | 14.8% |
| Over 30 | 5 | 3.7 | 3.3 | 3.8 | -11.8% | 14.8% |

Table 7.2 Impact on fisher profiles, FMA1, scenario two

| FMA1 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 41 | 14.1 | 13.8 | 14.2 | -2.5% | 2.9% |
| Under 5 High volume | 26 | 262.0 | 256.5 | 262.9 | -2.1% | 2.5% |
| 5 to 15 | 18 | 27.9 | 24.8 | 28.4 | -11.1% | 14.6% |
| 15 to 30 | 6 | 8.0 | 7.0 | 8.1 | -12.4% | 16.1% |
| Over 30 | 5 | 3.7 | 3.2 | 3.8 | -12.8% | 16.2% |

Table 7.3 Impact on fisher profiles, FMA1, scenario three

| FMA1 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 41 | 14.1 | 13.9 | 14.2 | -1.7% | 2.0% |
| Under 5 High volume | 26 | 262.0 | 258.2 | 262.9 | -1.5% | 1.8% |
| 5 to 15 | 18 | 27.9 | 25.7 | 28.4 | -7.8% | 10.4% |
| 15 to 30 | 6 | 8.0 | 7.3 | 8.1 | -8.6% | 11.2% |
| Over 30 | 5 | 3.7 | 3.4 | 3.8 | -8.7% | 11.0% |

Table 7.4 Impact on fisher profiles, FMA1, scenario four

| FMA1 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 41 | 14.1 | 13.9 | 13.9 | -1.5% | 0.0% |
| Under 5 High volume | 26 | 262.0 | 258.6 | 258.6 | -1.3% | 0.0% |
| 5 to 15 | 18 | 27.9 | 26.0 | 26.0 | -7.0% | 0.0% |
| 15 to 30 | 6 | 8.0 | 7.4 | 7.4 | -7.6% | 0.0% |
| Over 30 | 5 | 3.7 | 3.4 | 3.4 | -7.7% | 0.0% |

Table 7.5 Impact on fisher profiles, FMA1, scenario five

| FMA1 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 41 | 14.1 | 14.0 | 14.0 | -0.9% | 0.0% |
| Under 5 High volume | 26 | 262.0 | 259.8 | 259.8 | -0.8% | 0.0% |
| 5 to 15 | 18 | 27.9 | 26.7 | 26.7 | -4.5% | 0.0% |
| 15 to 30 | 6 | 8.0 | 7.6 | 7.6 | -4.8% | 0.0% |
| Over 30 | 5 | 3.7 | 3.5 | 3.5 | -4.7% | 0.0% |

## 7.2 FMA2

Table 7.6 Impact on fisher profiles, FMA2, scenario one

| FMA2 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 19 | 9.9 | 9.7 | 9.9 | -1.5% | 1.9% |
| Under 5 High volume | 13 | 297.0 | 294.9 | 297.3 | -0.7% | 0.8% |
| 5 to 15 | 10 | 35.5 | 29.8 | 36.7 | -16.1% | 23.2% |
| 15 to 30 | 6 | 4.2 | 2.6 | 4.6 | -38.8% | 77.6% |
| Over 30 | 3 | 6.6 | 4.4 | 7.0 | -32.8% | 59.7% |

Table 7.7 Impact on fisher profiles, FMA2, scenario two

| FMA2 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 1 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 19 | 9.9 | 9.7 | 9.9 | -1.6% | 2.0% |
| Under 5 High volume | 13 | 297.0 | 294.7 | 297.3 | -0.8% | 0.9% |
| 5 to 15 | 10 | 35.5 | 29.3 | 36.7 | -17.4% | 25.1% |
| 15 to 30 | 6 | 4.2 | 2.5 | 4.6 | -41.7% | 86.7% |
| Over 30 | 3 | 6.6 | 4.2 | 7.0 | -35.4% | 66.0% |

Table 7.8 Impact on fisher profiles, FMA2, scenario three

| FMA2 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 19 | 9.9 | 9.8 | 9.9 | -1.2% | 1.5% |
| Under 5 High volume | 13 | 297.0 | 295.4 | 297.3 | -0.5% | 0.6% |
| 5 to 15 | 10 | 35.5 | 31.1 | 36.7 | -12.4% | 17.9% |
| 15 to 30 | 6 | 4.2 | 3.0 | 4.6 | -30.0% | 55.3% |
| Over 30 | 3 | 6.6 | 4.9 | 7.0 | -25.4% | 43.7% |

Table 7.9 Impact on fisher profiles, FMA2, scenario four

| FMA2 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 19 | 9.9 | 9.8 | 9.8 | -1.0% | 0.0% |
| Under 5 High volume | 13 | 297.0 | 295.6 | 295.6 | -0.5% | 0.0% |
| 5 to 15 | 10 | 35.5 | 31.5 | 31.5 | -11.1% | 0.0% |
| 15 to 30 | 6 | 4.2 | 3.1 | 3.1 | -27.1% | 0.0% |
| Over 30 | 3 | 6.6 | 5.1 | 5.1 | -22.9% | 0.0% |

Table 7.10 Impact on fisher profiles, FMA2, scenario five

| FMA2 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 19 | 9.9 | 9.8 | 9.8 | -0.7% | 0.0% |
| Under 5 High volume | 13 | 297.0 | 296.2 | 296.2 | -0.3% | 0.0% |
| 5 to 15 | 10 | 35.5 | 32.9 | 32.9 | -7.4% | 0.0% |
| 15 to 30 | 6 | 4.2 | 3.5 | 3.5 | -18.3% | 0.0% |
| Over 30 | 3 | 6.6 | 5.5 | 5.5 | -15.4% | 0.0% |

## 7.3 FMA3

Table 7.11 Impact on fisher profiles, FMA3, scenario one

| FMA3 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 35 | 27.7 | 27.1 | 27.8 | -2.0% | 2.4% |
| Under 5 High volume | 18 | 395.6 | 390.7 | 396.5 | -1.2% | 1.5% |
| 5 to 15 | 10 | 4.9 | 4.4 | 4.9 | -10.3% | 13.6% |
| 15 to 30 | 2 | 10.0 | 8.6 | 10.2 | -14.1% | 19.1% |
| Over 30 | 2 | 1.4 | 1.2 | 1.4 | -16.5% | 23.1% |

Table 7.12 Impact on fisher profiles, FMA3, scenario two

| FMA3 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 1 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 35 | 27.7 | 27.1 | 27.8 | -2.2% | 2.6% |
| Under 5 High volume | 18 | 395.6 | 390.3 | 396.5 | -1.3% | 1.6% |
| 5 to 15 | 10 | 4.9 | 4.3 | 4.9 | -11.3% | 14.9% |
| 15 to 30 | 2 | 10.0 | 8.4 | 10.2 | -15.5% | 21.2% |
| Over 30 | 2 | 1.4 | 1.1 | 1.4 | -18.2% | 25.6% |

Table 7.13 Impact on fisher profiles, FMA3, scenario three

| FMA3 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 35 | 27.7 | 27.3 | 27.8 | -1.4% | 1.8% |
| Under 5 High volume | 18 | 395.6 | 392.0 | 396.5 | -0.9% | 1.1% |
| 5 to 15 | 10 | 4.9 | 4.5 | 4.9 | -7.4% | 10.1% |
| 15 to 30 | 2 | 10.0 | 9.0 | 10.2 | -9.8% | 13.4% |
| Over 30 | 2 | 1.4 | 1.2 | 1.4 | -11.4% | 16.0% |

Table 7.14 Impact on fisher profiles, FMA3, scenario four

| FMA3 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 35 | 27.7 | 27.3 | 27.3 | -1.2% | 0.0% |
| Under 5 High volume | 18 | 395.6 | 392.4 | 392.4 | -0.8% | 0.0% |
| 5 to 15 | 10 | 4.9 | 4.5 | 4.5 | -6.5% | 0.0% |
| 15 to 30 | 2 | 10.0 | 9.1 | 9.1 | -8.3% | 0.0% |
| Over 30 | 2 | 1.4 | 1.3 | 1.3 | -9.7% | 0.0% |

Table 7.15 Impact on fisher profiles, FMA3, scenario five

| FMA3 | Number | Base year ($millions) | Year 3 ($millions) | Year 20 ($millions) | Year 3 to Base | Year 20 to Year 3 |
|---|---|---|---|---|---|---|
| Under 5 Low volume | 35 | 27.7 | 27.5 | 27.5 | -0.6% | 0.0% |
| Under 5 High volume | 18 | 395.6 | 393.7 | 393.7 | -0.5% | 0.0% |
| 5 to 15 | 10 | 4.9 | 4.7 | 4.7 | -3.4% | 0.0% |
| 15 to 30 | 2 | 10.0 | 9.6 | 9.6 | -3.8% | 0.0% |
| Over 30 | 2 | 1.4 | 1.3 | 1.3 | -4.4% | 0.0% |

# 8 Projected impact on quota holders

In this section BERL examines the projected impact on all quota holders who hold stock that fall within or overlap with FMA1, FMA2, and/or FMA3, under three snapshot years for each scenario, across the 20 year period. These three snapshot years are the base year of 2016-17; year three (2020-21) by which time all scenarios have reached their peak reduction in tarakihi catch; and year 20 (2037-38) by which time all scenarios which will see an increase in tarakihi catch will have had their increase in catch implemented. This means that for each scenario across the three snapshot years we will see the base year; the year of maximum tarakihi reduction; and a year in which scenarios one, two and three will show an increase in tarakihi catch compared to scenario four and five where the TACC reduction is still in effect.

For this section total ACE is defined as the total ACE held for all fish stocks that fall within or overlap with FMA1, FMA2, and/or FMA3. BERL have used this definition because under the five scenarios fish stocks other than tarakihi are affected by the reduction in tarakihi catch, and using a narrower definition of total ACE could result in some of the impact from the tarakihi catch reduction being missed. BERL also considered using the narrower definition of total ACE as the total amount of ACE held by quota holders who also hold tarakihi ACE in FMA1, FMA2, or FMA3. While this definition would have brought the ACE definition closer to the definition used for total catch, there would have been too greater risk of impacts on other fish stocks being missed using this narrow definition.

For each scenario BERL have examined the change in total TAR1, TAR2, and TAR3 ACE resulting from the reduction in tarakihi TACC and the decline in fishing for associated fish species, as well as total ACE, as shown in the tables below. In addition the percentage decline for each individual quota holder has been determined to show the range of impacts facing individual quota holders, as shown in the figures below.

The main findings of our analysis of fishing profiles across the five scenarios is as follows:

- For all five scenarios around 33 percent of all quota holders will be unaffected by the change to tarakihi TACC.
- For scenario **one** by year three there will be a reduction in TAR1 ACE of 27.8 percent, TAR2 ACE of 59.4 percent, TAR3 ACE of 42.4 percent, and in total ACE of 1.7 percent (Table 8.1). Under this scenario the reduction in tarakihi TACC will end after 10 years, and therefore we will see an increase in ACE to above base year ACE in the year 20 snapshot (Table 8.1). In addition 79 percent of the quota holders affected by the tarakihi reduction will see a decline in year three of less than 5 percent in their total ACE. In total only two quota holders will see a decline in their total ACE of more than 50 percent, and combined these two quota holders had less than 170 kgs of ACE in the 2016-17 base year (Figure 8.1).
- For scenario **two** by year three there will be a reduction in TAR1 ACE of 30.2 percent, TAR2 ACE of 64 percent, TAR3 ACE of 46.8 percent, and in total ACE of 1.8 percent (Table 8.2). Under this scenario the reduction in tarakihi TACC will end after 10 years, and therefore we will see an increase to above base year ACE in the year 20 snapshot (Table 8.2). In addition 78 percent of the quota holders affected by the tarakihi reduction will see a decline in year three of less than 5 percent in their total ACE. In total only two quota holders will see a decline in their total ACE of more than 50 percent, and combined these two quota holders had less than 170 kgs of ACE in the 2016-17 base year (Figure 8.2).
- For scenario **three** by year three there will be a reduction in TAR1 ACE of 20.5 percent, TAR2 ACE of 46 percent, TAR3 ACE of 29.5 percent, and in total ACE of 1.2 percent (Table 8.3). Under this scenario the reduction in tarakihi TACC will end after 15 years, and therefore we will see an increase to above base year ACE in the year 20 snapshot (Table 8.3). In addition 85 percent of the quota holders affected by the tarakihi reduction will see a decline in year three of less than 5 percent in their total ACE. In total 22 quota holders

will see a decline in their total ACE of more than 20 percent, of which eight hold TAR quota, with the remaining 14 quota holders having small quotas of around 2.5 tonnes on average across all species (Figure 8.3).

- For scenario **four** by year three there will be a reduction in TAR1 ACE of 18.1 percent, TAR2 ACE of 41.5 percent, TAR3 ACE of 25.1 percent, and in total ACE of 1.1 percent (Table 8.4). Under this scenario the reduction in tarakihi TACC will end after 20 years, and therefore we will see a continuation of the reduction in fish catch in the year 20 snapshot. In addition 88 percent of the quota holders affected by the tarakihi reduction will see a decline in year three of less than 5 percent in their total ACE. In total 16 quota holders will see a decline in their total ACE of more than 20 percent, of which just four hold TAR quota, with the remaining 15 quota holders having small quotas of around 2.8 tonnes on average across all species (Figure 8.4).
- For scenario **five** by year three there will be a reduction in TAR1 ACE of 10.8 percent, TAR2 ACE of 28.1 percent, TAR3 ACE of 11.4 percent, and in total ACE of 0.6 percent (Table 8.5). Under this scenario the reduction in tarakihi TACC has no end point and therefore we will see a continuation of the reduction in fish catch in the year 20 snapshot. 92 percent of the quota holders affected by the tarakihi reduction will see a decline in year three of less than 5 percent in their total ACE. In total only two quota holders will see a decline in their total ACE of more than 20 percent (Figure 8.5).

Table 8.1 Impact on quota holders, scenario one

| | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base year | Year 20 to Year 3 |
|---|---|---|---|---|---|
| TAR1 ACE | 1.52 | 1.10 | 1.57 | -27.8% | 42.3% |
| TAR2 ACE | 1.82 | 0.74 | 2.06 | -59.4% | 179.7% |
| TAR3 ACE | 1.49 | 0.86 | 1.59 | -42.4% | 86.1% |
| All other ACE | 355.69 | 351.83 | 356.39 | -1.1% | 1.3% |
| Total ACE | 360.52 | 354.52 | 361.61 | -1.7% | 2.0% |

Figure 8.1 Percentage decline in ACE for affected quota holders, year three, scenario one

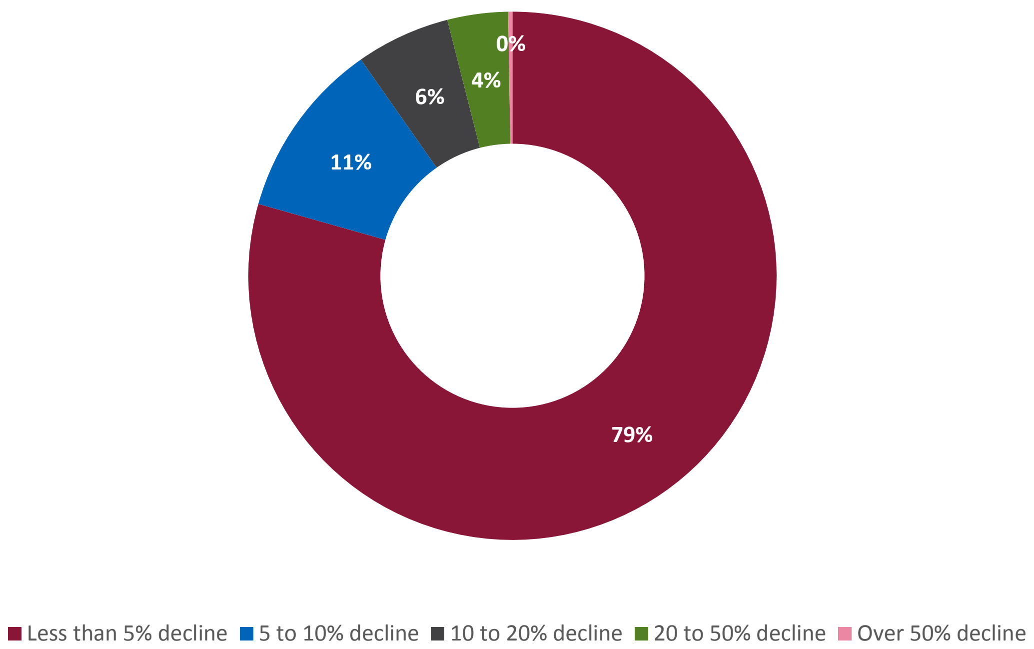


Table 8.2 Impact on quota holders, scenario two

| | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base year | Year 20 to Year 3 |
|---|---|---|---|---|---|
| TAR1 ACE | 1.52 | 1.06 | 1.57 | -30.2% | 47.3% |
| TAR2 ACE | 1.82 | 0.65 | 2.06 | -64.0% | 215.1% |
| TAR3 ACE | 1.49 | 0.79 | 1.59 | -46.8% | 101.5% |
| All other ACE | 355.69 | 351.49 | 356.39 | -1.2% | 1.4% |
| Total ACE | 360.52 | 354.00 | 361.61 | -1.8% | 2.2% |

Figure 8.2 Percentage decline in ACE for affected quota holders, year three, scenario two

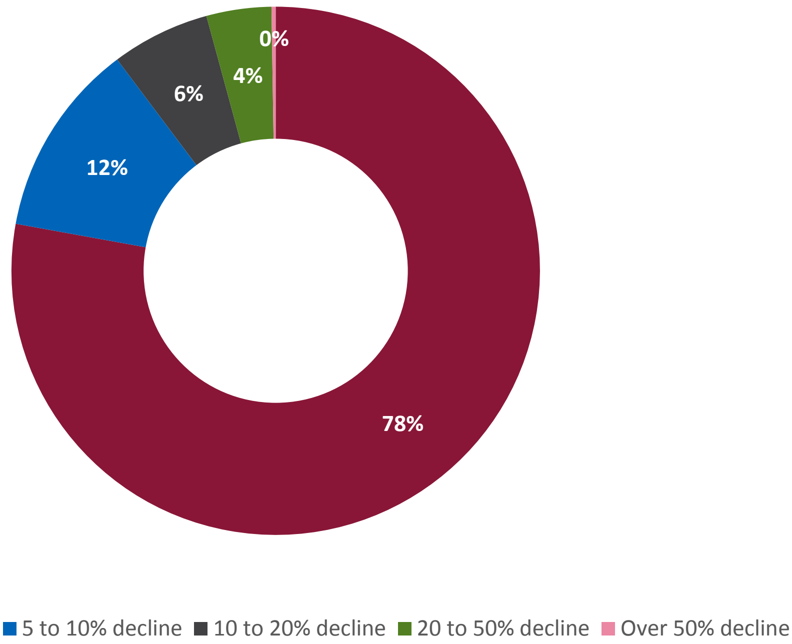


Table 8.3 Impact on quota holders, scenario three

| | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base year | Year 20 to Year 3 |
|---|---|---|---|---|---|
| TAR1 ACE | 1.52 | 1.21 | 1.57 | -20.5% | 29.3% |
| TAR2 ACE | 1.82 | 0.98 | 2.06 | -46.0% | 110.0% |
| TAR3 ACE | 1.49 | 1.05 | 1.59 | -29.5% | 51.9% |
| All other ACE | 355.69 | 352.83 | 356.39 | -0.8% | 1.0% |
| Total ACE | 360.52 | 356.07 | 361.61 | -1.2% | 1.6% |

Figure 8.3 Percentage decline in ACE for affected quota holders, year three, scenario three

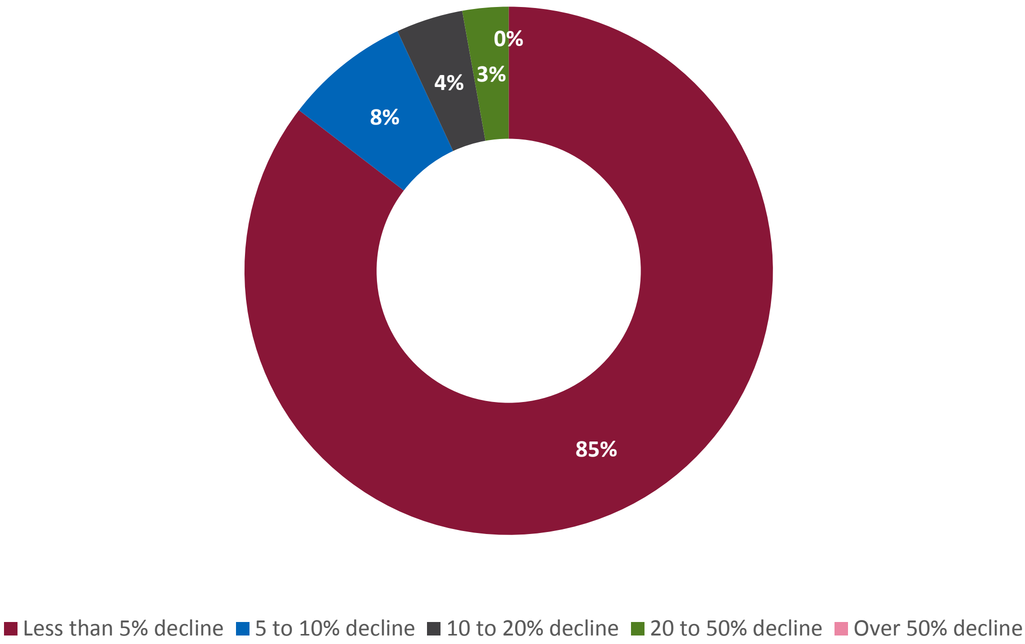


Table 8.4 Impact on quota holders, scenario four

| | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base year | Year 20 to Year 3 |
|---|---|---|---|---|---|
| TAR1 ACE | 1.52 | 1.25 | 1.25 | -18.1% | 0.0% |
| TAR2 ACE | 1.82 | 1.06 | 1.06 | -41.5% | 0.0% |
| TAR3 ACE | 1.49 | 1.11 | 1.11 | -25.1% | 0.0% |
| All other ACE | 355.69 | 353.17 | 353.17 | -0.7% | 0.0% |
| Total ACE | 360.52 | 356.59 | 356.59 | -1.1% | 0.0% |

Figure 8.4 Percentage decline in ACE for affected quota holders, year three, scenario four

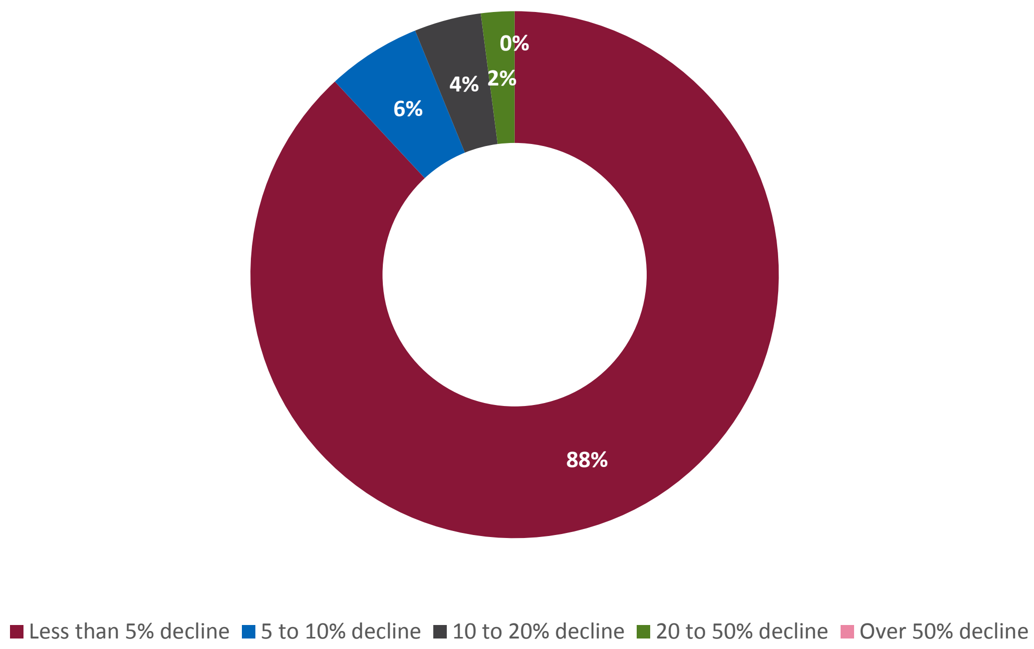
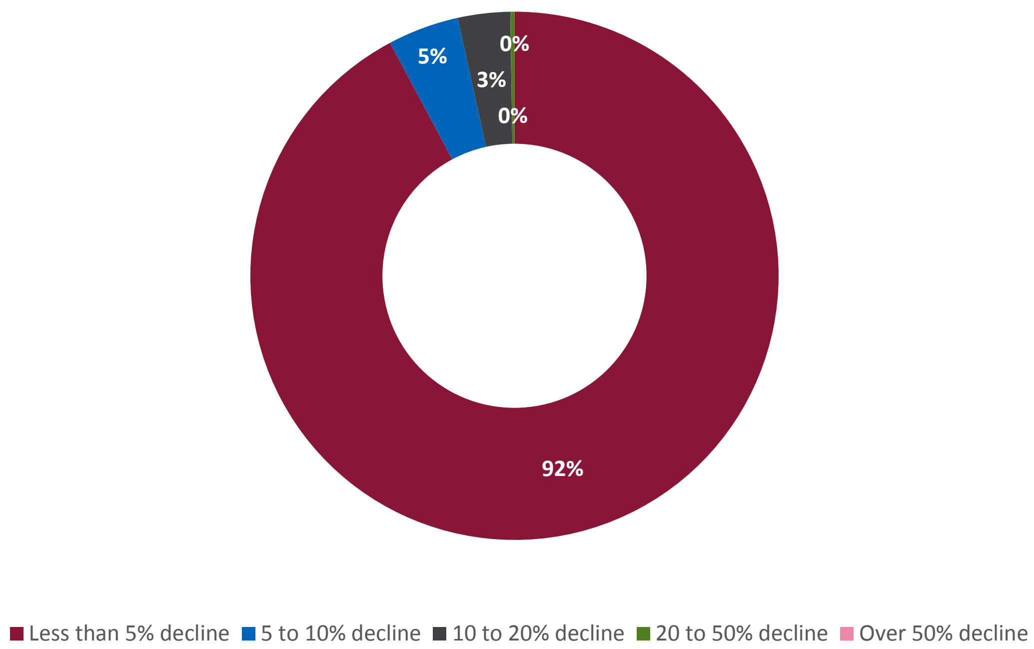


Table 8.5 Impact on quota holders, scenario five

| | Base year (thousand tonne) | Year 3 (thousand tonne) | Year 20 (thousand tonne) | Year 3 to Base year | Year 20 to Year 3 |
|---|---|---|---|---|---|
| TAR1 ACE | 1.52 | 1.36 | 1.36 | -10.8% | 0.0% |
| TAR2 ACE | 1.82 | 1.31 | 1.31 | -28.1% | 0.0% |
| TAR3 ACE | 1.49 | 1.32 | 1.32 | -11.4% | 0.0% |
| All other ACE | 355.69 | 354.19 | 354.19 | -0.4% | 0.0% |
| Total ACE | 360.52 | 358.18 | 358.18 | -0.6% | 0.0% |

Figure 8.5 Percentage decline in ACE for affected quota holders, year three, scenario five



# 9 Economic impact on regions

In this section BERL examines the economic impact of the projected change in revenue from fishing in terms of GDP and employment change on the regions supporting the fishing fleets on the east coast of New Zealand. BERL examines the economic impact in year three of the 20 year period, as it enables BERL to study the peak change in annual economic impact for each of the five scenarios. The process followed to assign the fish catch in each of the FMAs to each region is described in section 3.7 in the methodology.

BERL uses multiplier analysis to examine the impact. To re-iterate the underlying logic of multiplier analysis is relatively straightforward. An initial expenditure (**direct impact**) in an industry creates flows of expenditures that are magnified, or “multiplied”, as they flow through to the wider economy. This occurs in two ways:

- The industry purchases materials and services from supplier firms, who in turn make further purchases from their suppliers. This generates an **indirect impact.**
- People employed in the direct development and in firms supplying services earn income (mostly from wages and salaries, but also from profits) which, after tax is deducted, is spent on consumption. There is also an allowance for some savings. These are the **induced impact**.

Hence, for any amount spent in an area (direct effect), the actual output generated from that spend is greater once the flow on activity (indirect and induced effects) are taken into account.

For BERL’s analysis of the economic impacts on the regions, we have examined the direct impacts (direct impact) and the total impact (direct + indirect + induced impact)

The main findings of our analysis of the economic impact on region across the five scenarios is as follows:

- Across the five scenarios the Hawke’s Bay-Gisborne region will see the largest impact with direct losses of between $4.0 million in scenario five (Table 9.6), and $9.2 million in scenario two (Table 9.3). This translates to between $2.4 million to $5.5 million in total GDP impact, and between 22 FTEs and 49 FTEs in total employment losses.
- In scenario **one** the Hawke’s Bay-Gisborne region sees the largest impact with a loss of $8.6 million in year three to the fishing industry (Table 9.2). This translates to a direct $2.4 million impact in GDP and employment loss of 21 FTEs. Using multipliers this direct impact will have a $5.1 million impact on GDP in this region, and an employment impact of 46 FTEs (Table 9.2). Outside Hawkes’s Bay-Gisborne, each other region sees an average loss of $1.9 million in revenue, which translates to a total GDP loss of $1.3 million and a total employment loss of 11 FTEs (Table 9.2). Under scenario one there will be average loss of $8.3 million spread over the seven regions across the 20 year period, which will generate a total impact of $5.3 million in GDP losses, and 48 FTEs (Table 9.7).
- In scenario **two** the Hawke’s Bay-Gisborne region sees the largest impact with a loss of $9.2 million in year three to the fishing industry (Table 9.3). This translates to a direct $2.6 million impact in GDP and employment loss of 22 FTEs. Using multipliers this direct impact will have a $5.5 million impact on GDP in this region, and an employment impact of 49 FTEs (Table 9.3). Outside Hawkes’s Bay-Gisborne, each other region sees an average loss of $2.1 million in revenue, which translates to a total GDP loss of $1.4 million and a total employment loss of 13 FTEs (Table 9.3). Under scenario two there will be average loss of $8.3 million spread over the seven regions across the 20 year period, which will generate a total impact of $5.3 million in GDP losses, and 48 FTEs (Table 9.7).
- In scenario **three** the Hawke’s Bay-Gisborne region sees the largest impact with a loss of $6.6 million in year three to the fishing industry (Table 9.4). This translates to a direct $1.9 million impact in GDP and employment loss of 16 FTEs. Using multipliers this direct impact will have a $4.0 million impact on GDP in

this region, and an employment impact of 36 FTEs (Table 9.4). Outside Hawkes's Bay-Gisborne, each other region sees an average loss of $1.4 million in revenue, which translates to a total GDP loss of $0.9 million and a total employment loss of 8 FTEs (Table 9.4). Under scenario three there will be average loss of $11.7 million spread over the seven regions across the 20 year period, which will generate a total impact of $7.4 million in GDP losses, and 67 FTEs (Table 9.7).

- In scenario **four** the Hawke's Bay-Gisborne region sees the largest impact with a loss of $6 million in year three to the fishing industry (Table 9.5). This translates to a direct $1.7 million impact in GDP and employment loss of 15 FTEs. Using multipliers this direct impact will have a $3.6 million impact on GDP in this region, and an employment impact of 32 FTEs (Table 9.5). Outside Hawkes's Bay-Gisborne, each other region sees an average loss of $1.2 million in revenue, which translates to a total GDP loss of $0.8 million and a total employment loss of 7 FTEs (Table 9.5). Under scenario four there will be average loss of $13.3 million spread over the seven regions across the 20 year period, which will generate a total impact of $8.4 million in GDP losses, and 75 FTEs (Table 9.7).
- In scenario **five** the Hawke's Bay-Gisborne region sees the largest impact with a loss of $4.0 million in year three to the fishing industry (Table 9.6). This translates to a direct $1.1 million impact in GDP and employment loss of 10 FTEs. Using multipliers this direct impact will have a $2.4 million impact on GDP in this region, and an employment impact of 22 FTEs (Table 9.6). Outside Hawkes's Bay-Gisborne, each other region sees an average loss of $0.7 million in revenue, which translates to a total GDP loss of $0.4 million and a total employment loss of 4 FTEs (Table 9.6). Under scenario five there will be average loss of $8.1 million spread over the seven regions across the 20 year period, which will generate a total impact of $5.1 million in GDP losses, and 45 FTEs (Table 9.7).

To provide further insight into the economic impact on the seven regions, Table 9.1 shows the estimated 2017 national and regional GDP ($millions) and employment (FTEs) currently associated with the rock lobster and crab potting; prawn fishing; line fishing; fish trawling, seining and netting; and other fishing industries.

Employment numbers are based on February 2017 employee counts from each industry from Statistics New Zealand Business Demography dataset, while GDP has been attributed from Statistics New Zealand's 2017 national accounts totals for the fishing; aquaculture; and agriculture, forestry and fishing support services sector.

Table 9.1 Total GDP ($m) and employment (FTEs) for the fishing industry, by region, 2017

| Regions | GDP ($m) | Employment (FTEs) |
|---|---|---|
| Northland | $3.6 | 39 |
| Auckland | $6.1 | 66 |
| Bay of Plenty | $7.3 | 79 |
| Hawke's Bay-Gisborne | $4.0 | 44 |
| Wellington | $4.0 | 44 |
| Canterbury | $37.6 | 409 |
| Otago | $2.4 | 26 |
| **New Zealand** | **$165.6** | **1,801** |

Overall, apart from the Canterbury region, the other regions have a small number of FTEs employed in the fishing industries.

Table 9.2 Regional economic impact, year three, scenario one

| Regions | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Northland | $2.2 | $3.6 | $0.6 | $1.3 | 7 | 13 |
| Auckland | $1.3 | $2.3 | $0.4 | $0.9 | 4 | 8 |
| Bay of Plenty | $2.5 | $4.7 | $0.7 | $1.7 | 7 | 16 |
| Hawke's Bay-Gisborne | $8.6 | $14.1 | $2.4 | $5.1 | 21 | 46 |
| Wellington | $1.1 | $1.9 | $0.3 | $0.6 | 3 | 3 |
| Canterbury | $3.6 | $7.0 | $1.0 | $2.6 | 8 | 23 |
| Otago | $0.9 | $1.4 | $0.2 | $0.5 | 2 | 5 |

Table 9.3 Regional economic impact, year three, scenario two

| Regions | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Northland | $2.4 | $4.0 | $0.7 | $1.4 | 8 | 15 |
| Auckland | $1.4 | $2.5 | $0.4 | $0.9 | 5 | 9 |
| Bay of Plenty | $2.8 | $5.1 | $0.8 | $1.8 | 8 | 18 |
| Hawke's Bay-Gisborne | $9.2 | $15.2 | $2.6 | $5.5 | 22 | 49 |
| Wellington | $1.3 | $2.1 | $0.4 | $0.7 | 3 | 4 |
| Canterbury | $3.9 | $7.7 | $1.1 | $2.9 | 9 | 25 |
| Otago | $1.0 | $1.6 | $0.3 | $0.6 | 2 | 5 |

Table 9.4 Regional economic impact, year three, scenario three

| Regions | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Northland | $1.7 | $2.7 | $0.5 | $0.9 | 5 | 10 |
| Auckland | $0.9 | $1.7 | $0.3 | $0.6 | 3 | 6 |
| Bay of Plenty | $1.9 | $3.4 | $0.5 | $1.2 | 5 | 12 |
| Hawke's Bay-Gisborne | $6.6 | $10.9 | $1.9 | $4.0 | 16 | 36 |
| Wellington | $0.9 | $1.4 | $0.2 | $0.5 | 2 | 3 |
| Canterbury | $2.5 | $4.9 | $0.7 | $1.8 | 6 | 16 |
| Otago | $0.6 | $1.0 | $0.2 | $0.4 | 1 | 3 |

Table 9.5 Regional economic impact, year three, scenario four

| Regions | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Northland | $1.5 | $2.4 | $0.4 | $0.8 | 5 | 9 |
| Auckland | $0.8 | $1.5 | $0.2 | $0.6 | 3 | 5 |
| Bay of Plenty | $1.7 | $3.0 | $0.5 | $1.1 | 5 | 11 |
| Hawke's Bay-Gisborne | $6.0 | $9.9 | $1.7 | $3.6 | 15 | 32 |
| Wellington | $0.8 | $1.3 | $0.2 | $0.4 | 2 | 2 |
| Canterbury | $2.1 | $4.1 | $0.6 | $1.6 | 5 | 13 |
| Otago | $0.5 | $0.8 | $0.1 | $0.3 | 1 | 3 |

Table 9.6 Regional economic impact, year three, scenario five

| Regions | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Northland | $0.9 | $1.4 | $0.2 | $0.5 | 3 | 5 |
| Auckland | $0.5 | $0.9 | $0.1 | $0.3 | 2 | 3 |
| Bay of Plenty | $1.0 | $1.8 | $0.3 | $0.7 | 3 | 6 |
| Hawke's Bay-Gisborne | $4.0 | $6.7 | $1.1 | $2.4 | 10 | 22 |
| Wellington | $0.5 | $0.9 | $0.1 | $0.3 | 1 | 2 |
| Canterbury | $1.0 | $1.9 | $0.3 | $0.7 | 2 | 6 |
| Otago | $0.2 | $0.4 | $0.1 | $0.1 | 1 | 1 |

By determining the total regional economic impacts for each year of the 20 year period and averaging it, across the 20 year period, we get Table 9.7. This table shows for each scenario the annual average regional economic impact felt across the seven regions. This table shows that while scenario two has the largest peak economic impact in year three of the 20 year period, as shown in Table 9.3, over the full 20 year period it has the second best annual average economic impact.

Table 9.7 Total regional economic impact, annual average over the 20 year period

| Scenarios | Direct Output ($m) | Total Output ($m) | Direct GDP ($m) | Total GDP ($m) | Direct Employment (FTEs) | Total Employment (FTEs) |
|---|---|---|---|---|---|---|
| Scenario 1 | -$8.3 | -$14.5 | -$2.3 | -$5.3 | -22 | -48 |
| Scenario 2 | -$8.3 | -$14.5 | -$2.3 | -$5.3 | -22 | -48 |
| Scenario 3 | -$11.7 | -$20.3 | -$3.3 | -$7.4 | -31 | -67 |
| Scenario 4 | -$13.3 | -$23.1 | -$3.7 | -$8.4 | -35 | -75 |
| Scenario 5 | -$8.1 | -$14.0 | -$2.3 | -$5.1 | -21 | -45 |

# 10 Impact on retail market

In this section BERL examines the change in the retail market in New Zealand in terms of the price of tarakihi and the demand for close alternative fish substitutes, such as gurnard and trevally. For each of the five scenarios, BERL ran three retail models that cover the main consumer reactions to a decrease in the availability of tarakihi on the domestic market. The details of the three retail models are:

- Retail model one in which tarakihi consumers continue to spend the same total amount on tarakihi, and will not substitute away from tarakihi to another fish.
- Retail model two in which tarakihi consumers continue to spend the same total amount on fish, but will substitute away from tarakihi once the price has increased to a substantial degree (halfway between current average price and the price determined in retail scenario one).
- Retail model three in which tarakihi consumers continue to spend the same total amount on fish, but will substitute away from tarakihi once the price has increased by more than 5 percent.

BERL have assumed that with the reduction in tarakihi catch, that no tarakihi will be exported. In addition BERL have assumed no change in the domestic retail price for gurnard and trevally. This is based on the assumptions that there was in 2016-17 1.7 thousand tonnes of gurnard TACC unfished, along with 0.4 thousand tonnes of trevally. In addition it was assumed that with extra demand for gurnard and trevally, the domestic market could be supplied from fish currently exported, of which around 10 percent of gurnard is exported and around 60 percent of trevally is exported.

The main findings from our analysis of the retail models across the five scenarios is as follows:

- Across all five scenarios the smaller the decrease in tarakihi availability the smaller the change in price for tarakihi the smaller the extra demand for gurnard and trevally will be.
- For scenario **one** the price of tarakihi under retail model one will reach a projected average value of $45.75, compared to the current retail average price of $32.88 (Table 10.1). For retail model two, once the price of tarakihi reaches $39.31, consumers will substitute away to the nearest priced fish species. In total each year a further 408 tonnes of gurnard and 580 tonnes of trevally will be demanded at their current prices (Table 10.1). For retail model three, once the price of tarakihi reaches $34.52, consumers will substitute away to the nearest priced fish. In total each year a further 711 tonnes of gurnard and 1,013 tonnes of trevally will be demanded at their current prices (Table 10.1).
- For scenario **two** the price of tarakihi under retail model one will reach a projected average value of $52.28, compared to the current retail average price of $32.88 (Table 10.2). For retail model two, once the price of tarakihi reaches $42.58, consumers will substitute away to the nearest priced fish species. In total each year a further 538 tonnes of gurnard and 766 tonnes of trevally will be demanded at their current prices (Table 10.2). For retail model three, once the price of tarakihi reaches $34.52, consumers will substitute away to the nearest priced fish. In total each year a further 985 tonnes of gurnard and 1,402 tonnes of trevally will be demanded at their current prices (Table 10.2).
- For scenario **three** the price of tarakihi under retail model one will reach a projected average value of $44.22, compared to the current retail average price of $32.88 (Table 10.3). For retail scenario two, once the price of tarakihi reaches $38.55, consumers will substitute away to the nearest priced fish species. In total each year a further 372 tonnes of gurnard and 529 tonnes of trevally will be demanded at their current prices (Table 10.3). For retail model three, once the price of tarakihi reaches $34.52, consumers will substitute away to the nearest priced fish. In total each year a further 636 tonnes of gurnard and 905 tonnes of trevally will be demanded at their current prices (Table 10.3).

- For scenario **four** the price of tarakihi under retail model one will reach a projected average value of $42.58, compared to the current retail average price of $32.88 (Table 10.4). For retail scenario two, once the price of tarakihi reaches $37.73, consumers will substitute away to the nearest priced fish species. In total each year a further 330 tonnes of gurnard and 470 tonnes of trevally will be demanded at their current prices (Table 10.4). For retail model three, once the price of tarakihi reaches $34.52, consumers will substitute away to the nearest priced fish. In total each year a further 549 tonnes of gurnard and 781 tonnes of trevally will be demanded at their current prices (Table 10.4).
- For scenario **five** the price of tarakihi under retail model one will reach a projected average value of $38.24, compared to the current retail average price of $32.88 (Table 10.5). For retail scenario two, once the price of tarakihi reaches $35.56, consumers will substitute away to the nearest priced fish species. In total each year a further 203 tonnes of gurnard and 290 tonnes of trevally will be demanded at their current prices (Table 10.5). For retail model three, once the price of tarakihi reaches $34.52, consumers will substitute away to the nearest priced fish. In total each year a further 282 tonnes of gurnard and 402 tonnes of trevally will be demanded at their current prices (Table 10.5).

Table 10.1 Retail models, scenario one

| | Retail Model 1 | Retail Model 2 | Retail Model 3 |
|---|---|---|---|
| Current price of Tarakihi | $32.88 | $32.88 | $32.88 |
| Future price of Tarahiki | $45.75 | $39.31 | $34.52 |
| Extra demand for Gurnard (tonnes) | 0 | 408 | 711 |
| Extra demand for Trevally (tonnes) | 0 | 580 | 1,013 |

Table 10.2 Retail models, scenario two

| | Retail Model 1 | Retail Model 2 | Retail Model 3 |
|---|---|---|---|
| Current price of Tarakihi | $32.88 | $32.88 | $32.88 |
| Future price of Tarahiki | $52.28 | $42.58 | $34.52 |
| Extra demand for Gurnard (tonnes) | 0 | 538 | 985 |
| Extra demand for Trevally (tonnes) | 0 | 766 | 1,402 |

Table 10.3 Retail models, scenario three

| | Retail Model 1 | Retail Model 2 | Retail Model 3 |
|---|---|---|---|
| Current price of Tarakihi | $32.88 | $32.88 | $32.88 |
| Future price of Tarahiki | $44.22 | $38.55 | $34.52 |
| Extra demand for Gurnard (tonnes) | 0 | 372 | 636 |
| Extra demand for Trevally (tonnes) | 0 | 529 | 905 |

Table 10.4 Retail models, scenario four

| | Retail Model 1 | Retail Model 2 | Retail Model 3 |
|---|---|---|---|
| Current price of Tarakihi | $32.88 | $32.88 | $32.88 |
| Future price of Tarahiki | $42.58 | $37.73 | $34.52 |
| Extra demand for Gurnard (tonnes) | 0 | 330 | 549 |
| Extra demand for Trevally (tonnes) | 0 | 470 | 781 |

Table 10.5 Retail models, scenario five

| | Retail Model 1 | Retail Model 2 | Retail Model 3 |
|---|---|---|---|
| Current price of Tarakihi | $32.88 | $32.88 | $32.88 |
| Future price of Tarahiki | $38.24 | $35.56 | $34.52 |
| Extra demand for Gurnard (tonnes) | 0 | 203 | 282 |
| Extra demand for Trevally (tonnes) | 0 | 290 | 402 |

# 11 Opportunity costs

To explore the opportunity cost of the tarakihi stock rebuild taking longer than expected, BERL has explored two different approaches. For the first approach BERL calculated the annual catch and revenue amounts for each scenario over a 40 year period, rather than a 20 year period.

This approach has been undertaken for two reasons, the first is to explore how each scenario will perform in terms of catch and revenue over a longer period in time, and will that change the relative performances between the scenarios. The second reason is to examine if and when the other scenarios will provide a relatively better performance in terms of average annual catch and revenue compared to scenario five. Scenario five has the best relative performance across the initial twenty year period examined, but unlike the other four scenarios, has a defined end point for the reduction in tarakihi catch. Therefore for the purpose of this exercise BERL has assumed that the tarakihi reduction under this scenario will run for at least 40 years.

For the second approach BERL has explored a new scenario in which the 55 percent reduction in total catch seen in scenario one does not end at year 10, but ends at year 20. This approach allows BERL to explore the opportunity costs of the tarakihi taking twice as long as expected to complete. This assumption is based on scenarios one, two, three and four that there is a 50 percent probability that the tarakihi stock numbers will be at the target level by the end of the reduction period. BERL has used scenario one as the base for this new scenario and compared its performance to scenario one.

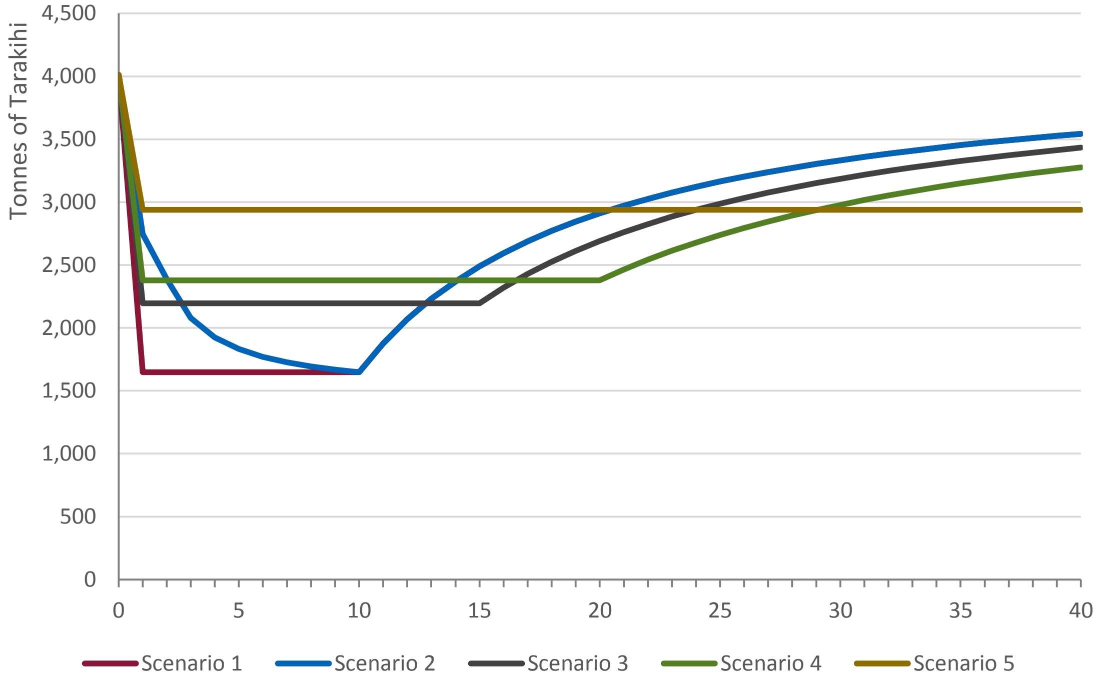
## 11.1 Scenario costs recalculated over a longer time period

To expand the tarakihi catch, total catch and total fish revenue out from a 20 year period to 40 year period, BERL has assumed that for scenario one, two, three and four, each year from year 20 to year 40 fishers can catch 4,175 tonnes of tarakihi, with its associated catch. For scenario five BERL has assumed that the tarakihi is still reduced by 20 percent to 2,938 tonnes, for each year between year 20 and year 40.

To compare the results between the five scenarios, BERL has graphed a running annual average catch of tarakihi, as well as a running annual average revenue. To calculate the running annual averages for each scenario BERL has for each year, averaged all the years up to that point. For example for year 10 the annual average tarakihi catch for each scenario is the average of the annual tarakihi catch for years one to 10, while for year 40 the annual average tarakihi catch for each scenario is the average of the annual tarakihi catch for years one to 40.

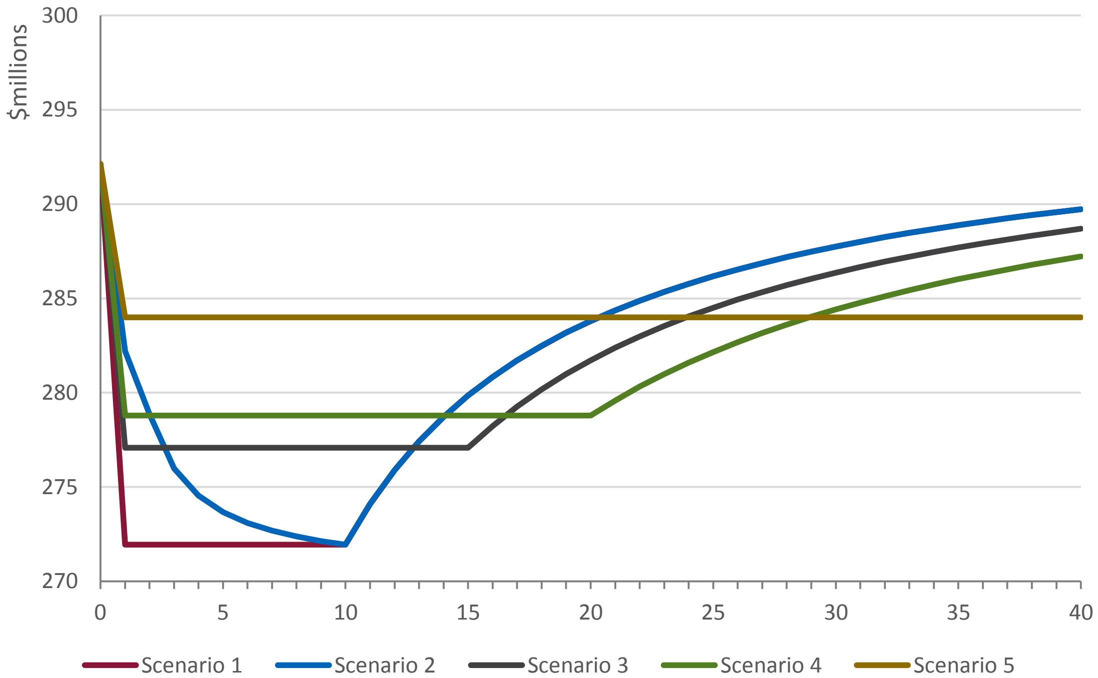
Overall, Figure 11.1 shows that by year 40, scenario one, two, three and four will all have higher annual average catches of tarakihi, resulting from an extended time period when these four scenarios have been able to catch at a higher level than scenario five after their reduction and rebuild periods ended. Also as shown in the figure, scenario one and two will surpass scenario five over a 21 year period, while scenario three will surpass scenario five over a 25 year period, and scenario four will need a 30 year period in order to have a higher annual average catch level of tarakihi compared to scenario five.

Figure 11.1 Average annual catch of tarakihi in FMA1, FMA2 and FMA3, scenarios




Looking broader than just tarakihi catch, Figure 11.2 shows that total average annual revenue generated from fish catches under each scenario. Similarly to previous figure, scenario one and two will have higher average annual revenues after 21 years than scenario five, while scenario three will have higher average annual revenues after 24 years, and scenario four will take 29 years to surpass the average annual revenue generated by scenario five.

Figure 11.2 Average annual total revenue in FMA1, FMA2 and FMA3, scenarios



## 11.2 Opportunity cost of stock rebuild taking longer

To determine the opportunity cost of rebuilding the tarakihi stock taking longer than the initially devised 10 year period, BERL have taken scenario one and extended the reduction in tarakihi catch from 10 years to 20 years. To model this alternative to scenario one, BERL undertook the same steps as other scenarios to model the change in catch volumes, and catch revenues. Comparing the difference in catch volumes and catch revenues over the 20 year period under this alternative scenario (scenario 1A) to scenario one, will highlight the opportunity costs that will arise from the rebuild of the tarakihi stock taking longer than anticipated.

Examining the total catch volumes for scenario one and scenario 1A, as shown in Table 11.1, shows that if the tarakihi rebuild took an additional 10 years there would be average additional loss of 1.42 thousand tonne of tarakihi. This would see around 28.31 thousand tonne less tarakihi caught over the 20 year period. In addition the total catch over the 20 years would be reduced by 73.69 thousand tonnes, or around 3.68 thousand tonnes per year.

Table 11.1 Total catch volumes, scenarios 1 and 1A

| Scenarios | Total summed catch over 20 years (thousand tonnes) | | Average annual catch over 20 years (thousand tonnes) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 2,894.59 | 58.22 | 144.73 | 2.91 |
| Scenario 1A | 2,820.90 | 29.91 | 141.04 | 1.50 |
| Base Year | | | 147.28 | 4.64 |

Examining the total catch revenue for scenario one and scenario 1A, as shown in Table 11.2, shows that if the tarakihi rebuild took an additional 10 years there would be average additional loss of $5.62 million worth of tarakihi. This would see an additional drop of around $112.33 million worth of tarakihi caught over the 20 year period, compared to scenario one. In addition the total catch over the 20 years would be reduced by $237.22 million, or around $11.86 million per year.

Table 11.2 Total catch revenue, scenarios 1 and 1A

| Scenarios | Total summed Fish revenue over 20 years ($millions) | | Average Fish revenue over 20 years ($millions) | |
|---|---|---|---|---|
| | Total catch | Tarakihi | Total catch | Tarakihi |
| Scenario 1 | 5,676.01 | 230.99 | 283.80 | 11.55 |
| Scenario 1A | 5,438.79 | 118.65 | 271.94 | 5.93 |
| Base Year | | | 292.13 | 18.43 |

# 12 Conclusion

After examining the impact each scenario has in terms of reduction in catch volumes, catch revenue, impact on fishers, impact on quota holders, and impact on regions, it is clear that scenario five has the smallest impact of any of the scenarios. The issue with scenario five is that it is the only scenario that does not have a 50 percent probability of rebuilding the tarakihi stock to 40 percent of $B_0$ within the 20 year period examined. In addition the relative impacts of scenario one would surpass scenario five if the time period explored was at least one year longer, as shown in section 11.1.

Of the remaining four scenarios which do provide a 50 percent probability of rebuilding the tarakihi stock to 40 percent of $B_0$ within the 20 year period examined, scenario one has the smallest impact over the 20 year period, marginally ahead of scenario two. This is not surprising given the difference between scenario one and two is around how the TACC reduction is implemented, with both having a 10 year timeframe for tarakihi stock rebuild. With scenario one having a straight reduction in year one, while scenario two has a staged reduction across three years.

# Appendix A Fish prices per kilogram

| Fish species | Final price | Fish species | Final price | Fish species | Final price | Fish species | Final price |
|---|---|---|---|---|---|---|---|
| ABR | 0.85 | BWH | 1.15 | EGA | 0.73 | HOK | 1.05 |
| ALB | 3.52 | BWS | 0.21 | EGR | 0.72 | HOR | 0.12 |
| ALG | 0.50 | BYA | 3.84 | ELE | 3.52 | HPB | 8.00 |
| ANC | 1.18 | BYX | 3.02 | EMA | 0.57 | JAV | 0.72 |
| ANT | 0.82 | CAC | 0.35 | EPL | 0.72 | JDO | 8.79 |
| ASH | 0.50 | CAN | 0.72 | EPR | 0.50 | JFI | 0.72 |
| BAC | 0.50 | CAR | 0.73 | ERA | 0.72 | JGU | 0.72 |
| BAR | 0.45 | CAT | 0.72 | ESZ | 0.50 | JMA | 0.40 |
| BAT | 0.72 | CAU | 0.72 | ETB | 0.72 | KAH | 0.90 |
| BBA | 0.85 | CBE | 0.72 | ETL | 0.72 | KBB | 0.57 |
| BBE | 0.72 | CDL | 1.36 | FHD | 0.72 | KEL | 0.83 |
| BCM | 1.90 | CDO | 0.72 | FHG | 0.50 | KIC | 0.20 |
| BCO | 16.27 | CHC | 0.20 | FLA | 7.45 | KIN | 7.68 |
| BCR | 0.85 | CHG | 0.84 | FLY | 0.74 | KOH | 0.72 |
| BEE | 0.77 | CHI | 0.84 | FOR | 0.85 | KWH | 0.71 |
| BEL | 0.72 | CHP | 0.78 | FOX | 0.85 | LAN | 0.74 |
| BEM | 0.82 | CMO | 0.72 | FRO | 0.73 | LAT | 0.84 |
| BEN | 0.72 | COC | 3.69 | FTU | 0.50 | LCA | 0.50 |
| BER | 0.72 | COM | 0.62 | GAR | 11.08 | LCH | 0.72 |
| BIG | 26.64 | CON | 0.82 | GLM | 0.86 | LDO | 2.46 |
| BKM | 0.83 | CRA | 81.62 | GMU | 5.31 | LEA | 1.12 |
| BLO | 0.72 | CRB | 0.72 | GON | 0.72 | LEG | 0.72 |
| BLU | 0.75 | CSQ | 0.74 | GRC | 0.72 | LEP | 0.85 |
| BMA | 0.73 | CUB | 0.74 | GRP | 0.84 | LES | 1.81 |
| BMO | 0.72 | CUC | 0.72 | GSA | 0.50 | LFB | 0.72 |
| BNS | 9.03 | CYO | 0.84 | GSC | 0.29 | LIN | 3.89 |
| BOA | 0.72 | CYP | 0.72 | GSH | 0.58 | LSK | 0.83 |
| BPE | 0.72 | DAN | 3.13 | GSP | 0.62 | MAC | 0.72 |
| BPF | 1.00 | DAP | 0.50 | GSQ | 0.72 | MAK | 0.60 |
| BRA | 0.73 | DAS | 0.85 | GTR | 0.73 | MAR | 0.83 |
| BRC | 0.81 | DFI | 0.50 | GUR | 2.77 | MDI | 2.04 |
| BRL | 0.50 | DOF | 0.85 | HAG | 1.83 | MDO | 0.72 |
| BRZ | 0.72 | DRU | 0.72 | HAK | 1.61 | MIQ | 0.72 |
| BSH | 3.48 | DSK | 0.72 | HCO | 0.86 | MJA | 0.50 |
| BSL | 0.81 | DSU | 2.89 | HCR | 0.69 | MMI | 0.83 |
| BSP | 0.84 | DWD | 0.72 | HEP | 0.50 | MOD | 0.73 |
| BSQ | 0.72 | DWE | 0.72 | HEX | 0.73 | MOK | 2.09 |
| BTU | 0.85 | DWO | 0.72 | HHS | 0.76 | MOO | 3.18 |
| BUT | 7.17 | ECO | 0.72 | HJO | 0.72 | MOR | 0.37 |

| Fish species | Final price | Fish species | Final price | Fish species | Final price | Fish species | Final price |
|---|---|---|---|---|---|---|---|
| NCB | 0.72 | PZL | 24.02 | SDR | 0.72 | STY | 0.72 |
| NSD | 1.05 | QSC | 2.04 | SEL | 0.72 | SUN | 0.84 |
| NSP | 0.76 | RAT | 0.72 | SEV | 0.75 | SUR | 8.28 |
| NTU | 0.78 | RAY | 0.82 | SFE | 5.69 | SWA | 1.11 |
| OBS | 0.72 | RBM | 1.75 | SFI | 0.92 | SWE | 0.72 |
| OCT | 3.45 | RBP | 0.81 | SFN | 0.72 | SWO | 7.86 |
| OEL | 0.50 | RBT | 0.32 | SHR | 1.81 | SYN | 0.50 |
| OEO | 1.25 | RBY | 1.48 | SKI | 2.70 | TAR | 3.97 |
| OFH | 0.84 | RCH | 0.72 | SKJ | 0.72 | TEL | 0.76 |
| ONG | 0.72 | RCO | 0.81 | SLK | 0.72 | THR | 0.81 |
| OPE | 0.72 | RHY | 0.72 | SLL | 0.72 | TOA | 0.72 |
| ORH | 3.38 | RIB | 1.39 | SLS | 0.50 | TOR | 52.67 |
| OSD | 0.75 | RMO | 0.73 | SMC | 0.72 | TRA | 0.72 |
| OSE | 0.85 | RMU | 1.04 | SNA | 9.45 | TRE | 2.27 |
| OSK | 0.84 | ROC | 0.72 | SND | 0.76 | TRI | 0.72 |
| OSP | 1.90 | RPE | 0.83 | SNI | 0.79 | TRU | 3.73 |
| OYS | 4.77 | RPI | 0.83 | SPD | 0.28 | TSQ | 0.72 |
| PAD | 5.18 | RRC | 0.81 | SPE | 0.94 | TUB | 0.72 |
| PAR | 3.54 | RSC | 0.73 | SPF | 1.10 | UNI | 0.50 |
| PAU | 62.79 | RSK | 0.72 | SPI | 0.78 | Unknown | 0.50 |
| PDO | 0.83 | RSN | 11.20 | SPO | 5.33 | VIT | 0.50 |
| PHC | 48.00 | RUD | 0.80 | SPP | 0.73 | VOL | 1.45 |
| PIG | 0.72 | SAE | 0.83 | SPR | 1.78 | VSQ | 0.72 |
| PIL | 1.20 | SAL | 0.72 | SPZ | 0.73 | WAH | 0.73 |
| PIP | 0.72 | SAM | 0.72 | SQI | 0.72 | WAR | 2.02 |
| PLS | 0.72 | SAU | 0.72 | SQU | 1.69 | WHE | 1.51 |
| PLZ | 0.72 | SBI | 0.50 | SQX | 0.72 | WHI | 0.72 |
| PMA | 0.75 | SBK | 0.72 | SRH | 0.72 | WHR | 0.72 |
| POP | 0.72 | SBO | 0.79 | SSF | 0.84 | WHX | 0.83 |
| POR | 4.26 | SBR | 0.85 | SSH | 0.72 | WIT | 0.73 |
| POS | 0.42 | SBW | 0.78 | SSI | 0.72 | WRA | 0.73 |
| POT | 1.90 | SCA | 60.02 | SSK | 0.67 | WSE | 1.51 |
| PPI | 0.92 | SCC | 3.97 | STA | 1.79 | WSQ | 0.72 |
| PRA | 0.72 | SCG | 0.73 | STB | 0.50 | WWA | 2.20 |
| PRK | 4.93 | SCH | 3.52 | STG | 0.80 | YBO | 0.72 |
| PSK | 0.72 | SCI | 19.88 | STM | 0.84 | YCO | 0.72 |
| PSY | 0.50 | SCO | 0.85 | STN | 18.44 | YEM | 5.25 |
| PTO | 16.91 | SDF | 0.72 | STR | 0.72 | YFN | 10.88 |
| PUF | 0.72 | SDO | 0.72 | STU | 0.72 | | |