Measuring New Zealand's Blue Economy

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m.e consulting

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Executive Summary

New Zealand's isolated location on the southern edge of the Pacific Ocean means that the country controls a vast maritime area (seventh largest in the world[1]) which contains substantial resources. At over 4,083,000 square kilometres the maritime area around New Zealand is more than 15 times larger than the land area (268,000km^2). The nature of the coastal geography of New Zealand also means that the country has one of the longest coast lines in the world, at 15,134 kilometres - there are only eight countries with more coastline.[2]

Until recently, the vast scale and the relatively low utilisation of the maritime area has meant that there have been few instances of conflict between different users of the resource. The majority of conflicts have occurred in harbours and inshore areas, with limited conflicts in the outer areas. While the maritime area is vast, it is not limitless, which means that more conflicts will arise between different users as the population increases.

The nature of economic value that society derives from the maritime area around New Zealand has been changing and growing. Therefore, it is expected that the government will need to control activities in the maritime area to maximise the benefits to New Zealand, while avoiding the negative costs. In order for the government to make informed decisions about potential controls, there needs to be fundamental research to understand the scale, nature, and location of the types of uses that occur currently and historically in the maritime area.

The Sustainable Seas National Science Challenge is undertaking core research required to ensure Aotearoa New Zealand uses its marine resources in ways that sustain healthy ecosystems and provide value for all New Zealanders. At its core, the Challenge aims to foster a use of the resource that is inclusive of Māori and key stakeholders, thus delivering and enhancing existing social, economic and cultural values.

The objective of this report is to establish a basis for developing measures that will support business, community, policy and regulatory actors to encourage a 'Blue Economy' in New Zealand and inform an ecosystem-based management regulatory regime.

The Sustainable Seas National Science Challenge defines a blue economy as one that is comprised of activities that will *generate economic value and* ***contribute positively to social, cultural and ecological well-being***. From the point of view of measurement, it is an aspirational definition. It is not possible at this stage to strip out those elements of a marine economy that meet this definition. In this report, we use the term blue economy to capture the aspiration, but the measures relate to *all marine economy activity*.

The following three steps have been undertaken in this report,

- Extent of the Blue Economy: define and describe the Blue Economy using frameworks that are commonly adopted in international literature.

[1] Based on Economic Exclusion Zone (EEZ). Only United States, Australia, Russia, Indonesia, Canada and Japan have greater maritime areas. Note this excludes France and Britain, who could be considered to have large EEZ associated with the remaining Pacific, Atlantic and Caribbean island territories.

[2] CIA (2017) World Fact Book 2016-17.

- **Populating the Framework:** This report populates the framework with information and knowledge which is available to measure the Blue Economy. To a large degree this research has drawn on available data and literature.
- **Identifying Gaps:** Finally, this report also identifies the gaps in information and knowledge that is required to properly inform the frameworks.

This report provides the following key findings,

Sectors of the Blue Economy

- The Sectors in the Blue Economy have a significant role in the national economy. This report estimates that around 3% of GDP in the economy is related to blue economy, with a total of $7.4 billion directly related to sectors that rely on the maritime area. The Blue Economy directly sustains employment of nearly 70,000, which is equivalent to 3.3% of total employment in New Zealand.
- The direct value added associated with the Blue Economy has increased by 2% per annum over the last decade, which is slower than the background growth observed in the economy. Most industries within the Blue Economy have seen strong growth (Commercial Fisheries, Coastal Tourism, Government Services), however the Offshore Minerals industry recorded a substantial drop over the decade (decline of over $1 billion).

Economic Benefits of the Blue Economy

- The economic benefits that are generated by the Blue Economy have been measured using a Total Economic Valuation framework, which measures use and non-use values. This assessment shows that while the economic benefits from use in the BE are substantial (approx. 37%), the economic benefits derived from non-use values are in combination much larger (in the order of tens of billions).
- The Total Economic Valuation assessment adopted in this report provides a general understanding of the potential scale of the economic benefits. It is important to include this assessment, as it provides an understanding of the potential magnitude of the different economic benefits relative to each other benefit. However, the results should not be viewed as providing a detailed estimate.

Spatial Distribution of the Blue Economy

- The economic benefits received from the maritime area have grown over the last decade, however the growth has been uneven across the maritime area. Most of the growth was located in a few of the areas near the main cities (Auckland, Christchurch, Wellington and Tauranga). Taranaki is the only area that experienced negative growth over the decade – which is primarily related to the decline in Offshore Minerals.
- The density of economic benefits received from the maritime area provides another alternative approach to interpret the relative value of the maritime areas. The results show most of the value is located in the inshore areas (near the main cities), while the offshore areas produce relatively little economic benefit.

Finally, the research conducted for this report has shown that there are still significant gaps in the knowledge base on the quantum and location of the economic benefits associated with the maritime area of New Zealand. While this report provides an understanding of the likely order of magnitude of the economic benefits, it does not establish a complete quantification of some of the key values. This report notes a number of research areas that could be implemented to provide a better understanding of the Blue Economy.

1 Introduction

New Zealand's isolated location on the southern edge of the Pacific Ocean means that the country controls a vast maritime area (seventh largest in the world[3]) which contains substantial resources. At over 4,083,000 square kilometres the maritime area around New Zealand is more than 15 times larger than the land area (268,000km^2). The nature of the coastal geography of New Zealand also means that the country has one of the longest coast lines in the world, at 15,134 kilometres there are only eight countries with more coastline.[4]

In 2017 direct economic activity that occurs in the maritime area was valued at $3.8 billion, which is equivalent to 1.4% of New Zealand's economy[5] and contributed to the employment of approximately 21,000 people[6]. The direct economic activity generates additional activity in the rest of the economy, in total Stats NZ considers that economic activity associated with the maritime area to be worth $7.0 billion in total, which is equivalent to 2.6% of the national economy in 2017.

Until recently, the vast scale and the relatively low utilisation of the maritime area has meant that there have been few instances of conflict between different users of the resource. The majority of conflicts have occurred in harbours and inshore areas, with limited conflicts in the outer areas. While the maritime area is vast, it is not limitless, which means that more conflicts will arise between different users as the population increases.

A key matter is the structure of ownership and stewardship of the maritime area. Unlike the land resource, few parts of the marine resource are permanently occupied, and few parts are owned. Much of the use of the marine resource (surface, subsurface, and seabed space) is "temporary" and not exclusive, unless different activities coincide in time and space. This means multiple uses of the maritime area may occur at different times – unlike the land resource where ownership confers the right to occupy and utilise and exclude other persons/activities. The maritime area is held 'in common', for all to use, on a first-come, first-served basis. Economic theory shows that resources held in common tend to be overutilized, with individuals collectively as a group using the resources to a point which is inefficient – famously known as "the tragedy of the commons".[7]

The nature of economic value that society derives from the maritime area around New Zealand has been changing and growing. Therefore, it is expected that the government will need to control activities in the maritime area to maximise the benefits to New Zealand, while avoiding the negative costs. In order for the government to make informed decisions about potential controls, there needs to be fundamental research to understand the scale, nature, and location of the types of uses that occur currently and historically in the maritime area.

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[3] Based on Economic Exclusion Zone (EEZ). Only United States, Australia, Russia, Indonesia, Canada and Japan have greater maritime areas. Note this excludes France and Britain, who could be considered to have large EEZ associated with the remaining Pacific, Atlantic and Caribbean island territories.

[4] CIA (2017) World Fact Book 2016-17.

[5] Stats NZ (2019) Environmental Economic Accounts – Total Marine Economy 2017.

[6] Stats NZ (2019) Business Demography – Employment Count.

[7] Hardin, G. (1968) "The Tragedy of the Commons" Science 162 (3859: 1243-1248).

This report has been commissioned by Sustainable Seas (SS) under the National Science Challenge (NSC) to collect available information on the nature of economic value that is derived from the marine environment. Market Economics (M.E) has worked with researchers from the University of Auckland - School of Environment (UOA-SOE), where possible to quantify the "Blue Economy".

1.1 Blue Economy

There is no consensus internationally on what the concept of the 'Blue Economy' (BE) encompasses. The narrowest definition of the BE focusses on the market value generated that is associated with the maritime area. This measure has been applied most recently by the European Commission (EC) in 2018, which conducts an annual measurement of the trends, performance, and growth of the European Union's economy that are related to established marine sectors.[8] A similar method has been adopted by Stats NZ in the Environment Accounts, which measures the "Marine Economy".[9] This narrow definitions adopts a method that focusses on market values generated by industries that use the maritime area in their production model, this generally focusses on established marine industries (commercial fishing, shipping, off shore minerals, tourism etc.) and in some instance extends to emerging sectors (energy, biotechnology, etc.).

The BE has also been defined in wider terms to include all economic benefits generated by the maritime area, which extends from just measuring market values to include non-market values. Conservation International considers that the Blue Economy includes economic benefits that may not be marketed, which would include economic benefits associated with recreational and cultural uses of the maritime area. This definition would extend to include non-use values, where the existence of ecosystems and biodiversity generates real economic benefits for society. The wider definition would align closely to the new policy framework that the New Zealand Government is developing.[10]

Finally, the BE is also commonly framed as a notion encouraging better stewardship of the maritime area. This concept of the BE focusses on sustainable economic development and understanding the potential conflicts between competing uses, commonly between activities in the economy (industries in narrow definition) which are generally extractive/exclusory and the wider economic benefits (users and communities in the wider definition) which tend to be more sustainable. The Economist Intelligence Unit defines the BE as being a sustainable economy which emerges when economic activity is in balance with the long-term capacity of ecosystems to support this activity and remain resilient and healthy.[11]

The recent OECD report on the ocean economy shows that while there is no widely accepted definition of the BE, it is still important to develop a knowledge base from which future decisions can be made.[12] New Zealand's maritime area is vast, which presents significant opportunities for society, however there will be increasing conflicts over the use of this limited resource which will need to be managed to ensure an efficient and sustainable outcome for society.

[8] European Commission (2018) The 2018 Annual Economic Report on the EU Blue Economy.

[9] Stats NZ (2019) Environmental Economic Accounts.

[10] Treasury New Zealand (2018) Intergenerational Wellbeing: Weaving the Living Standards Framework into public policy.

[11] Economist Intelligence Unit (2015) The Blue Economy: Growth, opportunity and a sustainable ocean economy.

[12] OECD (2019) Rethinking Innovation for a Sustainable Ocean Economy. https://doi.org/10.1787/9789264311053-en.

1.2 Objective and Scope

The Sustainable Seas National Science Challenge (SSNSC) is undertaking core research required to ensure Aotearoa New Zealand uses its marine resources in ways that sustain healthy ecosystems and provide value for all New Zealanders. At its core, the Challenge aims to foster a BE that is inclusive of Māori and key stakeholders, thus delivering and enhancing existing social, economic and cultural values.

The objective of this report is to establish a basis for developing measures that will support business, community, policy and regulatory actors to encourage a 'Blue Economy' in New Zealand and inform an ecosystem-based management (EBM) regulatory regime.

The scale and nature of the BE gives rise to a number of key issues which this report needs to address.

One obvious matter is that marine activity is not land-based, but has considerable functional overlap with land-based activity and resources. This means the BE must be examined both in and of itself, and also in conjunction with at least that land-based activity which is directly related, and also with the flow-on land-based activity.

A second key matter is the structure of ownership and stewardship of the marine resource. Unlike the land resource, few parts of the marine resource are permanently occupied, and few parts are owned. Much of the direct use or occupation of the marine resource (surface, subsurface, and seabed space) is "temporary" and not exclusive, unless different activities coincide in time and space. This means multiple uses of BE marine resources may occur at different times – unlike the land resource where ownership confers the right to occupy and utilise and exclude other persons/activities. Any framework to define and describe the BE must be able to accommodate this multiplicity of utilisation, effects, and inter-relationships.

Directly related to this is that the marine resource is not fixed in location. While the geographic boundaries may be defined (e.g. the bounds of a marine reserve) the tides and currents mean the sea itself is rather more flexible. This is relevant especially when there are flow-on effects, where activity or effects in one location transfer directly to another location(s).

In parallel with the multiplicity of uses or occupations is the multiplicity of the responsibilities for the marine resource, which is a critical matter for effective kaitiakitanga (guardianship) and EBM. Most of the marine resource is in public or shared ownership (especially through the Crown). At the same time, much of the activity within the resource is not usually directly observable, therefore effects and responsibilities for these effects may be difficult to establish (e.g. the relative contributions of commercial and recreational fishing to a reduction in fish stocks).

Nevertheless, despite these inherent complexities, description, and assessment of the BE, it is still subject to the simple and obvious structure of "what occurs where, and when", and the economic frameworks are directly relevant – as in, outcomes and effects arise from the nature, scale, location, and timing of activity, in combination with other activities. This can be a useful guide to a suitable framework for the BE.

1.3 Approach

The approach adopted in this report is to develop a draft Framework, as a structure which can adequately capture and represent each component of the BE as it currently exists, and accommodate other

components as they are defined, and integrated into the BE structure. This framework is broad, in order to cater for a wide variety of activities, environments and locations.

The framework has three dimensions:

i) Sector Activity – this covers how people derive market value from the maritime area, which is through the direct use of the maritime area and resources. This dimension of the BE focuses on values which are created in the economy. It follows the definition applied by the European Commission in the 2018 report.[13]

ii) Economic Benefits – extends the scope of the BE to include non-market values that are derived from the maritime area. There are significant values derived from both activity in the maritime area (such as customary and recreational) and from inherent values derived from the maritime area (largely non-use). Both aspects are important, since many in the community do not directly use or interact with the maritime area, but nevertheless derive considerable value from the existence and protection of the maritime area. This report applies the Total Economic Valuation (TEV) paradigm to understand this wider dimension of the BE.

iii) Spatial Location – also an obvious structure, GIS-based to place the various environments spatially, and to identify the distribution of activity and values in the BE. The spatial location provides a logical structure to cover different "environments" (or ecosystems) relating to EBM.

This simple 3-dimensional structure allows the framework to both accommodate a full range of activities/values sustained and environments contained within the maritime area, and to show spatial associations, and implied inter-relationships within the BE.

To illustrate, two important components of the BE are commercial fishing activity, and recreational fishing, which both deliver use benefits in TEV terms, one having a market value and the other having a non-market value. There is substantial information on commercial fishing (location, method, effort, catch) and reasonable information on recreational fishing, and both are obvious information layers (or sets of layers) for the framework. This understanding of the BE has an important locational component – where and when it occurs – and also the environmental components, in terms of in which ecosystems do the various commercial and recreational activities occur, and how they may conflict.

There is less information available on the cultural dimensions of fishing activity, and on the non-use values associated with the fish resource (which extend well beyond fishing activity). Nevertheless, these non-use values are an important aspect of TEV, and the Framework would need to capture the locational component and the environmental components of these activities / values – not least to understand their overlap with other components of the BE.

The frameworks in this report have been developed to do more than to simply log the locations where activities and environments coincide. While such information is important as a base, it will also be important to identify wherever possible the nature of the interaction (at least in summary terms). This is

[13] European Union (2018) The 2018 Annual Economic Report on the EU Blue Economy.

so that the framework can help inform the core question of "what is occurring where", to understand the scale and location of activities and effects.

A key matter is that within the BE a range of different processes and interactions take place, which may be difficult to directly reconcile but which need to be addressed within a common framework structure, in order the identify that processes x, y, and z are quite different but are taking place in the same location.

The following three steps have been undertaken in this report,

- Extent of the Blue Economy: An important part of preparing the framework was to define and describe the extent of the BE. This is to identify the geographical and functional boundaries – which are unlikely to coincide – and how the BE interfaces with other aspects of the economy. The BE does not function in isolation, and there is considerable overlap with the land-based economy and community. For a number of smaller coastal communities, the BE will be a significant or even dominant part of the local economy in terms of employment and incomes. Similarly, most seafood processing activity is land-based, but is dependent on catch from the BE. The obvious starting point for spatial definition of the BE is the EEZ, but the final functional definition is likely to be guided by wider considerations, including through the TEV framework.
- Populating the Framework: This report populates the framework with information and knowledge which is available to inform aspects of the BE. To a large degree this research has drawn on available resources and literature.
- Identifying Gaps: Finally, this report also identifies the gaps in information and knowledge that is required to properly inform the frameworks. As would be expected most of the gaps relate to the later two dimensions of the framework, that is the spatial and economic benefits.

1.4 Report Structure

This report is structured into five sections, as follows:

- Section Two provides a description of the framework that has been applied in this report to assess the Blue Economy. This description covers three dimensions, Sectoral, Spatial and Economic Benefits. These dimensions of the framework are defined to provide decision makers with valuable insight into the nature of the economic value that is generated by the maritime area around New Zealand.
- Section Three draws together research and information to populate the sectoral framework dimension of the BE. This section provides information on the established marine sectors (Commercial Fisheries, Infrastructure and Transport, Offshore Minerals, Coastal Tourism, Government Services) and emerging sectors (Blue Biotechnology and Ocean Energy).
- Section Four draws together research and information to populate the Economic Benefits framework dimension of the BE. This section provides information on the wider economic benefits that are derived from the maritime area, including both uses that have no market value (recreational, cultural, etc.) and non-use values (existence, bequeath etc.).
- Section Five populates the Spatial framework dimension of the BE. This section provides information on the location and nature of the activity within the marine.
- The report concludes with Section Six, which provides recommendations on future research that could be conducted to improve the population of the dimensions of the BE framework.

2 Blue Economy Framework

The following discussion outlines the frameworks which have been used in this report. The focus of this section is to define the structure of the BE that will be assessed using three key dimensions, Sectoral, Economic Benefits and Spatial.

Before each dimension of the framework is discussed, it is important to acknowledge that many readers may consider that another important dimension of the BE that should be assessed is sustainability. Importantly, sustainability is a relative concept, as is highlighted in Hardin's First Law of Human Ecology[14] which states that "*We can never do merely one thing. Any intrusion into nature has numerous effects, many of which are unpredictable*". Therefore, it is recognised that the various economic benefits that are derived from the maritime area have different levels of sustainability and a wide range of different impacts. As discussed by Sharp and Batstone, the maritime area can be examined in terms of resources that are renewable and non-renewable, which has important implications for optimizing the value that society receives, both today and in the future.[15]

While it would be valuable to assess the BE in terms of the sustainability dimension, this assessment would be very difficult as it requires detailed research into each type of use that occurs in the maritime area, both in terms of impacts on the,

- ecosystems directly, and
- other uses indirectly.

For example, commercial fishing within harbours that use set netting would have impacts, both directly on the ecosystem and indirectly on other uses (such as recreational uses). In order to establish the relative 'sustainability' of commercial fishing within harbours there would need to be detailed research on the ecosystem impact and the conflicts with other uses. Research on this one use would be substantial task in its own right. Obviously, populating the entire BE sustainability dimension would require considerable primary research which is beyond the scope of this report.

2.1 Sectoral Framework

The BE can be measured in terms of the market value, as measured in the economy, that is associated with the maritime area. This report defines BE, in the sectoral framework, to be any commercial activity that requires access to the maritime area as a core part of their production process – i.e. it would not be possible to produce the goods or services without access to resources in the maritime area.

For example, most of New Zealand's trade exits and enters the country via sea ports, which rely on the maritime area as a key piece of transport network. Clearly, the sea ports are entirely dependent on the maritime area for their operation and are included in sectoral framework of the BE.

[14] Miller, G.T. (1993) Environmental Science: Sustaining the Earth. Wadsworth Publishing.

[15] Sharp, B. and Batstone, C. (2008) Neoclassical Frameworks for Optimising the Value of Marine resources. In: Patterson M, Glavovic BC, editors. Ecological economics of the oceans and coasts. Edward Elgar Publishing; 2008. pp. 95–118.

The literature review undertaken for this report shows that the BE sectoral frameworks that have been applied in other studies generally have the following 'established' sectors,

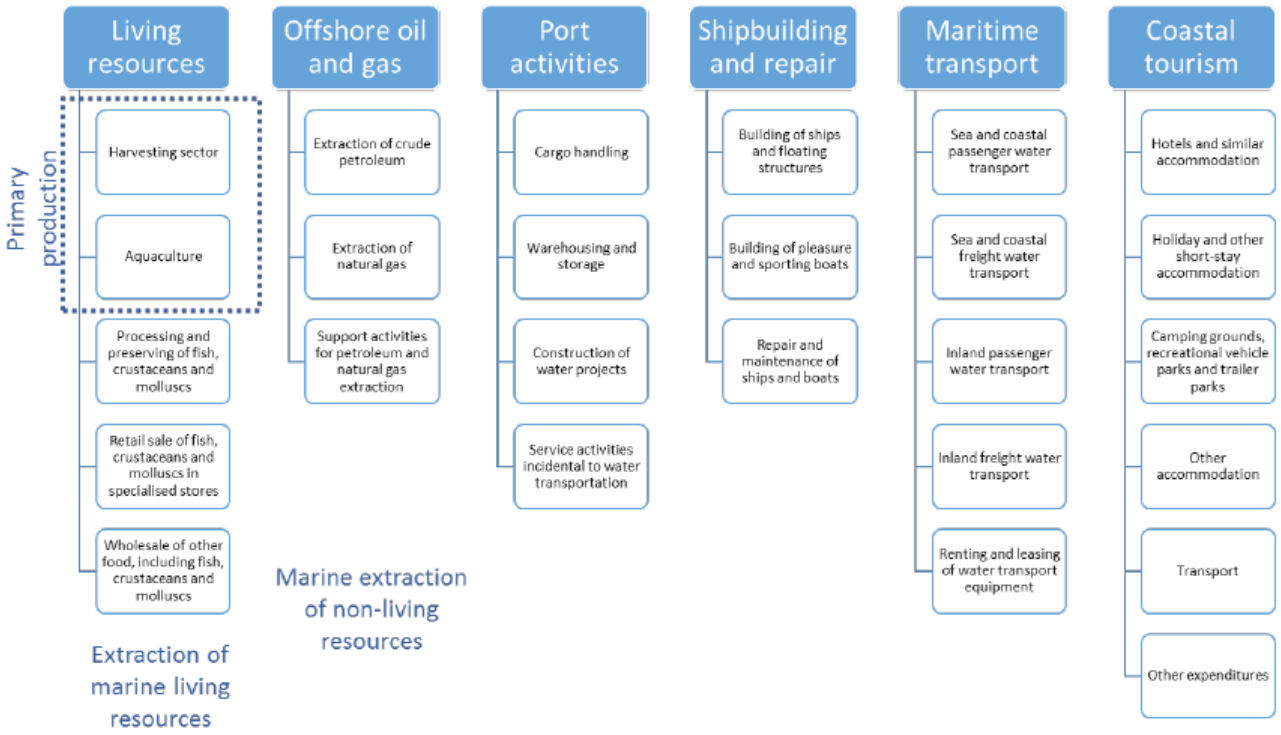
- commercial fisheries,
- offshore minerals
- ports/marinas,
- maritime transport,
- vessel building/repair, and
- coastal tourism.

However, some studies have included other sectors, which use the maritime area but may not be entirely dependent on this resource. For example, some BE sectoral frameworks have included the portion of the defence force which uses the maritime area. In some cases, the BE has been extended to include the value of activity that is associated with supporting the established sectors, which could include providing inputs and/or taking outputs from these businesses (e.g. fishing processing, exporters/importers, mineral refining). In some studies, the BE sectoral framework has been extended to include new emerging sectors like ocean energy and biotechnology.

While there is no consistent agreement on which parts of the economy should be included in the BE sectoral framework, this report has developed a framework based on the European Commission definition of the BE which is defined in *2018 Annual Economic Report on EU Blue Economy* and Stats NZ marine economy which is defined in *2019 Environmental Economic Accounts*.

Figure 2.1 shows the sectors that are recorded in the EC study of the BE, which is mainly established sectors that rely on the maritime area. The EC sectors are similar to sectors in the Stats NZ marine economy, which also includes Fisheries, Offshore minerals, Marine Services (Ports and Vessel building), Shipping and Tourism.

Figure 2.1: European Union Sectoral Framework of the Blue Economy



Each of the EC and Stats NZ include sectors that the other does not. First, Stats NZ includes the value of defence and government activities in the maritime area (navy, coast guard, biosecurity, etc.). Second, the EU includes new emerging sectors of ocean energy and biotechnology. The BE sectoral framework applied in this report extends to include both of these additions. Section 3 - Sectors of the BE, populates the framework using available data. Third, the framework has been extended to include waste management, comprising residential, commercial and rural waste (incl. dredging disposals).

2.2 Economic Benefits Framework

The BE can be extended to measure full economic benefits that are generated by the maritime area. This report defines BE, in the Economic Benefits framework, to be any value that humans receive from the maritime area. This framework extends to include economic benefits that are non-market but have important and real value.

It is common in resource economics to use the Total Economic Value (TEV) framework to establish the value of economic benefits derived from natural resource. This approach establishes value using the lenses of "use-value" and "non-use value" (see Figure 2.2 which is taken from Ministry for the Environment[16]). The latest thinking from Treasury is that the TEV framework can be used to understand the value of natural resources and policy assessments associated with those resources.[17]

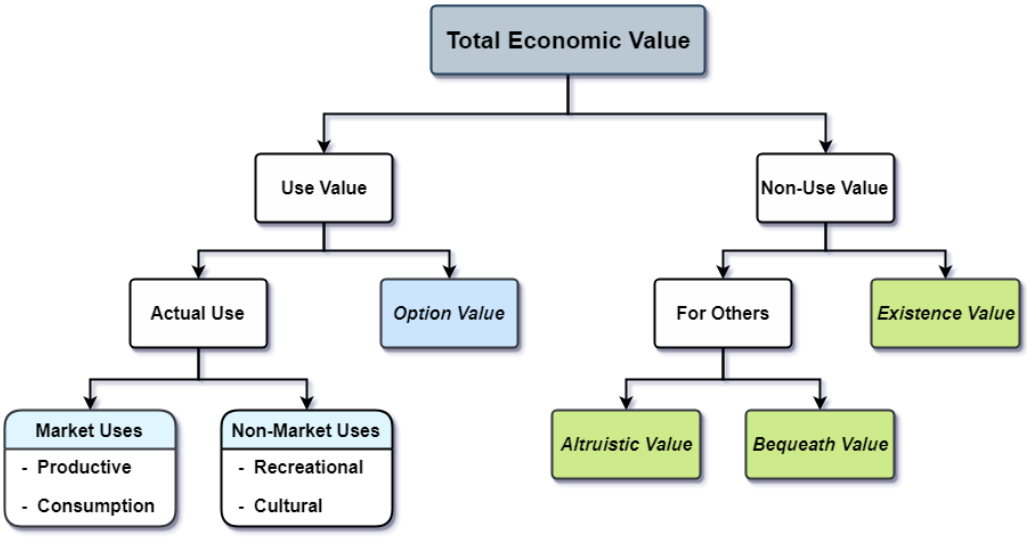
Most of the "use-value" of the maritime area has been discussed in previous sections, however there are important uses that have no market value that should be considered - i.e. recreational fishing, customary

[16] Ministry for the Environment (2005) Option and Existence values for the Waitaki Catchment.

[17] Treasury (2018) The Start of a Conservation on the Value of New Zealand's Natural Capital.

fishing, other recreational activity and cultural values. The maritime area also produces economic benefits in terms of non-use values, this includes existence and bequeath. Economic research shows that humans place a value on natural resources even if they do not directly use the resource in question. The mere knowledge that the resource is being used sustainably will generate economic benefits to society, which prefers that the resource is maintained today (existence value) and for the future (bequest value).

Figure 2.2: Total Economic Value Framework



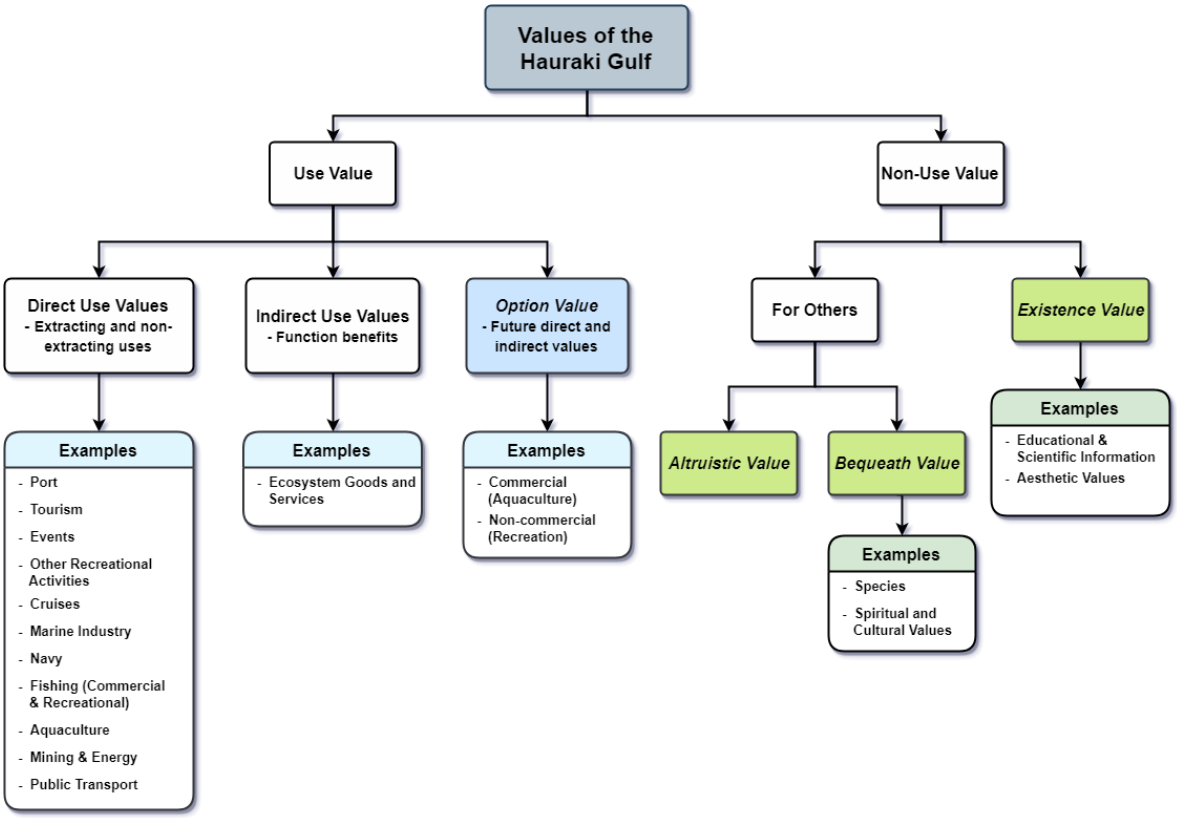
Auckland Council research on the value of the Hauraki Gulf provides an example of the TEV approach being applied to the maritime area.[18] This research is the most detailed attempt to apply the TEV to a marine area in New Zealand. The researchers applied the following framework to establish the value of economic benefits, however the study did not establish an estimate for the non-use value.

Unsurprisingly the Hauraki Gulf generates significant economic benefits, the Gulf was valued at over $2 billion (value added) and employment of 26,700 in 2011. This is substantial value, being almost a quarter of the Stats NZ estimate of the national marine economy.

The non-market value of recreational use of the Hauraki Gulf was estimated at over $0.6 billion. This value is likely to represent a large share of the total recreational value of the maritime area in New Zealand, as the Gulf is a very important location for recreational activity undertaken by Aucklanders.

[18] Barbera, M. 2012. Towards an economic valuation of the Hauraki Gulf: a stock-take of activities and opportunities. Auckland Council technical report TR2012/035.

Figure 2.3: Hauraki Gulf Total Economic Value Framework



This report has adopted the TEV approach to define the Economic Benefits framework for the BE. The framework includes the values assessed in the sectoral framework and extends to include the following non-market benefits,

- consumer surplus from consumption of goods and services produced in the economy.
- recreational fishing,
- customary fishing,
- other recreational activities (swimming, sailing, etc.),
- cultural values (kaitiakitanga and mana whenua obligations),
- existence benefits,
- bequeath benefits, and
- ecosystem services.

This report does not attempt to establish the associated costs for any of the use activities. Therefore, this framework is only a partial application of the TEV approach – i.e. it only measures the benefits and not the costs. As noted above in the introduction it is likely that future research will focus on developing a further framework dimension that assesses 'sustainability' associated with each use activities. This assessment would cover the direct costs and conflict issues associated with each use activity.

2.3 Spatial Framework

Finally, it is important to place the BE within a spatial framework. This framework would provide information about where the benefits of the BE arise, and which parts of the maritime area are important for each type of benefit.

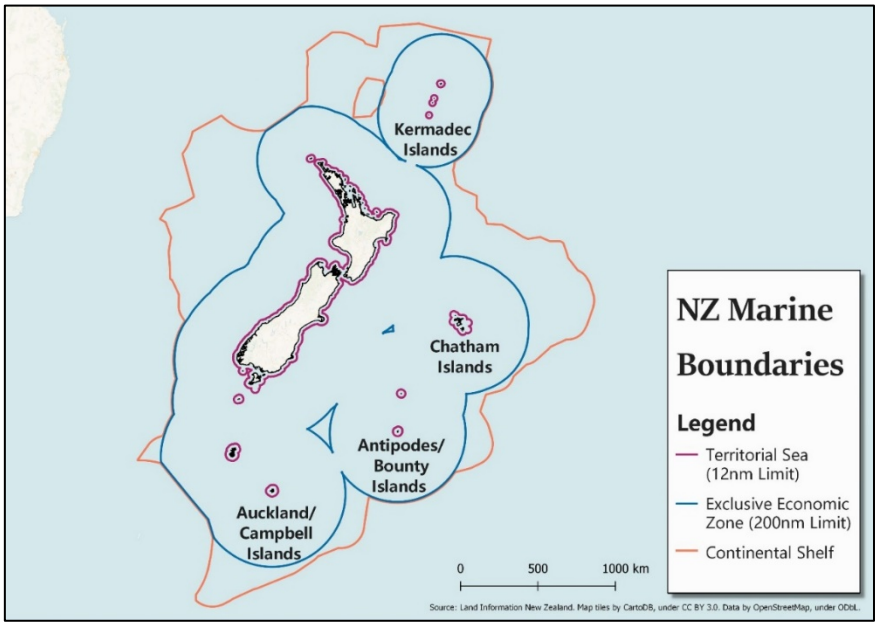
However, the nature of the maritime area means that there are multiple spatial dimensions that overlap. There are obviously spatial dimensions of the maritime area which include, sea surface, through the water column, sea floor and earth subsurface. There are also many overlapping ecosystems, habitats and environmental dimensions that shift with seasons, weather and tides.

Over top of these natural spatial dimensions are a number of human-defined legal and regulation boundaries. First, there are three legal definitions that could be used to define the total maritime area used in this spatial framework,

- Territorial Seas: are regarded as the sovereign territory of the state and is defined as the area of seas that are 12 nautical miles off the coast. Traditionally, this area was defined based on portion of an ocean that a sovereign state could defend from shore. Figure 2.4 shows New Zealand territorial seas as the inner purple (dotted) line that hugs the coast line.
- Economic Exclusion Zone: was developed in 1980's as the concept of territorial seas was being challenged. The EEZ is defined as 200 nautical miles off the coast, exception to this rule occurs when exclusive economic zones would overlap. The state has sovereign rights to use marine resources, both in the water column and the seabed. Figure 2.4 shows New Zealand EEZ as the outer blue line.
- Continental shelf: finally, some nations have made claims to the continental shelfs that extend beyond the EZZ. In 2008 the UN recognised New Zealand's claim to the continental shelf, which extends 1,700,000 square kilometres beyond the EEZ (shown by the orange line in Figure 2.4). A coastal nation has control of all resources on or under its continental shelf, living or not, but no control over any living organisms above the shelf that are beyond its exclusive economic zone.

This report has adopted a BE spatial framework that extends to the edge of the EEZ. This is because there is limited data on activity that is occurring in the continental shelf area beyond the EEZ. Future studies could extend the BE spatial framework to include the continental shelf, as this area is likely to generate additional economic benefits for New Zealand.

Figure 2.4: New Zealand Territorial Seas, Economic Exclusion Zone and Continental Shelf



Second, a wide range of legal and regulation boundaries have been placed over the maritime area. The following list outlines some of the more important spatial areas within New Zealand's legislation and regulation,

- Fisheries Management Areas (which are a subset of the EEZ),
- Regional Boundaries (which are a subset of the territorial seas),
- Harbours/Inlets,
- Foreshore (area between low and high tide),
- Beaches/shoreline ("Queen's chain"),
- Protected zones (reserves, parks and rāhui),
- Tangata Whenua management areas,
- Aquaculture management areas,
- Coastal Protection areas,
- Offshore minerals (exploration, prospecting and mining permits),
- Port operational areas,
- Navigation zones (governed by the harbour master),
- Shipping lanes,
- Defence zones,

The legal and regulation boundaries listed above are not intended to provide a complete list of the spatial locations that are defined in New Zealand laws and regulations. However, they do provide an understanding of the complexity of the range of ways in which the maritime area is treated.

Where possible this report has also adopted a simple disaggregation of the EEZ to 18 "regions", which is based on the gazetted land regions that are defined by Local Government Act 2002 and fisheries areas called General Statistical Areas (GSA).

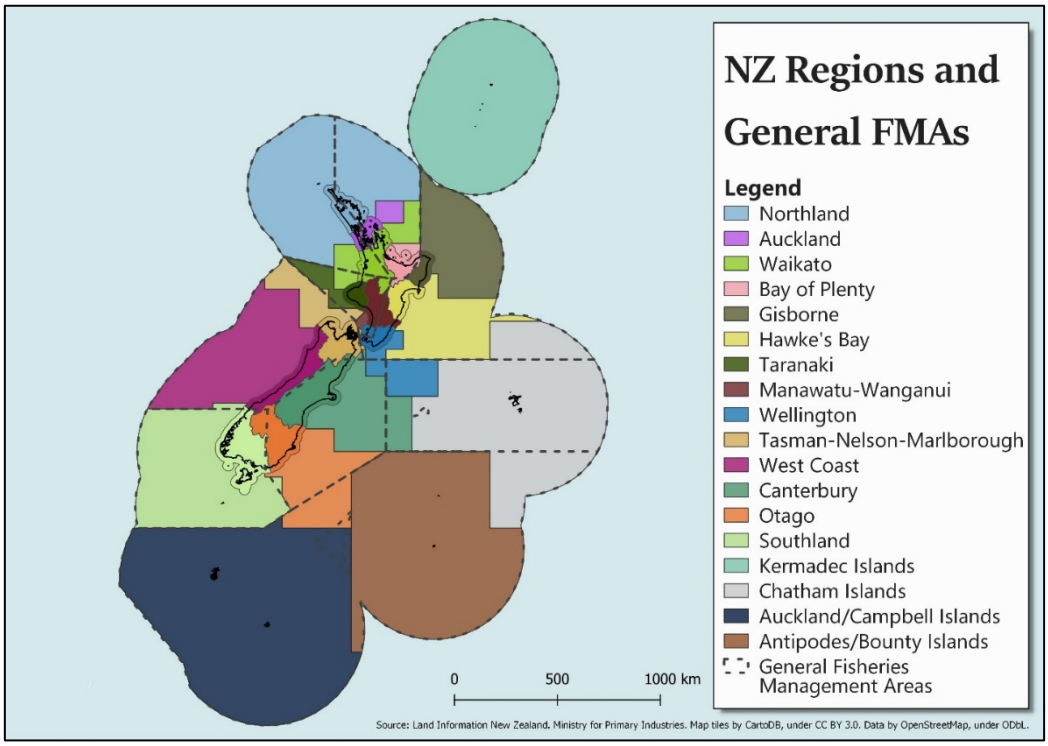
Figure 2.5 shows the definition of the regions which are defined as follows,

- Northland: is the land and inshore area that is controlled by Northland Regional Council and offshore areas adjacent to the coastline (blue shaded area)[19].
- Auckland: is the land and inshore area that is controlled by Auckland Council and offshore areas adjacent to the coastline (shaded purple)[20].
- Waikato: is the land and inshore area that is controlled by Waikato Regional Council and offshore areas adjacent to the coastline (shaded green)[21].
- Bay of Plenty: is the land and inshore area that is controlled by Bay of Plenty Regional Council and offshore areas adjacent to the coastline (shaded red)[22].
- Gisborne: is the land and inshore area that is controlled by Gisborne District Council and offshore areas adjacent to the coastline (shaded brown)[23].
- Hawkes Bay: is the land and inshore area that is controlled by Hawkes Bay Regional Council and offshore areas adjacent to the coastline (shaded light green)[24].
- Manawatu-Wanganui: is the land and inshore area that is controlled by Horizons Regional Council and offshore areas adjacent to the coastline (shaded dark brown)[25].
- Taranaki: is the land and inshore area that is controlled by Taranaki Regional Council and offshore areas adjacent to the coastline (shaded dark green)[26].
- Wellington: is the land and inshore area that is controlled by Wellington Regional Council and offshore areas adjacent to the coastline (shaded dark blue)[27].
- Nelson-Tasman-Marlborough: is the land and inshore area that is controlled by Nelson, Tasman and Marlborough district councils and offshore areas adjacent to the coastline (shaded light brown)[28].
- West Coast: is the land and inshore area that is controlled by West Coast Regional Council and offshore areas adjacent to the coastline (shaded dark red)[29].
- Canterbury: is the land and inshore area that is controlled by Canterbury Regional Council and offshore areas adjacent to the coastline (shaded green)[30].
- Otago: is the land and inshore area that is controlled by Otago Regional Council and offshore areas offshore areas adjacent to the coastline (shaded orange)[31].
- Southland: is the land and inshore area that is controlled by Southland Regional Council and offshore areas adjacent to the coastline (shaded light green)[32].

[19] Which is defined as the following GSA, 1, 2, 3, 44, 45, 46, 47, 48, 101, 102, 103, 104, 105, 106.
[20] Which is defined as the following GSA, 4, 5, 6, 7, 43.
[21] Which is defined as the following GSA, 8, 41, 42, 107.
[22] Which is defined as the following GSA, 9, 009H, 10.
[23] Which is defined as the following GSA, 11, 12, 201, 202, 203.
[24] Which is defined as the following GSA, 13, 14, 204, 205.
[25] Which is defined as the following GSA, 40, 801.
[26] Which is defined as the following GSA, 39.
[27] Which is defined as the following GSA, 15, 16, 19, 401, 402.
[28] Which is defined as the following GSA, 17, 36, 37, 40, 701, 801.
[29] Which is defined as the following GSA, 33, 34, 35, 702, 703, 704, 705, 706.
[30] Which is defined as the following GSA, 18, 20, 21, 22, 23, 301, 407.
[31] Which is defined as the following GSA, 24, 26, 302, 303, 604, 605.
[32] Which is defined as the following GSA, 25, 27, 28, 29, 30, 31, 32, 501, 502, 503, 504.

- There are four offshore regions, waters around Kermadec Islands (shaded green)[33], Chatham Island (shaded grey)[34], Antipode/Bounty Islands (shaded brown)[35] and Auckland/Campbells Islands (shaded dark blue)[36].

Figure 2.5: Spatial Framework - New Zealand Regions and General Fisheries Management Areas



The spatial framework adopted in this report is similar to the method adopted in the Ministry of Agriculture and Forestry research (2006-2010) on the mapping of New Zealand marine values. The goal of this research was to better identify, understand and manage the risks that non-indigenous species pose to the maritime environment. MAF Biosecurity New Zealand initiated a research programme in 2006 to map components of four core values around New Zealand's coastline: environmental[37], economic[38], social[39] and cultural values[40].

[33] Which is defined as the following GSA, 91, 92, 93, 94.

[34] Which is defined as the following GSA, 49, 50, 51, 52, 206, 403, 404, 405, 406, 408, 409, 410, 411, 412, 609.

[35] Which is defined as the following GSA, 606, 607, 608, 612, 613, 614, 615, 620, 621, 622.

[36] Which is defined as the following GSA, 601, 602, 603, 610, 611, 616, 617, 618, 619, 623, 624, 625.

[37] Beaumount, J., Oliver, M., MacDiarmid, A. (2008). Mapping the Values of New Zealand's Coastal Waters. 1. Environmental Values. MPI Technical paper No: 2008/16. 79 p. ISBN 978-0-478-33801-0

[38] Batstone, C., Elmetri, I., Taylor, M., Sinner, J., Clarke, S. (2009). Mapping the Values of New Zealand's Coastal Water. 2. Economic Values. MPI Technical paper No: 2009/05. 80 p. ISBN 978-0-478-33877-5

Samarasinghe, O., Briggs, C., Greenhalgh, S. (2009). Mapping the Values of New Zealand's Coastal Waters. 5. A Meta-analysis of Economic Values. MPI Technical paper No: 2010/09. 82 p. ISBN 978-0-478-36358-6

[39] Allen, W., Elmetri, I., Clarke, S., Gibbons, J., Clark, K., Sinner, J., Jiang W., Taylor, M. (2009). Mapping the Values of New Zealand's Coastal Waters. 3. Social Values. MPI Technical paper No: 2010/05. 45 p. ISBN 978-0-478-36303-6

[40] No report is available on this topic.

3 Sectors of the BE

The following section draws from existing research to populate the sectoral framework outlined in section 2. This report follows the same split of sectors as shown in the European Commission annual report on the Blue Economy, 'Established' and 'Emerging'. However, the Established Sectors have been extended to include the Defence Force and Waste Management and the Emerging Sectors has been reduced to exclude some sectors that are not relevant in the New Zealand context (Desalination and Deep-seabed mining). The assessment in this section focuses on direct value associated with each sector in the BE Sectoral framework. Wider value within the economy is estimated in the concluding subsection, specifically the total value of Sectors in the BE, both directly and indirectly.

3.1 Established Sectors

Established sectors that have been assessed in this report are quantified mostly using Stats NZ data. For the most part established sectors are quantified using data from Stats NZ marine economy data set. However, in some instances this report extends beyond that definition to include other activity in the economy.

The following subsections present data that populates the valuation of the BE sectoral framework for;

- Commercial Fisheries,
- Marine Infrastructure and shipping,
- Offshore Minerals,
- Coastal Tourism,
- Defence Force, and
- Waste Management.

This report extends beyond the Stats NZ definition marine economy by including coastal tourism and government services. The other sectors are, for the most part, comparable to Stats NZ marine economy.

3.1.1 Commercial Fisheries

Commercial fisheries are a key part of the BE, producing significant value in the economy and employment for the community. This report defines commercial fisheries as both extractive fishing (wild capture) and non-extractive (aquaculture) which harvest marine species for sale. Historically, extractive fishing has grown consistently, while aquaculture seen more recent growth as new species have been farmed.

Fisheries Inshore New Zealand have estimated the value of wild captured marine species as being worth $0.5 billion to the New Zealand economy directly in 2015.[41] Most of the value is associated with deep water species (47% - mainly hoki, ling, squid, tuna), rock lobster (20%) and wild caught shellfish (5% - mainly paua). The remaining value of wild captured species is associated with the inshore areas, with snapper (5%), blue cod, terakihi and flatfish contributing to the bulk of the remaining value. The scale and types of fishing methods that are applied by the extractive fisheries are controlled by various legislation and regulations. Most importantly is Quota Management System (QMS) which was introduced in the late 1980s, the

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

management system enables the government to allocate rights to harvest each marine species.[42] This system also has a number of detailed reporting requirements, which includes reporting of catch, effort, vessel information, by-catch, etc. The QMS is seen as world leading and is intended to ensure that the fish stocks and harvest levels are sustainable.

The aquaculture industry has grown significantly since the first oyster and mussel farms were started in 1970s, with production growing by 10% per annum.[43] Over the last fifty years new species have been farmed, most notably salmon which started in the 1980s. Currently these three species represent most of the revenue ($0.5 billion) generated by marine aquaculture in New Zealand, Mussels (62%), Salmon (32%) and Oysters (6%).[44] Most of aquaculture is located off the northern coasts of the South Island (65% of mussels and 63% of salmon), Coromandel (25% of mussels and 24% of oysters) and the top of the North Island (75% of Oysters and 4% of mussels).[45]

Other species are farmed but their combined commercial value is minimal. Of the other species, pāua ('blue abalone') has been commercialised.[46] Some species are still in the research or pre-commercial stages and these include sea cucumbers, kina, eels, seaweed, rock lobsters, kingfish and hapuka.

This report has adopted the Stats NZ definition that it uses for Marine Economy statistics, i.e. Commercial Fisheries in the BE Sector framework is set as Stats NZ 'Fisheries and aquaculture'. This means that the Commercial Fisheries sector includes wild catch fisheries[47], aquaculture fisheries[48], seafood processing[49] and seafood wholesaling[50].

There may be parts of the economy that rely on seafood as key part of their business operations however these have been excluded in this report. For example, fishmongers, takeaway outlets, restaurants and supermarkets/grocery stores are to a degree reliant on the marine environment to enable them to offer a full range of products to their customers. Similarly, it is likely that some primary production in other industries will also rely on products from the marine environment, most obviously is the on-shore aquaculture that may take feed and sea water from the marine environment and less obvious is the agricultural use of marine products as feed or fertilizer. Finally, there will also be a range of manufacturing and other support services which are reliant on the marine environment which are not captured in this definition of Commercial Fisheries.[51]

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[42] Fisheries Amendment Act 1986.

[43] FAO (2019) Global Aquaculture Production 1950-2016 – New Zealand.

[44] Aquaculture New Zealand (2018) A sector overview with key facts and statistics.

[45] Ibid.

[46] Moana New Zealand (2016) Moana achieves New Zealand first for Blue Abalone farming – press release Dec 7th.

[47] Capture fishing includes the following ANZSICS06, A04110 rock lobster and crab potting, A04120 prawn fishing, A041300 line fishing, A04140 fish trawling, seining and netting and A04190 other fishing. Some activity in A04190 other fishing may be involved in freshwater fishing (longfin and shortfin eels), however this is small and is unlikely to impact the findings of this report.

[48] Aquaculture includes the following ANZSICS06, A02010 longline and rack (offshore) aquaculture and A02020 caged (offshore) aquaculture. This definition excludes onshore aquaculture (A020300 Onshore Aquaculture).

[49] Processing of seafood is defined as ANZSICS06, C11200 seafood processing.

[50] Wholesaling of seafood is defined as ANZSICS06, F36040 fish and seafood wholesaling.

[51] For example, there are likely to be businesses in the ANZSICS06, A052900 Agriculture and Fishing Support Services, that are reliant on the maritime area for their operation.

Table 3.1 shows the value that the Commercial Fisheries directly contributes to the New Zealand economy, in terms of value added (GDP), gross earnings (incomes) and employment count (employment). The table also presents ratios of value to the employment to establish the level of value generated per employee, both in terms of value added and earnings. The results in the table provide the following key insights;

- Value added generated by the Commercial Fisheries sector has grown rapidly over the last decade, increasing by 8% per annum and almost doubling over the period to reach $1,086 million in 2017.[52] This rate of growth is substantially faster than the background rate of growth in the economy which was only 4% per annum.[53] The Commercial Fisheries sector has increased from 0.3% of the national economy in 2008 to almost 0.4% in 2017.
- Gross earnings have grown at a much slower pace than value added, which combined with small positive growth in employment indicates that the sector is becoming more capital intensive and/or technologically advanced.
- Employment in the sector has increased from 7,895 in 2008 to 8,286 in 2017, which is a growth rate of 1% per annum over the decade. Growth in employment is comparable to the background economy, which also had employment growth of 1% per annum.[54]
- Value added and gross earnings generated per employee has increased markedly over the decade. As noted above this could be caused by changes in fishing methods employed and/or significant growth in aquaculture. The results also show that the Commercial Fisheries sector generates similar value per employee (approx.$131,000) compared to values observed in the rest of the economy (approx. $125,000 per EC).

Table 3.1: Value of Commercial Fisheries in the Economy, 2008-2017

Commercial Fisheries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAGR
Value added - $m	$ 565	$ 689	$ 762	$ 851	$ 839	$ 855	$ 837	$ 932	$ 1,154	$ 1,086	8%
Gross earnings - $m	$ 584	$ 568	$ 560	$ 584	$ 666	$ 657	$ 654	$ 693	$ 631	$ 678	2%
Employment Count	7,895	8,190	7,900	7,790	7,896	7,803	7,793	7,523	7,849	8,286	1%
Value Added per employee	$ 71,517	$ 84,103	$ 96,485	$ 109,252	$ 106,281	$ 109,552	$ 107,396	$ 123,887	$ 147,029	$ 131,039	7%
Gross earnings per employee	$ 73,913	$ 69,309	$ 70,934	$ 74,972	$ 84,408	$ 84,191	$ 83,886	$ 92,172	$ 80,365	$ 81,820	1%
Contribution to total GDP (%)	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.4%	

3.1.2 Infrastructure and Transport

A core role of the maritime area is to enable the movement of goods and people, both to and from New Zealand and around the coast line. Compared to most countries in the world New Zealand has a relatively open (and small) economy, which is particularly reliant on imports and exports of merchandise trade, most of which transverse through the maritime area. This sector of the BE is defined as the marine infrastructure (ports, marinas, etc.), sea transport (freight and passenger) and supporting services (stevedoring, ship repairs and building).

Much of the activity associated with the Marine Infrastructure and Shipping sector occurs in and around the main sea ports. There are seven key sea ports in New Zealand that handle most of merchandise trade,

[52] Stats NZ (2019) Environmental Economic Accounts – Marine Economy, '*Fisheries and aquaculture*'.

[53] Stats NZ (2019) Gross domestic product, by region and industry (Annual-Mar).

[54] Stats NZ (2019) Business Demography.

both by value (76%) and weight (84%).[55] Ports of Auckland and Port of Tauranga are by far the largest ports with both handling $29 billion of trade each in 2017, which is equivalent to 53% of national merchandise trade. The biggest ports in the South Island are located in Christchurch (Lyttleton Port handles 9% of trade value) and Dunedin (Port Otago handles 4% of trade value). Also, there are three regional ports that handle large volumes of raw primary exports (wood), North Port (4%), Napier (5%) and New Plymouth (2%). The remaining which handle large volumes of low value raw primary exports (i.e. logs). The remaining sea ports handle much less trade than the ports discussed above.[56]

The Marine Infrastructure and Shipping sector will also be present around the many marina and boat ramps that are located along the New Zealand coast.[57] There are 38 marinas in New Zealand, most of which are located on the east coast of the North Island within short distances from major cities.[58] Many of the marinas have significant boat and vessel building businesses, most notable is the recent investments in large travel lifts in Whangarei[59], Auckland[60], Tauranga[61] and Nelson[62] which has allowed New Zealand to compete for high value refit and maintenance of superyachts and large commercial vessels.

There are also several passenger related services that operate commuter ferries (Auckland) and interisland services (Auckland-Great Barrier-Coromandel, Wellington-Picton and Bluff-Oban).

This report has adopted the Stats NZ definition that it uses in the Marine Economy statistics, i.e. Infrastructure and Transport in the BE Sector framework is set as Stats NZ 'Shipping' and 'Marine services'. This means that the Marine Infrastructure and Shipping sector includes sea ports/marina[63], sea transport (freight and passenger)[64] and support services (stevedoring, ship repairs and building, other water transport support services)[65]. Some activity captured by the definition will relate to activity on rivers and lakes, however this activity is likely to be small and is unlikely to materially impact the findings of this report.

There may be parts of the economy that rely on the maritime area as a key part of their business operations, however these have been excluded in this report. For example, manufacturing of fibreglass boats and most marine recreational equipment (surfboards, sailboards etc.) have not been included, as it is not possible to establish the scale of this activity from the official data.[66] Similarly, vessel charters and marine sightseeing (whale-watching) that rely on the marine environment for their business operation are not included.[67]

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[55] Stats NZ (2019) Overseas Trade Imports and Exports - Merchandise Trade by Port.

[56] Centre Port, South Port, Prime Port, Eastland Port, Port Nelson, Port Marlborough.

[57] Market Economics (2014) New Zealand marine Industry Survey.

[58] New Zealand Marina Operation Association.

[59] Oceania Marine has a 100 tonne travel lift and has purchased a 500 tonne travel lift that will be commissioned in the coming year.

[60] Orams Marine has a 75 tonne travel lift and has purchased a 620 tonne lift that will be commissioned in the coming year.

[61] Bridge Marine has a 35 tonne travel lift.

[62] Nelson Marina has a 150 tonne travel lift.

[63] Sea ports/marina is defined as the following ANZSICS06, I52120 port and water transport terminal operations.

[64] Sea transport includes the following ANZSICS06, I48100 water freight transport and I48200 water passenger transport.

[65] Support services includes the following ANZSICS06, I52110 stevedoring services, C23920 boatbuilding, C23910 shipbuilding and repair services repair services and I52190 other water transport support services.

[66] These types of marine activities are a subset of the C19190 other polymer product manufacturing and C25920 toy, sporting, and recreational product manufacturing.

[67] These types of marine activities are a subset of the within I50100 scenic and sightseeing transport and C66190 other motor vehicle and transport equipment rental and hiring.

There are also likely to be specialist marine construction businesses that rely on the BE and businesses that provide freight forwarding services which have been excluded.[68]

Table 3.2 shows the value that Infrastructure and Transport directly contributes to the New Zealand economy. The results in the table provides the following key insights about this part of the BE,

- The value added generated by the Infrastructure and Transport sector has grown consistently over the last decade, increasing by 4% per annum to reach $1,583 million in 2017.[69] Given the role of the sector (facilitating the rest of economy), it unsurprising that growth of the sector has been roughly equivalent to the background rate of growth in the overall economy, which means that the sector represented approximately the same proportion of the economy over the decade (0.6%).[70]
- The gross earnings have grown at a slower pace than value added, which combined with negative growth in employment indicates that the sector is becoming more capital intensive and/or technologically advanced.
- The employment in the sector has reduced from 11,910 in 2008 to 10,720 in 2017, which is a decline of -1% per annum over the decade. This decline in employment is in the context of growing employment in the background economy of 1% per annum.[71]
- The value added and gross earnings generated per employee has increased markedly over the decade. As noted above this could be caused by changes in the technology applied. However, the results also show that the Infrastructure and Transport sector generates relatively high value per employee (approx. $147,000) compared to values observed in the rest of the economy (approx. $125,000 per employee).

Table 3.2: Value of Infrastructure and Transport in the Economy, 2008-2017

Infrastructure & Transport	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAG
Value added - $m	$ 1,119	$ 1,019	$ 1,155	$ 1,127	$ 1,144	$ 1,151	$ 1,213	$ 1,291	$ 1,436	$ 1,583	4
Gross earnings - $m	$ 732	$ 769	$ 765	$ 773	$ 781	$ 767	$ 675	$ 874	$ 934	$ 920	3
Employment Count	11,910	11,160	10,410	10,350	10,120	9,720	9,870	9,970	9,990	10,720	-1
Value Added per employee	$ 93,924	$ 91,295	$ 110,951	$ 108,860	$ 113,075	$ 118,464	$ 122,943	$ 129,439	$ 143,746	$ 147,668	5
Gross earnings per employee	$ 61,502	$ 68,909	$ 73,443	$ 74,662	$ 77,176	$ 78,951	$ 68,402	$ 87,675	$ 93,513	$ 85,839	4
Contribution to total GDP (%)	0.6%	0.5%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	

3.1.3 Offshore Minerals

The maritime area around New Zealand contains large deposits of minerals, potentially worth up to $500 billion.[72] Currently the offshore deposits remain largely untapped, with very little extraction occurring in the EEZ.

[68] These types of marine activities are C52920 freight forwarding services.

[69] Stats NZ (2019) Environmental Economic Accounts – Marine Economy, '*Shipping*' and '*Marine services*'.

[70] Stats NZ (2019) Gross domestic product, by region and industry (Annual-Mar).

[71] Stats NZ (2019) Business Demography

[72] Ian Wright, 'Marine minerals', Te Ara - the Encyclopaedia of New Zealand, http://www.TeAra.govt.nz/en/marine-minerals (accessed 19 March 2019)

There is a long history of extracting minerals from the sands in the harbours and inshore areas (iron, other heavy metals, silica etc.). More recently there has been growing extraction of oil and gas from the sea bed in the EEZ. The growth in offshore mineral extraction and exploration has resulted in this sector becoming a significant part of the economic activity in the New Zealand economy.

However, production from key offshore oil and gas fields around Taranaki has declined over the last decade. Most importantly is the depletion of the Maui field, which at its peak in 1997 was producing 65% of total national production of oil and gas (284 PJ) and now produces 39 PJ (2018).[73] While there are other smaller fields that have been developed over the last decade (Tui, Maari, Kupe, Pohokura etc.), the rate of production has been declining and the remaining contingent resource in the existing fields may only last another decade.[74] There are existing exploration rights in the offshore areas that are yet to be exercised, which could result in new oil and gas fields being developed in the offshore.[75]

However, the level of expenditure on oil and gas exploration and development has been declining, with resulting drilling activity being relatively low.[76] Drilling activity has remained low, with a total of 12,633 metres made in 2017. By comparison, the average metres drilled annually over the last 10 years has been around 61,000 metres. It is likely that many of the existing exploration rights will not be exercised.

Finally, the environmental issues associated with the extraction and use of fossil fuels has resulted in the government introducing legislation that prohibits any further offers of oil and gas exploration rights in the offshore areas.[77] MBIE considers that over the coming decade the ban on new exploration rights (and the depletion of existing fields) is likely to result in oil and gas production reducing to less than half of 2018 production.[78]

Table 3.3 shows the value that the Offshore Minerals sector directly contributes to the New Zealand economy. The results in the table provide the following key insights about this part of the BE,

- Value added generated by the Offshore Minerals sector has declined consistently over the last decade, decreasing by -8% per annum to reach $1,005 million in 2017.[79] The sector now represents approximately the 0.4% of the economy.[80]
- Gross earnings have remained relatively stable over the last decade.
- The employment in the sector has increased from 780 in 2008 to 926 in 2017, which is an increase of 2% per annum over the decade.
- Value added and gross earnings generated per employee have decreased markedly over the decade. However, the results also show that the Offshore Minerals sector still generates relatively

[73] Ministry of Business, Innovation and Employment (2019) Oil and Gas Statistics – Indigenous Production 1974 -2018.

[74] Ministry of Business, Innovation and Employment (2019) 2C Resource Reserves – Oil and Gas.

[75] Ministry of Business, Innovation and Employment (2018) Regulatory Impact Statement – Proposed Crown Minerals Amendment Act 1991.

[76] Ministry of Business, Innovation and Employment (2018) Energy in New Zealand.

[77] Crown Minerals Amendment Act 1991 – passed as an Act in 2018.

[78] Ministry of Business, Innovation and Employment (2018) Regulatory Impact Statement – Proposed Crown Minerals Amendment Act 1991.

[79] Stats NZ (2019) Environmental Economic Accounts – Marine Economy, '*Offshore minerals*'.

[80] Stats NZ (2019) Gross domestic product, by region and industry (Annual-Mar).

high value per employee ($1.1 million) compared to values observed in the rest of the economy (approx. $125,000 per employee).

Table 3.3: Value of Offshore Minerals in the Economy, 2008-2017

Offshore Minerals	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAG
Value added - $m	$ 2,190	$ 2,304	$ 2,298	$ 2,328	$ 2,126	$ 1,968	$ 1,725	$ 1,636	$ 953	$ 1,005	-8
Gross earnings - $m	$ 98	$ 113	$ 120	$ 127	$ 124	$ 134	$ 135	$ 141	$ 125	$ 110	1
Employment Count	780	820	880	720	770	862	1,062	1,059	952	926	2
Value Added per employee	$ 2,807,364	$ 2,809,440	$ 2,611,334	$ 3,233,633	$ 2,760,483	$ 2,283,321	$ 1,624,014	$ 1,544,661	$ 1,000,618	$ 1,085,183	-10
Gross earnings per employee	$ 125,913	$ 137,541	$ 135,951	$ 176,233	$ 161,326	$ 155,311	$ 127,503	$ 132,797	$ 131,303	$ 119,188	-1
Contribution to total GDP (%)	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%	0.7%	0.7%	0.4%	0.4%	

3.1.4 Coastal Tourism

The maritime area around New Zealand plays a significant role in the tourism industry, both as a draw for international tourists and as a place for domestic tourists to visit. The New Zealand maritime area has an abundance of beautiful natural environments and marine species. In many cases these maritime areas contain things which are unique in the world, which draws tourists from New Zealand and around the world.

It is likely that almost every international tourist that visits New Zealand will undertake some activities in the maritime area during their visit (including viewing scenery). Similarly, a large proportion of domestic tourism is also likely to occur near the coast and revolve around the maritime area.

Tourism is New Zealand's largest industry and one that is rapidly growing.[81] The sector directly contributed $15.9 billion to GDP in 2018, which is equivalent to 6.1% of the New Zealand's economy.[82] The tourism industry directly sustained employment of 216,000, which is 8% of the total employment in the country.

Considering that most tourists undertake activities in or around the maritime area and that the sector is the largest in the economy, it is therefore important to understand the interrelationship between the tourism sector and the maritime area. However, it is acknowledged that a large proportion of tourism that occurs near the coast will be 'free' and not generate value in the economy. These non-market values are discussed in next BE framework that is applied in this report.

International research on the BE tends to adopt various definitions and methods for establishing the value of the Coastal Tourism sector. Many studies have applied distance bands around the coast, assuming that all tourism activity within a certain distance of the coast is associated with the maritime area.[83] While each method applied in the studies are slightly different, the results all show that tourism is the largest sector of the BE. For example,

- United States of America: 36% of the BE was related to tourism.[84]
- European Union: 40% of the BE was related to tourism.[85]

[81] Statistics New Zealand (2018) Tourism satellite account: 2018.

[82] Ibid.

[83] For example, see National Oceanic and Atmospheric Administration (2018) U.S Ocean and Great Lakes Economy.

[84] Ibid.

[85] European Union (2018) The 2018 Annual Economic Report on the EU Blue Economy.

- China: 33% of the BE was related to tourism.[86]
- Australia: 38% of the BE was related to tourism.[87]

There are also studies that have adopted narrow definitions, which mostly focus on retail goods and/or tourism operators that is related to the maritime area. For example, Stats NZ defines 'Marine tourism and recreation' as "G424500 marine equipment retailing", which consists of units mainly engaged in retailing new or used boats or boat accessories. As a result, only 2% of the officially reported marine economy is related tourism. There are other international studies that also use similar narrow definitions,

- Korea: 0.4% of the BE was related to tourism.[88]
- Canada: 10% of the BE was related to tourism.[89]

While there is no consistent method applied to value Coastal Tourism sector this report has adopted a method which more closely aligns with the wider definitions used in the EU, U.S.A, China and Australia. Stats NZ has acknowledged that the definition of tourism in the marine economy is narrow and a more fulsome definition would be appropriate.

This report has extended the Stats NZ definition by including the following,

- Marine Tourism Operators: which is defined as tourism operators that rely on the maritime area for their business. There is no official Stats NZ data on the potential number and size of marine tourism operators. Therefore, this report has collected information on marine tourism operators to establish an estimate of the employment and economic activity associated with the maritime area. The following business types have been included,
    - Watching marine species: most notably is the eco-tourism operators that offer viewings of unique/rare marine animals such as whale watching[90], dolphin tours[91], seal encounters[92], penguin viewing[93] and pelagic birds[94]. There are also many tourism operators that provide tour to see fish species, scuba diving[95] and snorkelling[96].

[86] Zhao, R., Hynes, S., & Shun He, G. (2014). Defining and quantifying China's ocean economy. Marine Policy, 43, 164–173.
[87] Australian National Centre for Ocean Resources and Security (2017) The Blue Economy in Australia.
[88] Korea Maritime Institute (2019) Korea's Ocean Economy.
[89] Fisheries and Oceans Canada (2016) Maritime Sector in Canada Summary Tables. http://www.dfo-mpo.gc.ca/stats/maritime-eng.htm
[90] Whale Watch Kaikoura, Explore Group Limited, Fullers Bay of Islands, Perfect Day Ocean Cruise, Perfect Day Ocean Cruise, She's A Lady Charters, Vigilant Yacht Charters Ltd, Bay of Islands Cruise & Night Safari.
[91] Gulf Eco Adventures, Milford Sound Overnight Cruise - Fiordland Discovery, Akaroa Dolphins, Milford Sound Overnight Cruise - Fiordland Discovery, Black Cat Cruises.
[92] Seal Swim Kaikoura, Akaroa Seal Colony Safari, Seal Coast Safari.
[93] Pohatu Penguins, Blue Penguins Pukekura, Oamaru Blue Penguin Colony, Yellow-eyed Penguin Trust. etc.
[94] Royal Albatross Centre, Albatross Encounter Kaikoura, Gannet Beach Adventures, Gannet Safaris, Rakiura and Aurora Charters Pelagic Birds, etc.
[95] Dive! Tutukaka Dive Zone Whitianga, New Zealand Diving, Descend Scuba Diving Milford Sound, etc.
[96] Perfect Day Ocean Cruise, Cathedral Cove Dive & Snorkel, Paihia Dive, Gulf Eco Adventures, etc.

- Sightseeing/harbour tours: again, most notably in Bay of Islands (Hole in the rock[97]), Milford Sounds[98], Marlborough Sounds[99], Banks Peninsula[100] and most harbours in New Zealand[101]. There are also other tour operators that offer tours that relate directly to the maritime area, Cape Reinga/90 mile beach[102] and Farewell Spit[103] bus tours which operate on the beaches and tidal areas. There will be other operators that also rely on marine activities as part of their offer, for example tours of Coromandel will always include stops at to Cathedral Cove and Hot Water beach.
- Recreational Sports: there are many small businesses that offer recreational sports in the maritime area. This includes surfing[104] and other adventure activities (kayaking, sailing, wind surfing, kite surfing, paddle boarding, etc)[105].

In total, the 250 marine tourism operators captured in this report generated $120 million in direct value added and supported employment of approximately 1,500. However, this report only provides partial coverage of the tourism businesses that operate in maritime area, which means that the value presented above is likely to be an underestimation. It is suggested that it would be beneficial to commission separate research into the marine tourism operators.

- Cruise Industry: the international and domestic cruise industry is a significant part of the tourism industry. The industry has been growing faster than the rest of the tourism industry, 13% per annum.[106] Stats NZ estimated that international cruise tourists spent $434 million in 2018[107]. There is no official estimate of domestic cruise tourists or other key economic metrics (value added or employment). This report has drawn on the New Zealand Cruise Associations research which estimates the value of both international and domestic cruise tourism, which suggests that cruise related tourism was worth approximately $300 million in direct value added and supported employment of 6,100.[108]
- Ancillary International Tourism: most international tourists undertake a range of activities, some of which will be marine related and others that will not be related to maritime area. The main difference between the international studies is the point at which they define tourism spend as being related to maritime area. For example, if a tourist undertakes whale-watching trip in Kaikoura which requires most of the day, it would be fairly uncontroversial to assume that all of the tourists spend on that day, either side of the trip, would be related to the maritime area. In this case none

[97] Explore Group Limited, Gulf Eco Adventures, Fullers Bay of Islands, Perfect Day Ocean Cruise, She's A Lady Charters, Vigilant Yacht Charters Ltd, Bay of Islands Cruise & Night Safari

[98] Milford Sound Overnight Cruise - Fiordland Discovery, Milford Sound Encounter Nature Cruise - Southern Discoveries

[99] Beachcomber Cruises. Queen Charlotte Cruise & Track Adventures, Cougar Line - Queen Charlotte Track Cruises, Pelorus Mail Boat Ltd.

[100] Akaroa Dolphins, Black Cat Cruises - Akaroa Harbour Cruises, Diamond Harbour Ferry & Quail Island Adventures

[101] Gulf Eco Adventures, Perfect Day Ocean Cruise, Abel Tasman Charters- Best Abel Tasman Day Trip

[102] Fullers Great Sights, Dune Rider Kaitaia Tours

[103] Farewell Spit Tours, Tasman Tours

[104] Surf New Zealand has 38 approved surf schools in New Zealand.

[105] Work Safe (2019) Register of adventure activity operators. This data set shows over 50 businesses that operate in the marine area.

[106] New Zealand Cruise Association (2018) Various reports and tables.

[107] Statistics New Zealand (2018) Tourism satellite account: 2018.

[108] Market Economics (2018) Cruise Tourism's Contribution to the New Zealand Economy 2018.

of the spend would have occurred in this location if there were no marine are (whales). This would include accommodation, retail, food and other expenditure by the tourist.

At the other end of the scale is a tourist that may simply transit past the coast line and only view the maritime area. While this viewing of the coast line may generate value to the tourist, it is unlikely that the spend that occurs either side of that viewing should be thought of as being associated with the maritime area.

Without undertaking detailed research it would not be possible to accurately establish the value of ancillary spend that is associated with the maritime area. This report has adopted a conservative approach and has assumed that international tourism spend that occurs within one kilometre of the coast line is associated with the maritime area.[109] Base on this definition the Ancillary International Tourism was estimated to generate $783 million in direct value added and supported employment of 9,540. This estimate suggests that Ancillary International Tourism related to the maritime area represents approximately 20% of total value generated by international tourists in the New Zealand economy.

- Domestic Coastal Holiday: a large number of New Zealanders undertake summer holidays in the coastal areas. There are domestic tourism hotspots close to most major cities, with the biggest being the beach areas in Northland and Coromandel. This research has analysed the number of holiday homes that are indicated from Census information, which provides an understanding of the scale and location of domestic tourism in New Zealand.

  Base on the available information the Domestic Coastal Tourism was estimated to generate $1,745 million in direct value added and supported employment of 26,000. This estimate suggests that Domestic Coastal holiday related to the maritime area represents approximately 20% of total value generated by domestic tourists in the New Zealand economy.

Table 3.4 shows the value that the Coastal Tourism sector directly contributes to the New Zealand economy. The results in the table provides the following key insights about this part of the BE,

- The value added generated by the Coastal Tourism sector has increased consistently over the last decade by 6% per annum to reach $3,023 million in 2017. The sector now represents approximately 1.1% of the economy.[110]
- The employment in the sector has increased from 40,813 in 2008 to 43,128 in 2017, which is an increase of 1% per annum over the decade.
- The value added generated per employee has increased markedly over the decade. However, the results also show that the Coastal Tourism sector still generates relatively low value per employee ($70,000) compared to values observed in the rest of the economy (approx. $125,000 per employee).

[109] This includes spend on Accommodation, XXX

[110] Stats NZ (2019) Gross domestic product, by region and industry (Annual-Mar).

Table 3.4: Value of Coastal Tourism in the Economy, 2008-2017

Coastal Tourism	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CA
Value added - $m	$ 2,009	$ 1,883	$ 1,952	$ 1,980	$ 2,069	$ 2,109	$ 2,201	$ 2,566	$ 2,952	$ 3,023	
Employment Count	40,816	40,805	38,442	37,415	36,141	35,717	36,019	39,422	43,128	43,071	
Value Added per employee	$ 49,216	$ 46,144	$ 50,787	$ 52,915	$ 57,237	$ 59,043	$ 61,099	$ 65,090	$ 68,436	$ 70,181	
Contribution to total GDP (%)	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	1.1%	1.2%	1.1%	

3.1.5 Government Services

There are a number of government services that occur in the maritime area, both central and local government. The key central government services that rely on the maritime area include the defence (navy, air force), compliance (regulation/biosecurity/customs), safety (coastguard) and research (universities/Crown Research Institutes). The key local government services that rely on the maritime area include marine safety (harbour master), inshore governance (resource consents), waste management (sewage and stormwater) and public transport (ferries).

The New Zealand has around 2,700 personnel in the Navy, which is 19% of the total defence force.[111] The Navy has a budget of $445 million, which is used to provide/preform three capabilities, Combat, Sustainment and Maritime Trade operations.[112] The Air Force also has a significant role in surveillance and border protection in the maritime area, which may be in the order of $100 million expenditure and some hundreds of air force personnel (of the total 2,500 excluding reserves). Also, it is likely that a substantial portion of the Ministry of Defence role will relate to the defence of the maritime area.

There are a number of central government agencies that also roles that directly relate to the maritime areas, which this report refers to as compliance. Obvious agencies are Maritime NZ (budget of $49 million[113]), Ministry of Primary Industry (fisheries management - $61 million and a large portion of biosecurity - $100 million[114]), Customs (border clearance of craft - $10 million and National Maritime Coordination Centre - $13 million[115]) and the Environmental Protection Agency (EEZ compliance – $8 million[116]). There are a number of other agencies that also have roles associated with the maritime area (and budget).[117] It is likely that the central government spends many hundreds of millions of dollars on services that are related to the maritime area.

The central government also provides part-funding for search and rescue services, which are predominantly provided by non-profit organisations. There are a number of non-government agencies that provide search and rescue services in the maritime area. For example, the Royal New Zealand Coastguard has a budget of $19 million of which 10% comes from central government.[118] Surf Life Saving New Zealand

[111] New Zealand Defence Force (2017) Annual Report 2016-2017.

[112] Ibid.

[113] Maritime New Zealand (2017) Briefing to the Incoming Minister of Transport.

[114] Ministry of Primary Industry (2017) Annual Report 2016-2017.

[115] New Zealand Customs Services (2017 Annual Report 2017.

[116] Environmental Protection Authority (2018) Annual Report 2018.

[117] Statistics New Zealand, Ministry for the Environment, Department of Conservation, New Zealand Transport Agency, Ministry of Business, Innovation and Employment, New Zealand Petroleum and Minerals, Ministry of Transport, Ministry of Foreign Affairs and Trade, Ministry of Civil Defence and Emergency Management, Department of Internal Affairs, Sport New Zealand, Accident Compensation Corporation, etc.

[118] Coastguard New Zealand (2017) 2017 Annual Report.

is another significant provider of rescue services in the maritime area, which has a total budget of $9.4 million.[119] There are also other search and rescue organisations that will provide services in the maritime area, for example rescue helicopter and in some cases SPCA. It is likely that the central government spends many millions on search and rescue services that are related to the maritime area. The community augments the governments spend via donations and voluntary work.

The central government also funds significant amount of research on the maritime area, including this report. Most universities in New Zealand will have departments and researchers that focus on the maritime area. There are also number of Crown Research Institutes and Crown Entities that have focus on the maritime area, including National Institute of Water and Atmospheric Research, GNS Science, Institute of Environmental Science and Research, Plant & Food Research, Landcare Research, Callaghan Innovation, etc. There is no data available for these groups from which this report can assess the activity that is generated in the economy that is associated with the maritime area. However, it is considered that the value is likely to be in the order of tens of millions of dollars across the country.

Finally, local government also provides services that are reliant on the marine environment. The key services that is provided by councils relates to wastewater and stormwater. The geography of New Zealand means that most councils discharge wastewater and stormwater into the maritime area. These services are sizeable, with Auckland alone spending over $300 million each year on wastewater[120] and an average of $56 million on stormwater[121]. It is likely that local government in New Zealand would spend in the order of a billion per annum on wastewater and stormwater, of which the vast majority flows into the maritime area.

Local government also provides other services that, marine safety (harbourmaster) and governance (resource consenting). This report has found no reliable information from which to assess the potential value of either of these services. However, the value is likely to be many millions of dollars across the country.

This report has not adopted the Stats NZ definition that it uses in the Marine Economy statistics. Stats NZ has undertaken a "partial measure" of government services, which estimates a very small value of $4.4 million. The definition applied by Stats NZ has only included a very small segment of the government services that are related to maritime area. This is because it is difficult to measure the various values.

While it is acknowledged that it is difficult to establish the government services that relate to the maritime area, it is true that the value is likely to be many orders of magnitude larger than is estimated by Stats NZ in the marine economy statistics. This study has drawn on relevant reports from key government agencies to establish the following estimate of 'Government Services' sector.

Table 3.5 shows the value that the Government Services sector directly contributes to the New Zealand economy. This report has developed two point estimates of the value of Government Services sector, the start and end of the decade. The intervening years are interpolated assuming that Government Services sector is maintained on a per capita basis – specifically the results shown for 2009 to 2016 are calculated

[119] Surf Life Saving New Zealand (2017) Financial Report 2016-17.

[120] Watercare (2017) 2017 Annual Report.

[121] Auckland Council (2017) Annual Report 2017/18.

by applying the average per capita Government Services sector from 2008 and 2017 to the national population in each year. The results in the table provides the following key insights about this part of the BE,

- Value added generated by the Government Services sector has increased over the last decade by 6% per annum to reach $681 million in 2017.[122] The sector now represents approximately the 0.3% of the economy.[123]
- Gross earnings have increased at a slower rate of 4% per annum over the last decade.
- Employment in the sector has increased from 5,626 in 2008 to 6,355 in 2017, or 1% per annum over the decade.
- Value added and gross earnings generated per employee has increased over the decade. The results show that the Government Services sector generates relatively low value per employee ($107,000 million) compared to values observed in the rest of the economy (approx. $125,000 per employee). This is expected as the majority of entities included in this assessment do not have profit requirements or minimal profit requirements. This means that value added generated is generally lower per head in the government sectors than in the rest of the economy.

Table 3.5: Value of Government Services in the Economy, 2008-2017

Government Services	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAG
Value added - $m	$ 387	$ 416	$ 445	$ 473	$ 501	$ 530	$ 564	$ 601	$ 640	$ 681	6
Gross earnings - $m	$ 357	$ 370	$ 383	$ 396	$ 407	$ 420	$ 436	$ 454	$ 474	$ 495	4
Employment Count	5,626	5,684	5,750	5,797	5,831	5,879	5,971	6,087	6,219	6,355	1
Value Added per employee	$ 68,848	$ 73,128	$ 77,404	$ 81,677	$ 85,946	$ 90,211	$ 94,473	$ 98,732	$ 102,987	$ 107,238	5
Gross earnings per employee	$ 63,440	$ 65,046	$ 66,650	$ 68,253	$ 69,855	$ 71,455	$ 73,054	$ 74,651	$ 76,247	$ 77,842	2
Contribution to total GDP (%)	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	

While this report provides a wider estimate of the Government Services sector than the official Stats NZ estimate, there are still some known gaps in the measure applied in this report. It is likely that this report underestimates the total economic value associated with this sector. The key areas that could be added to the sector in the future are,

- Research: which would include both universities and Crown Research Institutes.
- Other Local Government: it is likely that local government spends considerable resources on the services that relate to the maritime area which are not captured. For example, boat ramps, research, resource consenting, etc.
- Other Central Government: there are a number of departments that will have minor roles and small teams that relate to the maritime area. For example, Department of Conservation is likely to have a roles and teams of officials that are related to the maritime area.

[122] Based on data from Annual reports from New Zealand Defence Force, Ministry of Defence, Ministry of Primary Industry, Maritime NZ, Customs New Zealand, Environmental Protection Agency, Watercare, Auckland Council, Royal New Zealand Coastguard and Surf Lifesaving New Zealand.

[123] Stats NZ (2019) Gross domestic product, by region and industry (Annual-Mar).

Based on the assessment undertaken in this report the Government Services sector that provides services or has roles related to the maritime area is likely to be close to one billion per annum.

3.2 Emerging Sectors

There is likely to be future growth in the BE driven by industries not currently operating (or operating at a small scale) in the New Zealand economy. This report focusses on two key emerging industries that may be important for the BE, Blue Biotechnology and Ocean Energy. This report has selected these emerging sectors because of their strong growth in other countries, which provides an insight into their potential for growth in New Zealand.

It is acknowledged that this section is not intended to provide a complete understanding of the range of potential emerging sectors that could occur in future in the maritime area around New Zealand. The future is inherently uncertain which means that new technology could result in the creation of sectors not addressed in this report. For example, "Blue Carbon" (sequestering of CO_2) may be used as a future business model that could generate significant value in the economy.

3.2.1 Blue Biotechnology

Blue biotechnology is the creation of products and processes from marine organisms through the application of the techniques of biotechnology, molecular biology, and bioinformatics.[124] There are numerous applications of the use of biotechnology to improve and maintain a sustainable marine environment, from stimulating reproduction and improving growth rates of fishes in aquaculture farms to creating biofuels from microalgae – potentially contributing to solving important global societal challenges of sustainable food security, environmental sustainability, and human health.

In 2012 the Blue Growth Study considered that biotechnology would be likely to be a high-growth sector in the maritime area. A key opportunity is the research and development in the use of algae for creating biofuels and marine-derived polysaccharides (a type of carbohydrate) are viewed as one of the key drivers in growing the biotechnology sector.[125] Other industrial sectors that can benefit from biotechnology advancements include pharmaceuticals, textiles, cosmetics, plastic and paper processing.[126] The global marine biotechnology sector is expected to reach $4.8 billion by 2020 and $6.4 billion by 2025, but is only a small fraction (0.9%) of the global biotechnology market which expected to be valued at $727.1 billion by 2025.[127]

The National Oceanic and Atmosphere Administration estimates that 91% of all ocean species have yet to be discovered.[128] This emphasises the vast scale of the ocean and its untapped potential for the marine biotechnology sector. Blue biotechnology is a rapidly emerging sector that is still in its infancy. But barriers

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[124] Thakur, N.L and Thakur, A.N (2006) Marine biotechnology: An Overview. Indian Journal of Biotechnology, Vol 5, July 2006 pp 263-268.

[125] ECORYS Research and Consulting (2012) Blue Growth: Scenarios and Drivers for Sustainable Growth from the Oceans, Seas and Coasts

[126] Grand View Research (2017) Biotechnology Market Analysis By Application (Health, Food & Agriculture, Natural Resources & Environment, Industrial Processing Bioinformatics), By Technology, And Segment Forecasts, 2018 – 2025.

[127] Smithers Group (2015) The Future of Marine Biotechnology for Industrial Applications to 2025.

[128] Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) How Many Species Are There on Earth and in the Ocean? PLoS Biol 9(8): e1001127. doi:10.1371/journal.pbio.1001127

are inhibiting growth, such as the initial discovery process, lack of major infrastructure, limited capability to cultivate the organisms in the laboratory, and most importantly, at a commercial scale. Other barriers include underfunding, legal and regulatory issues, and restricted access to the ocean.

Given New Zealand's location and scale of the maritime area, it is likely that there are substantial unexplored and underexploited marine resources that could be developed for biotechnology sector uses. The research undertaken for this report shows that there is limited Blue biotechnology that has been commercialised in New Zealand. However, it is likely that there is research underway that is not public because of commercial confidentially. There are a number of Crown Research Institutes[129], private companies[130] and universities[131] that are all conducting research. There are media reports of some new marine biotechnology under development, such as,

- Bio fuels: there is research underway into the potential use of fast-growing seaweeds to produce bio fuels,[132]
- Animal feed: Cawthron has developed microalgae at its aquaculture park that can be grown for feed,[133]
- Cosmetics: for example, Ngai Tahu Seafood and Moana New Zealand have collaborated with biotech researchers (NIWA) to explore methods for extracting bio-actives from seafood by-products.[134]
- Pharmaceuticals: project PharmaSea is a coloration to tap novel diversity not seen before and to evaluate their potential as drug leads, and antibiotics. The research involves New Zealand universities and is being conducted off New Zealand,[135] and
- Waste research: the Faculty of Science at the University of Auckland was awarded funding for a research project looking into whether microalgae and their interactions with ocean sediments are causing microplastics to invade our food chain.[136]

Also, there is no national strategy for marine biotechnology or biosciences[137] which indicates there is limited coordination by the government. Stats NZ discontinued its research of the sector in 2011, which showed total revenues related biotechnology was valued at $670 million and 15% of biotechnology was related to Marine and fresh water biosciences.[138]

This report has chosen not attempted to measure the value of Blue biotechnology as there is limited data from which a robust estimate can be developed. However, it is acknowledged that Blue biotechnology

[129] National Institute of Water and Atmospheric Research – NIWA, Plant & Food Research.

[130] Cawthron Institute, Callagahan innovation, Malaghan Institute, New Zealand Pharmaceuticals Ltd.

[131] University of Auckland (School of Biological Sciences), University of Victoria (Centre for Biodiscovery), University of Canterbury (Marine Chemistry Group), University of Waikato (Environmental Research Institute).

[132] Stuff (2018) Underwater seaweed forests tipped as next big thing in climate change fight – Nov 27th.

[133] Cawthron (2018) Microalgae production for aquaculture feed.

[134] Moana New Zealand (2015) A long-term view in everything we do. Annual report.

[135] PharmaSea (2015) What is PharmaSea?

[136] Royal Society (2018) Are Microalgae putting plastic in our food? Marsden Fund Nov 8th.

[137] BIOtechNZ (2019) New Zealand urgently needs a biotech strategy – media release Feb 27th.

[138] Stats NZ (2012) Bioscience Survey.

could be worth in the order of one hundred million per annum.[139] BIOtechNZ (industry body) is planning to conduct new research in 2019 which is likely to provide insights into how the wider sector and Blue biotechnology may have grown.[140]

Finally, while growth in Blue biotechnology could produce significant gains to the economy, there should be awareness that the commercial interest in bioprospecting of natural marine life and genes can also generate negative impacts.

3.2.2 Ocean Energy

Ocean energy is the generation of power by harnessing kinetic energy that naturally occurs in the oceans. There is vast store of renewable energy in the maritime area, which is being extracted by generation methods that use technologies to harness movement of the water (waves, tidal, currents), wind (offshore turbines), thermal gradients in the water column and osmotic process (mixing of fresh and salt waters at the mouth of rivers).

Internationally, there is substantial power generated (18,800MW) by a large number of marine wind turbines operating in Northern Europe (84% of world production occurs in Britain, Germany and Scandinavian countries), Asia (16% of world production mostly China and small amounts in Vietnam, Japan and South Korea) and North America (0.2% of world production in Unites States).[141] Also of importance is the current and emerging deployments of various tidal power stations, with current production of over 520MW (mostly in South Korea, France and Canada).[142] Finally, wave power is still in its infancy, with only a few power stations constructed in Sweden, United Kingdom, Portugal, with total production of 15MW.[143]

New Zealand's location in the Roaring Forties and the coastal geography, particularly around the western and southern coasts, mean that there is significant potential for wave and tidal energy production. New Zealand has a significant tidal energy resource in and around the Cook Strait, French Pass, and Foveaux Straight powered by the Southern Ocean and Tasman Sea. New Zealand also has some very large harbours on the west coast also possess strong tidal movements, with potential to generate power in the mouths of the harbours (e.g. Kaipara and Hokianga).

Over the last decade there has been numerous proposals to develop ocean power generation. The government has invested funding to support the development of sustainable marine energy solutions.[144] However, none of the government or private projects have eventuated in the deployment of working generators.

One of the proposed projects was to deploy a tidal power station in the main channel of the Kaipara Harbour, which received approval from the Minster of Conservation in 2011.[145] This station could have

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[139] Ibid, assuming that biotechnology businesses had same *pro rata* revenue return for all research areas. Then 15% of firms that undertake research of Marine and fresh water biosciences could have generated $100.5 million in 2011. It is likely that the revenue may have increased since 2011, and that marine biotechnology could be generating significantly more in 2019.

[140] BIOtechNZ (2019) BIOTechNZ 2019 a year if opportunity and growth – media release Feb 8th.

[141] Global Wind Energy Council (2018) A Snapshot of Top Wind Markets in 2017 – Offshore Wind.

[142]

[143]

[144] Energy Efficiency and Conversation Authority (2012) Marine Energy Deployment Fund 2007 to 2011.

[145] Minister of Conservation (2011) Kaipara Harbour tidal turbine projected approved – Press Release Mar 17th

produced 200MW, which would have been one of the largest tidal power stations in the world.[146] It was estimated to be able to power the entire Northland region as well as parts of the Auckland region. However, due to various reasons the project was put on hold in 2013. The Kaipara tidal power station and other projects in the fund showed the potential of renewable marine energy sources in New Zealand.

There have also been a number of proposed projects to deploy tidal turbines in the Cook Strait. In 2008 one proposal was granted consent to deploy test turbines, however the deployment has not eventuated.[147] There have been other ocean energy projects that have been proposed, however none have gone as far as applying for consent to deploy power stations.

Finally, most countries around the world have goals to reduce carbon emissions which has resulted in a need to develop ocean energy as an alternative to non-renewable energy. New Zealand has a goal to become carbon neutral by 2025 which would mean that 90% of energy would need to generated by renewable sources.[148] However, most of the energy that is generated in New Zealand already comes from renewable sources (82% in 2017), from land based hydroelectricity (58%), geothermal (17%) and wind (5%) and a much smaller degree solar, bio-gas and wood.[149] There are also a number of proposed land based renewable energy projects which are underway[150], which suggests that the governments goals will be achievable with little need to develop ocean energy.

Despite the recognised potential for ocean energy generation in New Zealand, other renewable energy types have been favoured in the foreseeable future. Currently, the ocean energy sector of the BE is likely to be very small in New Zealand (some research and development), however there is potential for this to change in the future.

3.3 Total Sectoral Value

The Blue Economy has a significant role in the national economy. This report estimates that around 3% of GDP in the economy is related to blue economy, with a total of $7.4 billion directly related to sectors that rely on the maritime area. The Blue Economy directly sustains employment of nearly 70,000, which is equivalent to 3.3% of total employment in New Zealand.

As noted above this report has not been able to incorporate an estimate for every part of the economy that relies on the maritime area. Therefore, the estimate presented in this report is conservatively low. However, the remaining parts of the BE are likely to be relatively small (parts of Government Services and Coastal Tourism), and at most would add an additional be 5% to the measure presented in this report.

Figure 3.1 shows that the direct value added associated with the industry has increased by 2% per annum over the last decade, which is slower than the background growth observed in the economy. The sector level results provide the following key points,

[146] Crest Energy (2011) Kaipara tidal power.

[147] Neptune Power (2019)

[148] Minister for the environment (2008) Carbon neutral electricity by 2025 – Press Release Feb 22nd

[149] Ministry of Business, Innovation & Employment (2019) Quarterly Electricity Generation and Consumption Data.

[150] There are multiple wind farms and domestic solar systems that are likely to developed in the coming five years.

- Offshore Minerals was the only sector in the BE to decline. This sector recorded a substantial drop over the decade (decline of over $1 billion), the importance of the sector changed from 35% of the BE in 2008 to 14% in 2017.
- Commercial Fisheries has increased in importance over the decade. This sector recorded a consistent increase, growing from 9% of the BE in 2008 to 15% in 2017.
- Coastal Tourism has increased substantially over the decade (increase of over $1 billion). This sector recorded a consistent increase, growing from 32% of the BE in 2008 to 41% in 2017.
- Infrastructure and Transport has increased in importance over the decade. This sector recorded a consistent increase, growing from 18% of the BE in 2008 to 21% in 2017.
- Government Services has increased in importance over the decade, growing from 6% of the BE in 2008 to 9% in 2017.

Figure 3.1: Value of Sectors of the BE in the Economy – Value Added $ million, 2008-2017

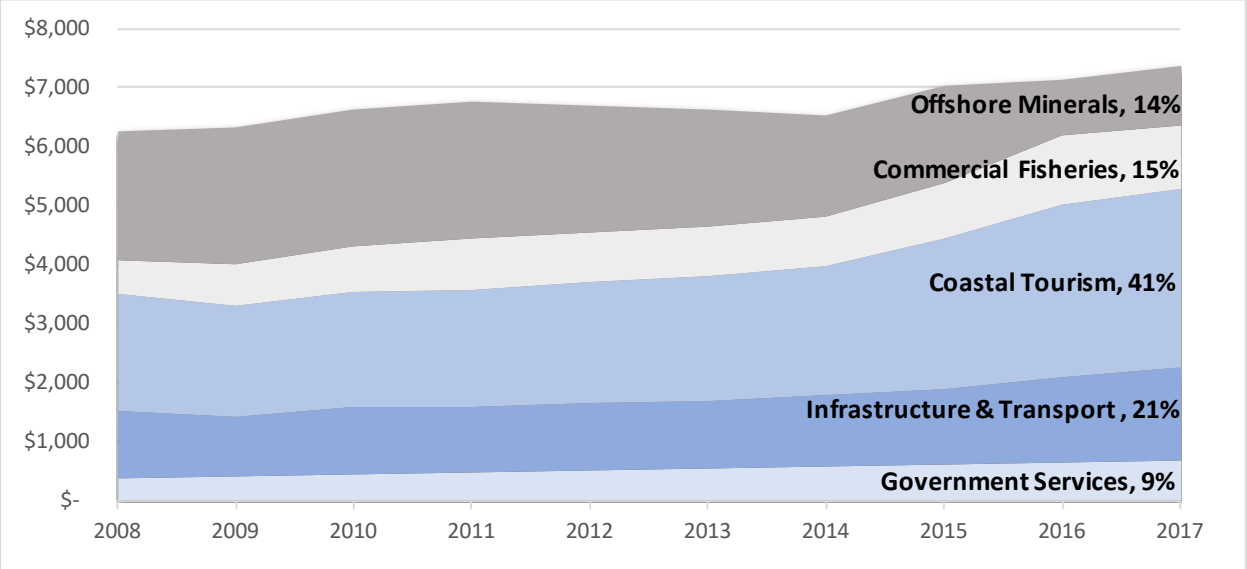
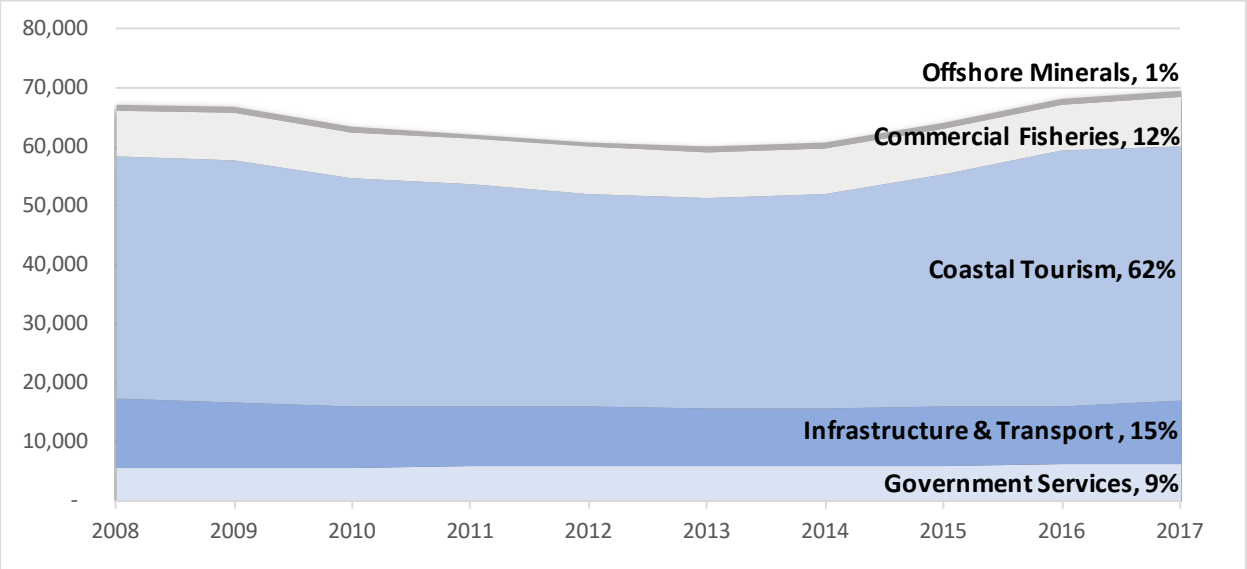


Figure 3.2 shows that the direct employment associated with the industry has increased by 0.4% per annum over the last decade, which is slower than the background growth observed in the economy. The sector level results provide the following key points,

- The relative importance of the sectors of the BE has remained relatively static over the decade.
- Coastal Tourism generated more employment than the combined rest of the sectors in BE. Throughout the decade this sector sustained 62% of the employment in the BE.
- Infrastructure and Transport was the second most important sector of the BE in terms of employment. However, this sector was part of BE to record a decrease in employment over the decade. The importance of the sector changed from 18% of the BE in 2008 to 15% in 2017.
- Commercial Fisheries sector sustained 12% of the employment in the BE, which was unchanged throughout the decade.
- Government Services sector sustained 9% of the employment in the BE, which was unchanged throughout the decade.
- Offshore Minerals sector produced very little employment over the decade, with less than 1% of employment in the BE occurring in this sector.

Figure 3.2: Value of Sectors of the BE in the Economy – Employment, 2008-2017



Finally, it is important to note that Stats NZ and many international studies also estimate the additional secondary economic activity that occurs as a result of the direct activity that occurs in the Blue Economy sectors. The secondary economic activity is generated by two resulting flows in the economy, which are commonly referred to as indirect and induced impact.

The indirect impact records the economic activity that occurs in other non-BE businesses that provide goods and services to the BE businesses. Some non-BE businesses will sell inputs of production to BE businesses, which results in additional economic activity in the National economy.

The induced impact records the economic activity that occurs as a result of income (wages/salaries/profits) being received from BE businesses, which has resulting implications for household spending. The household spending flows into other non-BE businesses, which then generates other benefits.

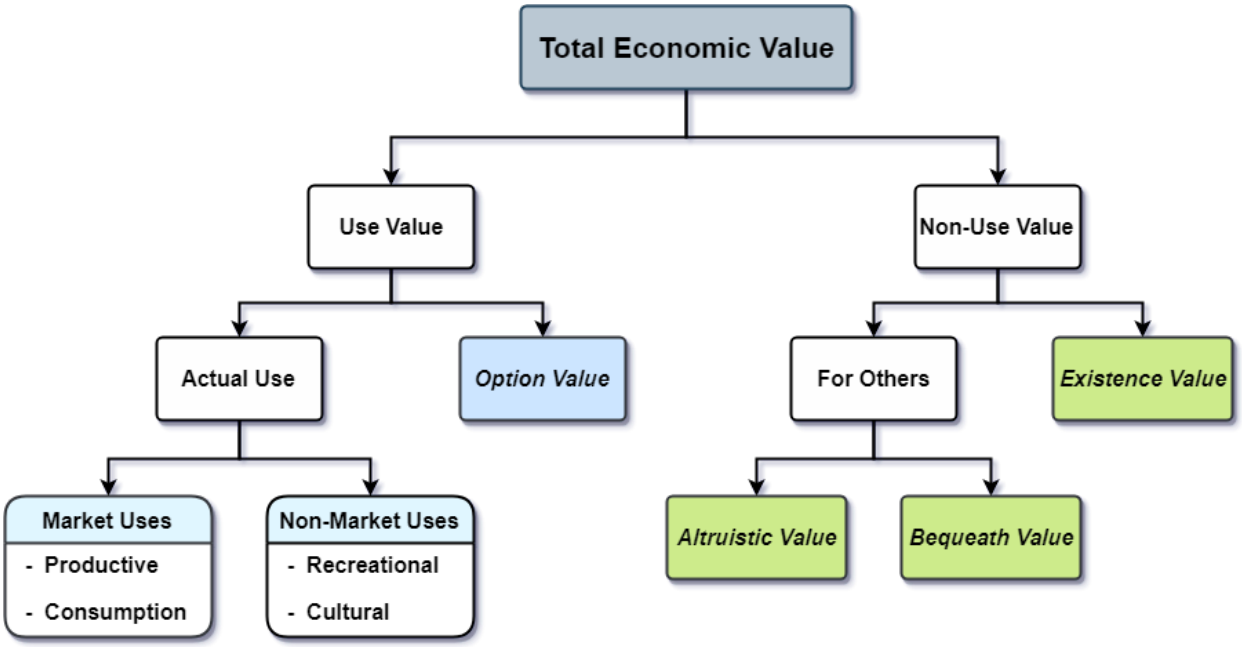
Stats NZ marine economy data suggests that for every dollar of direct value in the BE sectors there is approximately 90 cents of secondary value generated in the national economy. While this report has not directly estimated the secondary values, it is likely that ratio would be about the same as the relative structure of the economy is unchanged. Therefore, it may be that the total value added generated by the BE Sectors could be $13.8 billion in 2017, which is equivalent to 5.1% of the national economy.

4 Economic Benefits of the BE

The following section draws from existing research to populate the economic benefits framework outlined in section 2. This report has adopted the Total Economic Valuation framework shown in Figure 4.1 to define the Economic Benefits framework for the BE. This framework splits economic benefit into direct use and non-use – the first split in tree shown in the diagram.

The use values are then split into actual uses and option uses. The actual uses are divided further into market uses and non-market uses. The market uses are valued in terms of productive, which are the values that where covered in the sectors of the BE framework – i.e. value added in the economy. The market uses also produce benefits when domestic residents consumes goods and services from the economy that relate to the maritime area. Finally, there are economic benefits associated with the option to use the maritime area, which is the value associated with the potential intended use that may or may not eventuate.

Figure 4.1: Framework of Economic Benefits of the BE in the Economy



The non-use values are split into existence and for others. The existence use is the value that people place in the knowledge that a resource exists, which is separate from any potential use of the resource. The non-use value for others is defined as the value that people place on future generations (bequest) and other existing people (altruism) having access to the resource.

A key aspect of the Economic Benefits framework of the BE is that it extends to include non-market benefits which were not assessed in the sectoral framework. This extension includes the following aspects of the BE;

- consumption values (consumer surplus from market goods and services),
- recreational values (fishing and other activities),
- cultural values (customary fishing, kaitiakitanga and mana whenua obligations),

- amenity values (views from private and public land).
- option values,
- existence values, and
- bequeath values.

This report does not present a full assessment of potential impacts of each use and non-use on the overall societal position. In order to fully understand the overall societal position, there would need to be an assessment of costs that are associated with all uses and non-uses. It is likely that each economic benefit will generate costs that may flow to other users of the maritime area and/or to the ecosystem. Specifically, in order to gain the economic benefits from the maritime area there will be associated costs. Some economic benefits have very small associated costs (e.g. eco-tourism), while others will have greater costs (e.g. commercial fishing).

Consequently, the comparison of economic benefits in this report should be taken with care. While this report presents all benefits in a single figure, this does not mean that they all have the same value or impact on the overall societal position. Further research is required to assess costs associated with each economic benefit to allow policy makers to assess the benefits along with their associated costs, in order to understand the overall societal position.

4.1 Use Values

This report focuses on the following three key use-values that generate economic benefits related to the BE,

- Market uses – production and consumption,
- Recreational uses – active and experiential,
- Cultural uses – customary and spiritual, and
- Amenity uses – visual.
- Option use.

4.1.1 Market Uses

Sectoral value defined in the previous section provides an estimate of value generated in the economy associated with **production**. Specifically, the value added (GDP) estimate in the Sectoral BE framework, is a measure of incomes generated by production which are associated with the maritime area (profits, wages, salaries etc.). Value added provides a measure of the values generated during the production process (production surplus) but does not consider the economic benefits associated with the **consumption** of the outputs of production. Total economic benefits associated with market uses of the maritime area would include surpluses generated from both production and consumption.

Surplus from consumption is the difference between value a consumer attaches to a product (the maximum price a consumer is willing to pay) and the price the consumer actually pays (market price). This value is commonly referred to as consumer surplus.

For example, an aquaculture firm in Marlborough grows salmon which is sold to domestic consumers. The Sectoral framework would measure the direct market value of the salmon as the salary/wages paid to staff working on the farm and profits made by the firm (i.e. value added). Domestic consumers receive value from consuming salmon, which must exceed the price paid for the salmon, or they would not purchase the

goods. Therefore, the consumer receives a 'consumer surplus', which is equal to the difference between the costs of consuming the salmon (purchase price) and consumption value. Consumer surplus is an economic benefit (use value) associated with the maritime area and the BE.

Unfortunately, it is notoriously difficult to accurately estimate consumer surplus. However, it is likely that consumer surplus will be significant for goods and services that are consumed domestically. This report does not estimate of the economic benefits arising from consumer surplus associated with direct market uses of the maritime area. However, this value is likely to be several billions of dollars each year.

This report includes a notional value as a placeholder for consumer surplus – which is calculated by taking expenditure by domestic consumers on goods and services in the Sectors of the BE (i.e. domestic tourism, government services and commercial fishing products consumed locally) and known properties of demand for the goods that are consumed[151] and an assumed demand function[152] as the basis of this notional value.

Table 4.1 shows the economic benefits associated with market uses of the maritime area. The results provides the following key insights about this part of the BE,

- Most of the economic benefits from market uses of the maritime area are related to production. This is expected as most of the activity is related to export activity that is not consumed in New Zealand – much of the seafood, offshore minerals and coastal tourism will be consumed by non-residents.
- The consumer surplus received by New Zealanders via the consumption of goods and services from the maritime are is likely to be significant, in the order of several billions per annum or a third of the total market use economic benefits from the Blue Economy. The notional consumption value presented in the table is less than $700 per capita – i.e. this notional value is equivalent to each person in New Zealand receiving less than $700 per annum from goods and services that are sourced from the maritime area. This is relatively small economic benefit, which is likely to substantial underestimate the actual consumer surplus.
- Also, it is likely that the consumption use value has been growing faster than production values.

Table 4.1: Market Use Economic Benefits from the Blue Economy, 2008-2017

Market Use value	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAGR
Production	$ 6,269	$ 6,310	$ 6,613	$ 6,759	$ 6,679	$ 6,614	$ 6,540	$ 7,025	$ 7,135	$ 7,378	2%
*Consumption**	*$ 2,296*	*$ 2,455*	*$ 2,391*	*$ 2,526*	*$ 2,615*	*$ 2,653*	*$ 2,805*	*$ 3,001*	*$ 3,062*	*$ 3,205*	4%
Total Surplus	**$ 8,565**	**$ 8,765**	**$ 9,003**	**$ 9,285**	**$ 9,294**	**$ 9,267**	**$ 9,345**	**$ 10,027**	**$ 10,197**	**$ 10,583**	2%

**notional value, based on consumption of goods in the domestic market and assumed demand functions.*

[151] Goods and services that have low price elasticity of demand tend to have a greater differential between the market price and the willingness to pay – i.e. greater consumer surplus. Most of the consumer goods and services that are related to the maritime area have inelastic demand, both tourism and fish are inelastic. See,

Schiff, A., & Becken, S. (2011). Demand elasticity estimates for New Zealand tourism. Tourism Management, 32(3), 564–575.

Nghiem N,Wilson N, Blakely T. (2011). Price elasticities for health economic modelling of food pricing interventions in Australia and New Zealand.

[152] The demand function for the goods and services is assumed to be linear.

4.1.2 Recreational Uses

New Zealanders use the inshore areas for many different recreational activities, which provides economic benefits which are not measured in any market. Most of the population lives within easy travel distance to the sea, which means recreational use of the sea is inherent to the way of life in the country.

The following recreational uses have been considered in this report,

- Swimming,
- Fishing (and other motorboating),
- Sailing (other wind-riding),
- Surfing (other wave-riding),
- Other experiential uses (walking/viewing), and
- Scuba Diving/snorkelling.

One illustration of the significance of recreational activity to inherent way of life in New Zealand, is the example of Auckland city which is known as the "City of Sails" because of the popularity of sailing and other water sports in the Hauraki Gulf. The recreational fishing in the area is substantial, with catch from recreational fisherman estimated to exceed commercial fishing in the Hauraki Gulf.[153] Most recent research suggests that approximately a quarter of households in Auckland own a recreational craft[154], which suggests that there are approximately 140,000 craft in Auckland.[155]

Also New Zealanders undertake many 'active' recreational activities in the maritime area. The Sports New Zealand participation survey shows that large shares of people undertake active recreational in the maritime area.[156] The survey shows that in the past year (2017),

- 33% of people participated in swimming (some of which would have been in the maritime area),
- 11% of people participated in Canoeing / Kayaking (some of which would have been in the maritime area),
- 8% of people participated in Surfing / Body boarding,
- 3% of people participated in Yachting / Sailing,
- 1% of people participated in Paddle boarding, and
- 1% of people participated in Waka Ama.

It is likely that many of the people that participate in walking (85% of the population) and running (38% of people), may also be utilising marine area – i.e. experiential use of the shoreline. Finally, the survey showed very few people participate in other recreational activities that occur in the maritime area – i.e. snorkelling, scuba diving, water skiing, wake boarding.

Clearly, the sea has a central role in many of the most popular recreational activities undertaken by the domestic population. While it is obvious that there are substantial economic benefits drawn from recreational uses of the maritime area, there is very little data on the value or scale of this activity. A key

[153] Hartill, B. (2014) Recreational fisheries in the Hauraki Gulf – NIWA.

[154] Beca Infrastructure (2012) Auckland Recreational Boating Study.

[155] Panuku Development (2018) Marina Berth Supply & Demand Trends.

[156] Sports New Zealand (2017) Active NZ – The New Zealand Participation Survey 2017.

issue is that most recreational activity (excluding tourism and marine retail) are not represented in any market transaction. Specifically, the majority of recreational use of the maritime area have non-market values, which are difficult to quantify (similar to the issues noted for consumer surplus).

Applied economic research tends to utilise two key methods to quantify non-market values associated with recreational activities, travel cost and state preference.

The travel cost method has been applied in New Zealand to establish the value of recreational fishing[157] and boating[158]. This method establishes the non-market value using an estimate of the expenditure of resources, both time and money, to undertake the recreational activity. The concept of the travel cost method is that participants gain benefit that is greater than the value of resources that are expended to undertake the activity. For example, to undertake a fishing trip a fisherman will buy goods (bait, tackle etc) and will use time during the trip (which could be used on an alternative activity or work). The travel cost method values these resources, which provides a proxy of the minimum value of economic benefits from the recreational activity – i.e. economic benefits must be greater than the travel cost. The existing travel cost assessments of recreational uses of the maritime area suggest that the economic benefits could be in the billions of dollars per annum.

The stated preference method uses survey of participants to measure the value that recreational users place on using the maritime area. An example of this valuation method can be found in the Ministry of Fisheries in 1999, which collected data from recreational fisherman to establish the willingness to pay for fishing of five key species.[159] The study suggests that recreational fishing could be worth many hundreds of million per annum.

Alternatively, the non-market recreational values have been discussed using other non-market metrics. For example, Allen *et al* collected data on the key locations where recreational uses occur.[160] The researchers collected data on the location and quality of beaches, boat ramps, surf breaks, dive sites, marina, moorings and clubs. This research provides an understanding of the probable locations and potential quantum of recreational activity however this research did not place a value on recreational activity.

Another applied study has valued recreational use of the Hauraki Gulf at over $631 million per annum, which is approximately $430 per Auckland resident.[161] This data provides a partial understanding of the potential recreational value of a small part of the maritime area. It is likely that an assessment of the total maritime area would produce a considerably larger value.

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[157] For example see Moana Consultants et al (2016) Recreational Fishing in New Zealand: A billion Dollar Industry.
Jiang, L (2013) Economic Value of Freshwater Recreational Angling in Otago – A Travel Cost Method Approach.

[158]

[159] South Australian Centre for Economic Studies (1999) Value of New Zealand recreational fishing, Project: REC9801, undertaken for Ministry of Fisheries.

[160] Allen, W., Elmetri, I., Clarke, S., Gibbons, J., Clark, K., Sinner, J., Jiang W., Taylor, M. (2009). Mapping the Values of New Zealand's Coastal Waters. 3. Social Values. MPI Technical paper No: 2010/05. 45 p. ISBN 978-0-478-36303-6.

[161] Barbera, M. 2012. Towards an economic valuation of the Hauraki Gulf: a stock-take of activities and opportunities. Auckland Council technical report TR2012/035.

4.1.3 Cultural Uses

The oceans hold particular importance to Māori. Historically it was a very important food source for tribes who lived near the ocean. Unsurprisingly, the sea continues to be a vital food source, which is protected in the Quota Management System via an allocation of the Total Allowable Catch to customary uses (approx. 1% of Total Allowable Catch). Giving seafood or kaimoana is also a very important way to show hospitality and generosity at hui (meetings) and tangi (funerals) and other gatherings. The sea has also been used as a means to trade with other tribes.

The sea is also very important spiritually and culturally to Māori. Many parts of the Māori worldview relate to aspects of the sea. For example, the iwi (tribes) trace their entire origins and whakapapa (genealogy) back to seven waka hourua (sea going canoe) that arrived at Aotearoa.[162] Also, many of the spiritual traditions include elements of the sea, some iwi consider that Aotearoa was formed by a demigod (Māui) who pulled up a giant fish (Te Ika-a-Māui) from his canoe (Te Waka-a-Māui) which became the North Island and South Island respectively. There are also important aspects of Māori spiritual philosophies that relate to the seas, for example Cape Reinga (Te Rerenga Wairua) is the place where the spirits leave Aotearoa on a journey back to the traditional homeland (Hawaiki). There are many other aspects of Māori spirituality and cultural worldview that relates to the maritime area.

An important aspect of Māori cultural worldview is the concepts of kaitiakitanga (guardianship), which are obligations that mana whenua (Māori that have links to an area) are required to perform to maintain mana (spiritual force). Most Māori have obligations to the sea, as they live on the coast or their ancestors arrived via waka hourua along the coast. These obligations have been recognised in some aspects of the development of coastal management plans across the country. Many local governments have delegated powers to mana whenua to jointly manage the coastal areas, where kaitiaki are appointed to the management of customary food gathering within some maritime areas (rohe moana).[163] There are also rights provided in some legislation that recognises the concepts of kaitiakitanga, such as the placement of a rāhui (tapu restriction)[164], a taiāpure (special significance to iwi), and enforcements of mātaitai reserves (where only recreational fishing are permitted) over a fishing area, which are typically located in harbours or estuaries. Another example is decisions by the judiciary to require businesses that operate in the maritime area (ports[165] and wastewater[166]) to mitigate the impacts on mana whenua kaitiakitanga obligations.

The literature review undertaken for this report has found no previous research that has attempted to consistently measure the cultural values in the maritime area. There is mention of research commissioned by Biosecurity New Zealand in 2009 to map cultural values, however there is no evidence of this work being

[162] The seven waka hourua were called Tainui, Te Arawa, Mātaatua, Kurahaupō, Tokomaru, Aotea and Tākitimu.

[163] Resource Management Act s61(2A)(b) and s66(2A)(b).

[164] Fisheries Act 1996

[165] Port of Tauranga (2014) Annual Report. The Port has funded the trust with a $500,000 initial payment, and will donate $50,000 per annum through to 2027, the life of the resource consents governing the dredging work.

[166] Tauranga City Council (2009) Environmental Mitigation and Enhancement Fund Policy Manual. Tauranga Waste has paid $250,000 in reparation waste water discharges.

completed.[167] It is also acknowledged that there is a lot of *ad hoc* research undertaken for specific purposes (mainly planning consents) that includes cultural values for particular marine locations.

It is beyond the scope of this report to establish estimates of the potential economic benefits and location where cultural values are derived from the maritime area. However, the nature of the Māori worldview means that there is likely to be very substantial cultural values associated with the maritime area.

4.1.4 Amenity Value

The nearshore provides significant economic benefits to individuals that view the maritime area from their dwelling or business premises. Most people place greater value on certain visual outlooks – i.e. views of the seas compared to outlook over an industrial zone. These values are observable in price that are paid for dwellings and business premises that have different types of views. All else being equal, a dwelling with a nicer visual outlook will tend to sell for more than other similar houses.

The MAF Biosecurity New Zealand mapping research acknowledged the amenity value, which was includes as one of the three metrics presented in the economic value mapping.[168] In this study the researchers mapped the total land value of residential properties within 1 kilometre of the coast. It is acknowledged that this metric is a proxy, and does not provided a complete understanding of the value of the amenity values associated with the maritime area.

There is an extensive body of literature that applies Hedonic price models to establish a 'shadow price' which isolates the amenity value associated with property sales.[169] This method of assessment applies regression analysis to isolate the value of a specific economic benefit associated with a good (dwelling or business premises) that is purchased. This method is most commonly applied to establish the value of different characteristics of dwellings, which includes non-market and market goods. For example, Hedonic models can be used to establish the value of non-market goods such as neighbourhood parks/openspace, beaches, views, traffic, pollution, nuisances, public facilities etc.[170]

The literature review undertaken for this report shows that there have been a number of Hedonic models conducted for some coastal areas in New Zealand. However there has been no attempt to apply the method to the entire coastal area.

One study undertaken for Auckland region shows that dwellings with a sea view sell for approximately 8% more than the same dwelling without a view.[171] This study estimated that more than one tenth of Auckland's residential dwellings have a view of the sea, which is over 70,000 dwellings[172]. The dwellings with sea views are likely to have a total value of over $60 billion[173], which suggests that the amenity value

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[167] See documents on https://marinebiosecurity.niwa.co.nz/mapping-coastal-values/.

[168] Batstone, C., Elmetri, I., Taylor, M., Sinner, J., Clarke, S. (2009). Mapping the Values of New Zealand's Coastal Water. 2. Economic Values. MPI Technical paper No: 2009/05. 80 p. ISBN 978-0-478-33877-5

[169] Fernandez, M. (2019) A review of Applications of Hedonic Pricing Models in the New Zealand housing market. Discussion Paper 2019/02

[170] Ibid.

[171] Nunns, P, Hitchins, H and Balderston, K (2015). The value of land, floorspace and amenities: a hedonic price analysis of property sales in Auckland 2011-2014. Auckland Council technical report, TR2015/012

[172] Auckland Council (2018) Auckland Plan – Direction 2 Dwelling estimates.

[173] REINZ (2019) Monthly Property Report - Median House Prices – Auckland.

associated with residential dwellings that have views of the maritime area in Auckland would be over $5 billion.

While this value may seem large, it is important to note that there is also likely to many billions of dollars of amenity value in the other major coastal towns (Tauranga, Wellington etc.) There will also be substantial amenity value associated with commercial premises.

4.1.5 Option Value

Finally, individuals receive use value that are associated with the option to use the maritime area, which is the value associated with potential intended use that may or may not eventuate. The option value of a resource is akin to the non-use values (existence, bequeath and altruistic), because in many cases the option is not exercised so the resource is not actually used. The concepts of option value and non-use value may seem to overlap, however while in nature these values are similar they do represent unique and separate values that can be assessed.

The literature review conducted for this report shows there are few studies that have attempted to measure the option value of maritime resources. Given the lack of information available it has not been possible to evaluate the potential scale of the option value associated with the maritime area.

4.2 Non-use values

The TEV approach includes non-use values, which are usually referred to as existence, bequeath and altruistic. These values are expressed as follows,

- Existence Value: which is the value from knowing that a particular environmental asset exists. The concept of existence value is outlined by Ministry for Environment, “Changes in natural character affect the values that citizens perceive to be embodied in the environment. These changes are independent of use of that environment and are commonly termed existence values".[174] Existence values can be very large, especially when aggregated over a sizeable population. For example, the Exxon Valdez oil spill in Prince William Sound Alaska entailed losses of existence value in the order of several billion dollars.[175]
- Bequeath Value: which is the value arising from the desire to bequeath certain resources to one's heirs or future generations. Alternatively, this could be thought of the willingness of the existing community to maintain or preserve an asset that has no use now (or little use), so that it is available for future generations.
- Altruistic Value: which is the value of people’s willingness to pay for preservation or maintenance of an environmental asset for public use, despite no plans for personal use.

These non-use values are tangible and important to the community, which has associated economic benefits. However, it is difficult to appreciate the importance of non-use values from the simple definitions outlined above. It is easiest to understand how these values accrue to the community using a real-world example to reveal the process and importance of the non-use values.

[174] Ministry for the Environment (2005) Option and Existence values for the Waitaki Catchment.

[175] Carson et al. (1992). A Contingent Valuation Study of Lost Passive Use Values Resulting from the Exxon Valdez Oil Spill.

As an example, Māui and Hector's dolphins are iconic species in New Zealand which are facing real threat of extinction. The species could be valued in a number of ways, including its use value, as part of an environment that many visitors enjoy (eco-tourism). The value of the direct uses would be relatively small. It would be absurd to consider that the community only draws direct use value from Māui and Hector's dolphins. Any decision associated with the use or protection of the dolphins should have reference to the wider non-use values as well.

It is clear that these dolphin species would have significant non-use value in terms of existence value, as the wider community (who may never observe them in the marine area) would receive benefit from merely having the knowledge that the species is being protected. Also, the community would receive great benefits from knowing that the species is safeguarded for future generations. The non-use values associated with dolphins would be orders of magnitude larger than the direct use values. The most recent research shows that the value of protecting Māui and Hector's (from being killed as bycatch) to potential be $46 million per annum.[176] This example shows that natural resources in the maritime area can have very real and significant non-use values, these values should be assessed when considering policy decisions associated with natural resources.

For example, Wilson and Lui (2008) conducted an extensive literature review of non-market valuation research that showed that non-use values are a sizeable portion of the total economic benefits associated with nearshore ecosystems.[177] They also concluded that the available research had only covered small parts of the of the nearshore ecosystems in the world.

Internationally, non-market valuation techniques such as contingent valuation were used to estimate these non-use values. This survey-based valuation measures people's willingness to pay (or willingness to accept) for improvements in public or private services that are focused on environmental preservation. This research has found examples of studies in Australia[178], United Kingdom[179] and Europe[180] that indicate that the non-use value of the maritime area could be thousands of dollars per capita.

The literature review undertaken for this report has found no previous research that has attempted to consistently measure the non-use values in New Zealand's maritime area. New Zealand Treasury has commissioned research on non-use values for the Living Standards Framework, which concluded that existing research of non-use values for the whole environment (including land) are limited and too varied to infer a reliable and clear measurement.[181] Another research commissioned by Biosecurity New Zealand in 2009 that mapped social values mentioned both non-use values, however there is no discernible results

[176] Hoyt, E., McGrath, G., Bossley, M., Knowles, T., 2014 Assessing New Zealanders' Willingness-to-pay to Protect the Endangered New Zealand Dolphin (Cephalorhynchus hectori): A benefit-cost analysis comparing three scenarios, Economists at Large, Melbourne, Australia and Critical Habitat Marine Protected Areas Programme, Whale and Dolphin Conservation, Chippenham, UK.

[177] Wilson, M. and Lui, S. (2008) Non-Market Value of Ecosystem Services Provided by Coastal and Nearshore Marine Systems. In: Patterson M, Glavovic BC, editors. Ecological economics of the oceans and coasts. Edward Elgar Publishing; 2008. pp. 119–137.

[178] Gillespie, R., and Bennett, J., 2010. Non Use Economic Values of Marine Protected Areas in the South West Marine Region. Research Report 107582, Environmental Economics Research Hub, Australian National University.

[179] McVittie A, Moran D (2010) Valuing the non-use benefits of marine conservation zones: an application to the UK Marine Bill. Ecol Econ 70:413–424

[180] Aanesen, M., Armstrong, C., Kahui, V. (2010): TEV (Total Economic Value) analysis of a marine environment in Norway, IIFET 2010 Montpellier Proceedings, 1–11.

[181] Clough, P., and Bealing, M. (2018). What's the use of non-use values? (Report for The Treasury)

in the report that relate to non-use values, existence, bequeath, and altruistic values.[182] It is also acknowledged that there is some *ad hoc* research undertaken for specific purposes (mainly species that are endangered, marine reserves or areas with outstanding natural value) that includes non-use values for particular marine resources.

In conclusion, it is common for the community to attach an intrinsic value to the environment and natural resources, which is likely to be the case for much of the maritime area and the resources within the area. While this value is likely to be relatively small on a per individual basis for each resource in the maritime area, the value will be very significant when calculated for the whole of New Zealand community and the entire maritime area.

4.3 Total Economic Benefits

This section of the report draws together the economic benefits from all the preceding sections to establish a total economic value of the BE. This report has elected to introduce notional values to represent the economic benefits that have not been quantified in the previous sections. It is important to include notional values, as it provides an understanding of the potential magnitude of the different economic benefits relative to each other benefit. The results in this section only provide a general understanding of the potential scale of the economic benefits and should not be viewed as providing a detailed estimate. It is likely that this work could be updated in the future via additional research on the key gaps in the knowledge base.

Notwithstanding the comments in the previous paragraph, Figure 4.2 shows the estimated total economic benefits that are derived from the maritime area. The results in the figure provides the following key insights about the BE,

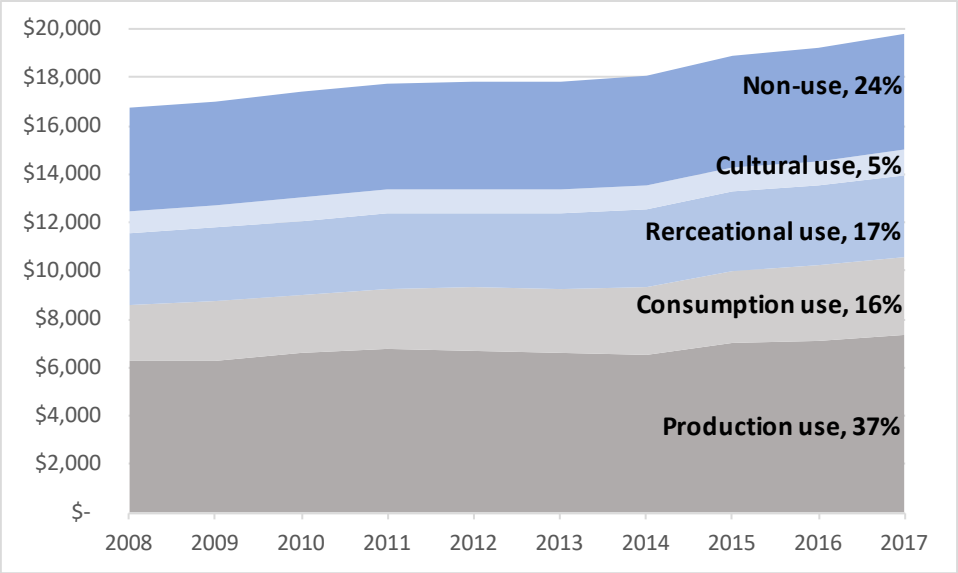
- The economic benefits from production use in the BE are substantial (approx. 37%), however the economic benefits derived from non-market values are in combination much larger.
- The non-use values associated with the maritime area is likely to be the largest non-market value associated with the BE (one quarter). The existence and bequeath values are likely to be many billions of dollars per annum.
- The recreational and cultural use values may jointly contribute to another quarter of the economic benefits derived from the BE. The recreational and cultural values are likely to be several billions of dollars per annum.
- The consumption use in the BE are likely to be important, with economic benefits of several billions of dollars per annum been derived from the BE.

Per capita results provide an alternative point of reference. The results indicate that the average New Zealander derives $11 of value from the BE every day or $4,000 per annum. This comparatively low level

[182] Allen, W., Elmetri, I., Clarke, S., Gibbons, J., Clark, K., Sinner, J., Jiang W., Taylor, M. (2009). Mapping the Values of New Zealand's Coastal Waters. 3. Social Values. MPI Technical paper No: 2010/05. 45 p. ISBN 978-0-478-36303-6.

of economic benefits suggests that the methods employed in this report are likely to be overly conservative. It is likely that the BE generates more economic benefits than is presented in this report.

Figure 4.2: Total Economic Benefits of the BE in the Economy, $ million 2008-2017



NOTE: no amenity value has been included.

5 Spatial Distribution of the BE

This report has collected data and developed a range of spatial data sets that have been used to establish the potential distribution of sectoral and economic values discussed in the previous two sections. These values have been attributed to General Statistical Areas and reported using the regional definitions shown in section 2.

It is acknowledged that MPI has provided many of the spatial layers, developed in 2009 research within the 'Mapping New Zealand Marine values' project. MPI has provided over 100 layers of spatial data from that research, which includes environmental (X0), economic (X0) and social (x0).[183] This report has also collected and developed a further X0 layers. The table in appendix X lists the layers and their sources, by topic.

The sectoral and economic benefits have been attributed to GSA using the following methods,

- Commercial Fisheries: it is considered that the majority of economic benefits generated by this sector relate to the locations where the fish are caught or grown, therefore it is reasonable to allocate the value from this sector of the BE according to the areas fished and the locations where aquaculture farms operate. Therefore, it is reasonable to attribute the value of this sector to GSA according to the fishing effort by species and scale of aquaculture (i.e. assessed in terms of FOB).
- Infrastructure and Transport: it is considered that the majority of the economic benefits generated by this sector relate to the locations where the ports operate. This is because most of the activity in the sector relates to movement, handling and storage of exports and imports which enters or exits the maritime area via a port. Therefore, it is reasonable to attribute the value from this sector of the BE according to the scale of trade handled at each port (i.e. merchandise trade in FOB and CIF terms).
- Offshore Minerals: it is considered that most of the economic benefits generated by this sector relate to the locations where the oil and gas is extracted. Therefore, it is reasonable to attribute the value of this sector according to the production of each of the oil and gas fields (in $ terms).
- Coastal Tourism: it is considered that most of the economic benefits generated by this sector relate to the locations that tourist visits. There is limited data on the scale of the visits to each location, a reasonable method is to use information on the accommodation in each area as a proxy of the scale of coastal tourism. For the most part this report attributed the economic benefits from this sector according to the location of accommodation along the coast line, both commercial and holiday homes. The cruise tourism was allocated to stops or ports which are visited by the cruise ships. While, marine tourism has been allocated to the operational locations of each business.
- Government Services: it is considered that most of the economic benefits generated by this sector relate to the locations where the services are provided. Therefore, it is reasonable to attribute the value of this sector according to location of main operations for each service. For example, navy bases, points of entry, ministry offices, coast guard locations, beaches patrolled etc.
- Consumer Surplus: it is considered that most of the economic benefits received by consumers relate to the location of the resident population. In this report the consumer surplus was allocated

[183] Ministry of Primary Industry (2009) Mapping New Zealand Marine Values – spatial layers.

to the population assuming a common per capita consumption. The consumer surplus enjoyed by the residents in each area was assigned to the closet GSA.

- Recreational Uses: it is considered that most of the economic benefits received by recreational users relate to the places at which the population are able to access the marine area. The recreational use value was attributed according key recreational areas, beaches and harbours, along with information about the potential uses – i.e. surf breaks, sailing clubs, diving/snorkelling locations.
- Cultural Uses: it is considered that much of the economic benefit received by Māori relates to the places that iwi and hapū have spiritual and customary links. In this report the cultural values were attributed according to the relative scale of the iwi interests associated with each GSA area and the locations of marae. However, it is acknowledged that this allocation is very rough, a lot of research would be required to produce a robust allocation, which is beyond the scope of this report or the expertise of the authors.
- Non-uses: it is considered that much of the non-use economic benefits received by the community relate to the places and resources that are distributed across the maritime area. It is acknowledged that the MPI study from 2009 developed a wide base of material on the environmental values which could be used to allocate the non-use values. However, given the rough nature of the national level estimate of non-use values developed in this report, it is considered that there would be little benefit from undertaking a detailed allocation using environmental layers from 2009. This report adopts a simple pro rata allocation of the non-use values according to the relative size of the water areas in each GSA.

The allocation methods provide a broad approximation of the potential distribution of values that are associated with the maritime area. This report has noted many instances where values at the national level cannot be estimated with sufficient accuracy, therefore allocation down to Regions or even GSA is obviously more speculative.

Notwithstanding gaps in the knowledge base, this report provides a method for comparing the potential order of magnitude of values associated with the maritime area and their potential distribution.

Table 5.1 displays the regional distribution of the BE between 2008 and 2017. In general, results show that a significant proportion of economic benefits associated with the BE are located in the inshore areas and near large cities. Also most of the growth in the BE over the decade has been located in these areas. The following points are of interest,

- Auckland region has the largest economic value associated with the BE ($3.7 billion). This is unsurprising as a considerable share of non-market values are received by the New Zealand residents, which are most heavily concentrated in Auckland. On a spatial basis the maritime area around Auckland is the most valuable (over $150,000 per km^2). However, on a per capita basis the value received by Aucklanders is much lower than some other regions ($2,200 per person).[184] Also, growth in BE in Auckland has been significant, at 4% per annum over the decade which is mainly drive by growth in the coastal tourism, infrastructure, recreational uses, and non-use values.

[184] Compared to some other regions, Auckland has less water space and more people. Therefore, the value of the BE is spread across more people.

- Bay of Plenty region also has a high value maritime area ($1.5 billion), which is equivalent to almost $90,000 per km^2. Most BE value in this region is associated with coastal tourism, infrastructure, recreational uses, and non-use values. The BE in the Bay of Plenty has also grown by 4% per annum, and has a comparatively high value per capita of almost $5,000.
- Taranaki region stands out from all the other regions because of the significant value associated with the extraction of offshore minerals. While the BE in Taranaki region has reduced by more than half over the decade, the region still has a high value per capita ($10,370) and per square km of water ($39,300). However, the rapid decline is likely to continue in the future as reserves in the existing fields are exhausted and restriction on new exploration starts to take effect.
- Tasman-Nelson-Marlborough region also stands out, as it has seen the strongest growth over the decade (8% per annum). The BE has more than doubled since 2008, reaching nearly $1 billion in 2017. Growth in this area is driven by the strong presence of aquaculture and coastal tourism.
- West Coast and Southland regions which has a high value, which is mainly generated by commercial fisheries, coastal tourism and non-use value. Also these regions have relatively sparse population, which means on a per capita basis the BE values are relatively large.

The offshore areas around the Kermadec, Chatham, Auckland and Antipodes Islands also produce significant value. Most of the value is associated with commercial fisheries and non-use values. The following sections provide a summary of the results for the North Island and South Island, along with maps of the scale of the economic benefits that have been attributed to each GSA.

Table 5.1: Regional Distribution of the Blue Economy, $ million 2008-2017

Total Economic Value	2008	2017	CAGR	$ per capita	$ per km^2
Northland	$ 1,531	$ 1,777	2%	$ 10,133	$ 3,744
Auckland	$ 2,490	$ 3,646	4%	$ 2,200	$ 153,239
Waikato	$ 420	$ 554	3%	$ 1,203	$ 8,388
Bay of Plenty	$ 1,071	$ 1,497	4%	$ 4,990	$ 89,075
Gisborne	$ 381	$ 440	2%	$ 9,063	$ 2,160
Hawke's Bay	$ 992	$ 1,259	3%	$ 7,675	$ 8,075
Taranaki	$ 2,626	$ 1,224	-8%	$ 10,370	$ 39,330
Manawatu-Wanganui	$ 460	$ 588	3%	$ 2,446	$ 80,931
Wellington	$ 976	$ 1,208	2%	$ 2,350	$ 17,970
Tasman-Nelson-Malborough	$ 476	$ 972	8%	$ 6,534	$ 13,453
West Coast	$ 496	$ 635	3%	$ 19,552	$ 2,457
Canterbury	$ 1,201	$ 1,658	4%	$ 2,709	$ 11,658
Otago	$ 536	$ 679	3%	$ 3,027	$ 5,311
Southland	$ 713	$ 920	3%	$ 9,347	$ 3,281
Kermadec Island	$ 658	$ 741	1%		$ 1,175
Chatham Island	$ 609	$ 730	2%		$ 1,366
Auckland/Campbell Islands	$ 621	$ 719	2%		$ 1,240
Antipodes/Bounty Islands	$ 496	$ 564	1%		$ 1,188
Total	**$ 16,754**	**$ 19,810**	2%	$ 4,133	$ 4,777

The following sub-sections display maps of the 'total' economic benefits generated in each GSA. It should be understood that these maps do not control for the size of the local population or the spatial extent of the GSA (as shown in the last two columns of the table above).

5.1 North Island

The maritime area around the North Island accounts for approximately two-thirds of the economic benefits in the New Zealand BE. The economic values from the BE has increased from $10.9 billion in 2008 to $12.2 billion in 2017, which is equivalent to a growth of 1.2% per annum.

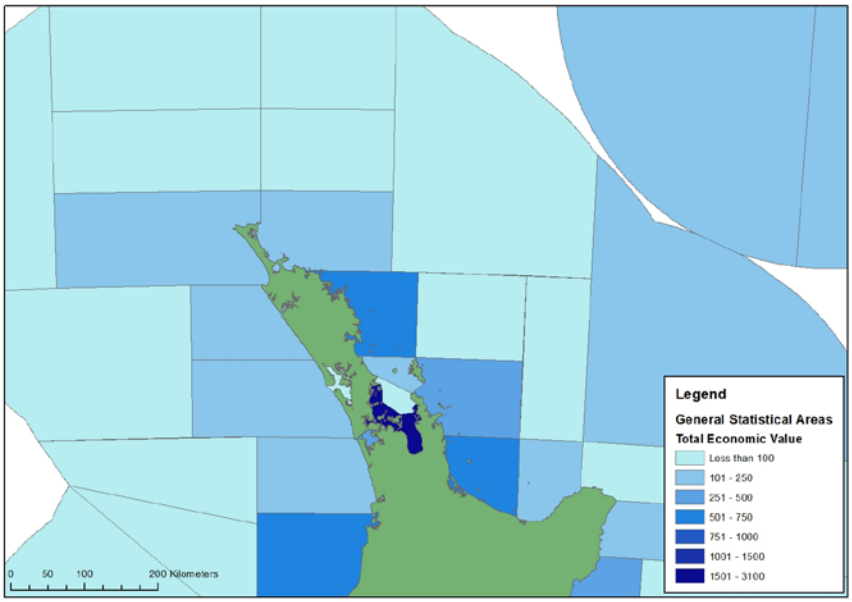
The North Island has seen significant growth in economic benefits in areas close to the main cities and tourist destinations. However, the BE around Taranaki has declined significantly because of the significant drop in off shore minerals.

5.1.1 Upper North Island

Over one-third of the total national level BE is located in the Upper North Island, mainly being located in the areas around Auckland and Tauranga. Figure 5.1 shows the value of the BE in each of the GSA, where the darker blues represent high value and lighter blues represent low value. The following key points can be made about the Upper North Island,

- Hauraki Gulf generates by far the most economic benefits value of any GSA in the country. The results show that Hauraki Gulf generates three times more economic benefits than any other area in the maritime area.
- Tauranga harbour and coastal areas generating economic benefits of over a billion per annum in 2017.
- The rest of the inshore areas along the east of the Upper North Island also generate significant economic benefits, most notably the coast near Whangarei, Bay of Islands and Coromandel.
- The inshore areas on the west coast (excluding the harbours) generate comparatively less value than the east coast. However, the west coast does produce economic benefits worth almost a billion per annum.

Figure 5.1: Map of Upper North Island Blue Economy, 2017

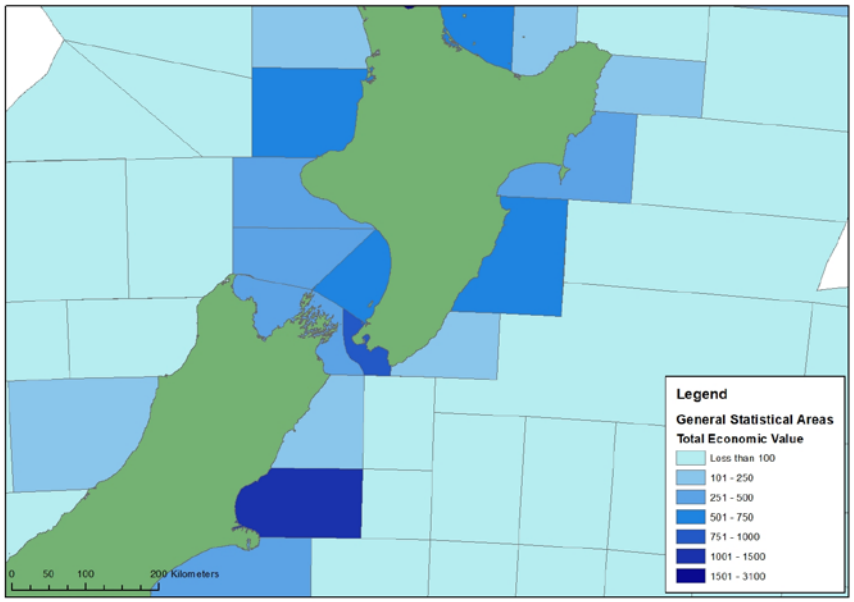


5.1.2 Lower North Island

Just under a quarter of the total national level BE is located in the Lower North Island, mainly being located in the areas around Wellington, Taranaki and Hawkes Bay (see Figure 5.2). The following key points can be made about the Lower North Island,

- Wellington harbour is the third most important GSA in the country. This GSA generates almost a quarter of the economic benefits from the BE in the Lower North Island.
- The inshore areas on the west coast (including Taranaki) are also very important, representing over a third of the economic benefits from the BE in the Lower North Island.
- The rest of the inshore areas along the east of the Lower North Island also generate significant economic. Most notably the coast near Hawkes Bay.

Figure 5.2: Map of Lower North Island Blue Economy, 2017



5.2 South Island

The maritime area around the South Island accounts for approximately a quarter of the economic benefits in the New Zealand BE. The economic values from the BE has increased from $3.4 billion in 2008 to $4.9 billion in 2018, which is equivalent to a growth of 4.0% per annum.

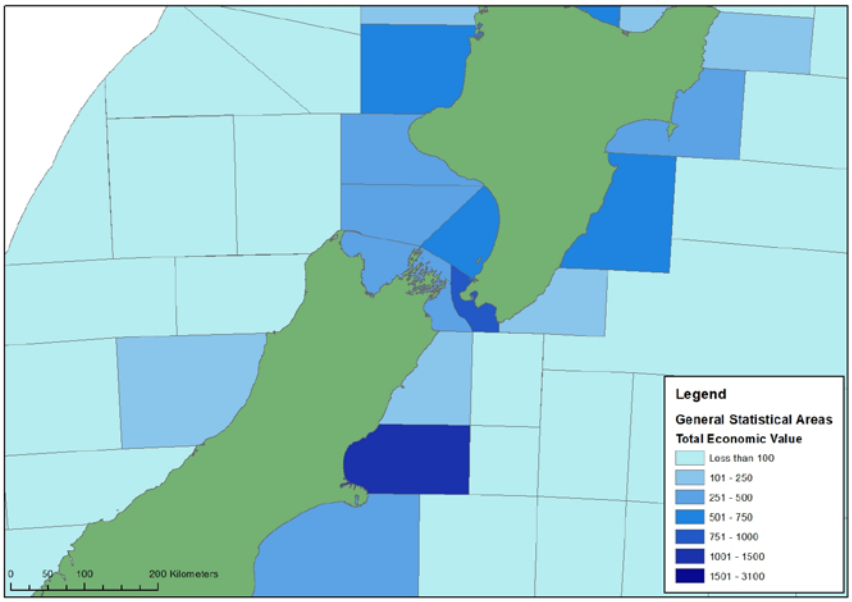
The South Island has seen significant growth in economic benefits in areas close to the tourist destinations and aquaculture. There has also been significant growth in value near the larger cities (Christchurch, Dunedin and Nelson).

5.2.1 Upper South Island

Approximately a quarter of the BE in the South Island is located in the Upper South Island. The majority of the value is located in the areas around Nelson and Marlborough (see Figure 5.3). The following key points can be made about the Upper South Island,

- The majority of the economic benefits is located in the area near Nelson.
- While at a national level the economic benefits may seem small, they are important relative to the regions.

Figure 5.3: Map of Upper South Island Blue Economy, 2017



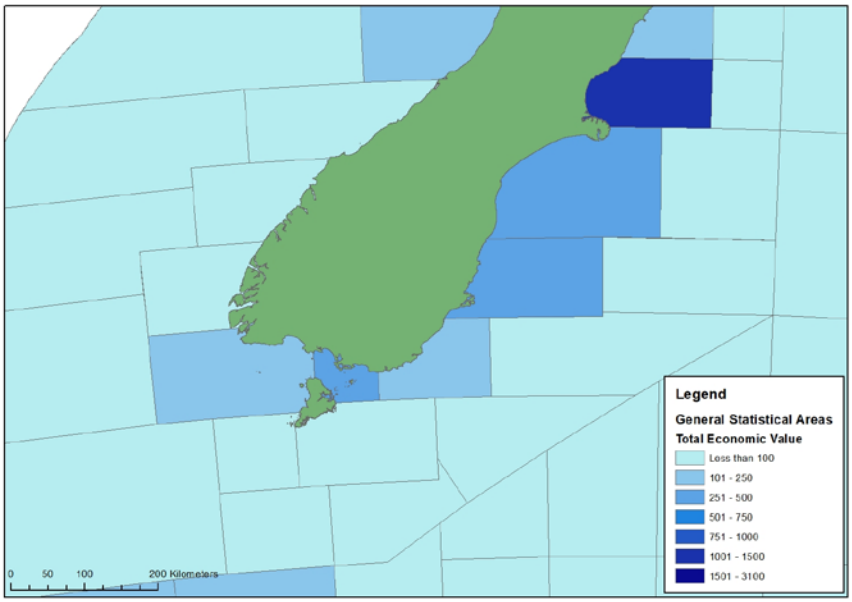
5.2.2 Lower South Island

The remaining three quarters of the BE in the South Island is located in the lower South Island, mainly being located in the areas around Christchurch and Dunedin (see Figure 5.4). The following key points can be made about the Lower North Island,

- The coast around Christchurch generates by far the most economic benefits value of any GSA in the South Island and is the second most important in the country. Most of the value is associated with recreational and tourism, along with significant economic benefits from infrastructure.
- Dunedin is the second most important GSA in the South Island, generating economic benefits of nearly half a billion per annum in 2017.
- The inshore areas along the southern coast of the South Island also generate significant economic. Most notably the southern coast near Invercargill.

The inshore areas on the west coast generate comparatively less value than the east coast. However, the west coast does produce economic benefits worth over half a billion per annum.

Figure 5.4: Map of East Coast South Island Blue Economy, 2017

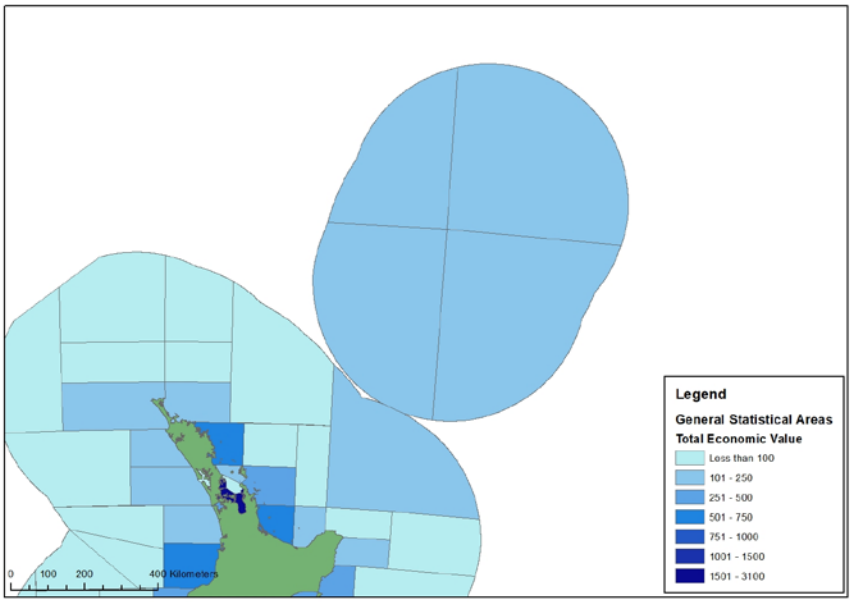


5.3 Other Islands Offshore areas

The majority of offshore areas around the other islands in New Zealand's maritime area generate less value than the onshore areas around the North and South Islands. In spatial terms the GSA around these Islands accounts for 54% of the maritime area, but generates less than 15% of economic benefits from the BE. Most of the value generated in the maritime areas around the other Islands is related to either commercial fishing or non-use values. However, while the values are comparatively low for these areas they are still very important. It is considered that the value of the maritime area around the other Islands is likely to be more valuable than displayed in this report. The method adopted in this study for allocating non-use values is may potential underestimate the value of these pristine areas, as these areas have unique ecosystems and species.

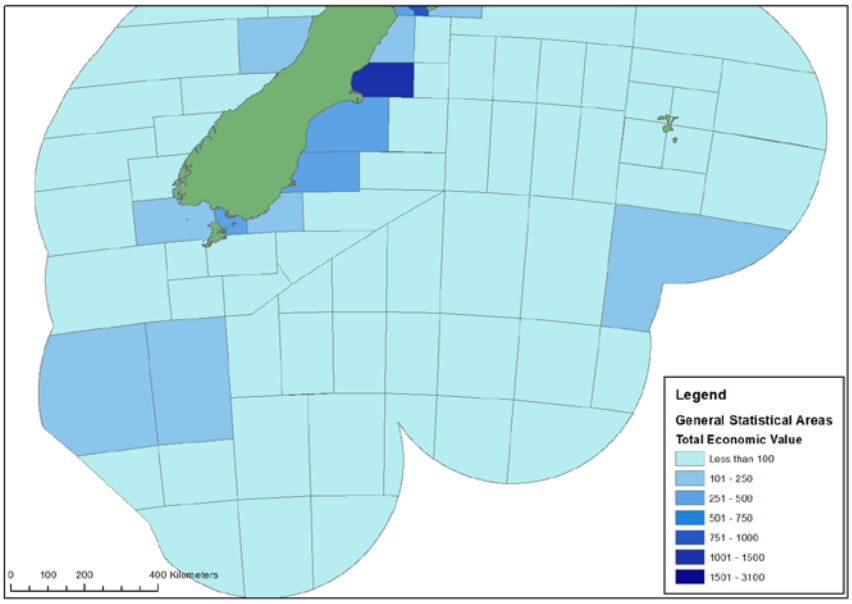
The maritime area around the Kermadec Islands produced under a billion dollars in economic benefits in 2017. However, Figure 5.5 shows that this value is relatively low compared to the in-shore maritime areas (i.e. lighter blue). Also, the economic benefits are relatively small compared to the spatial area around the islands, which means that the area produces very little on a per square kilometre basis.

Figure 5.5: Map of Kermadec Islands Blue Economy, 2017



Likewise, the maritime area around the Chatham Islands and the Sub-Antarctic Islands produces over two billion dollars in economic value in 2017. However, Figure 5.6 shows that this value is relatively low compared to the in-shore maritime areas (i.e. lighter blue). Also, economic benefits are relatively small compared to the spatial area around the islands, which means that the area actual produces very little on a per square kilometre basis.

Figure 5.6: Map of Chatham Islands and Sub-Antarctic Islands Blue Economy, 2017



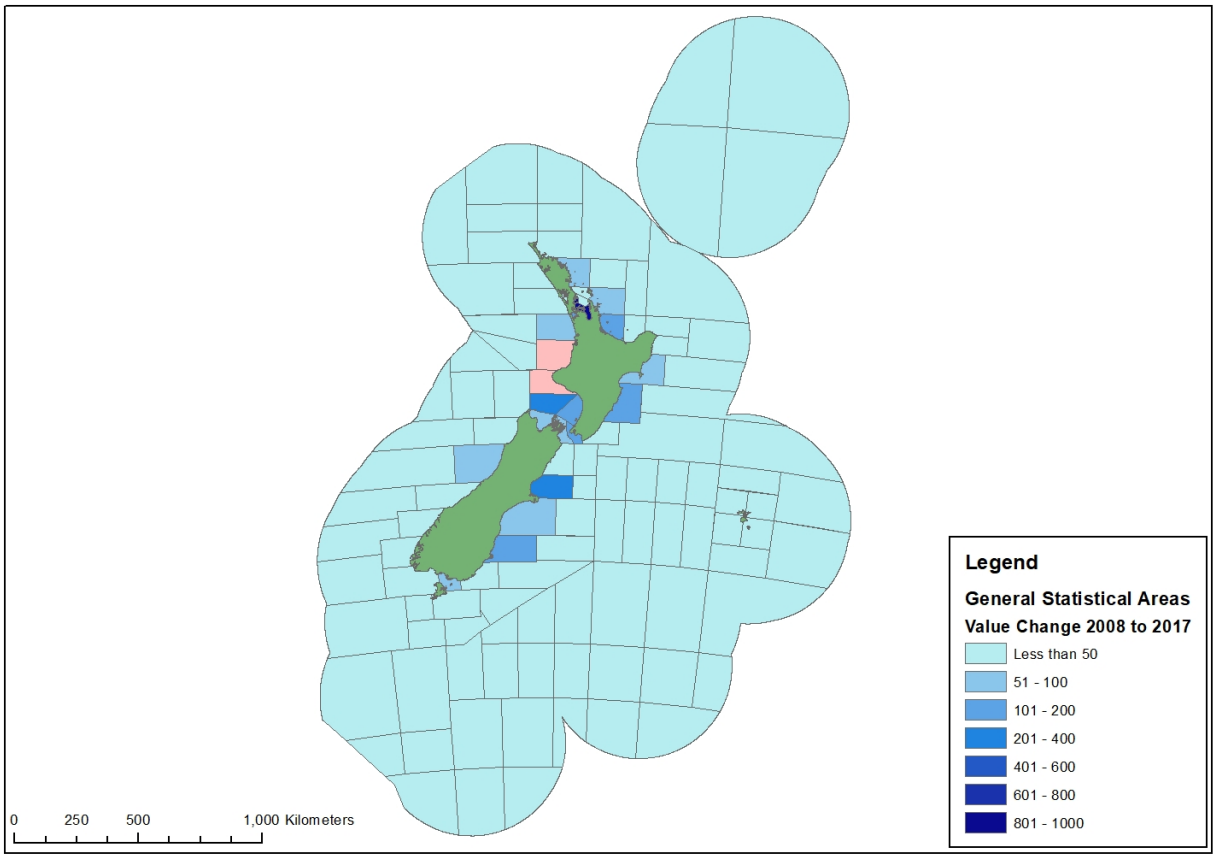
5.4 Change in Economic Benefits

The economic benefits received from the BE has grown over the last decade, however the growth has been uneven across the maritime area. The distribution of the change is represented in Figure 5.7, which shows the value of the change in economic benefits for each GSA between 2008 and 2017.

The results indicate that,

- Most of the growth is located in a few of the GSA that are near the main cities (Auckland, Christchurch, Wellington and Tauranga) – i.e. dark blue areas in the map.
- Taranaki is the only area that experienced negative growth over the decade.
- Some of the inshore areas experienced relatively little growth in economic benefits, including the west coast of the upper North Island, the coast around East Cape and much of the inshore area around the southern/western coasts of the South Island.
- The majority of the offshore areas did not see much change in the economic benefits over the decade.

Figure 5.7: Map of New Zealand Blue Economy, change between 2008-2017

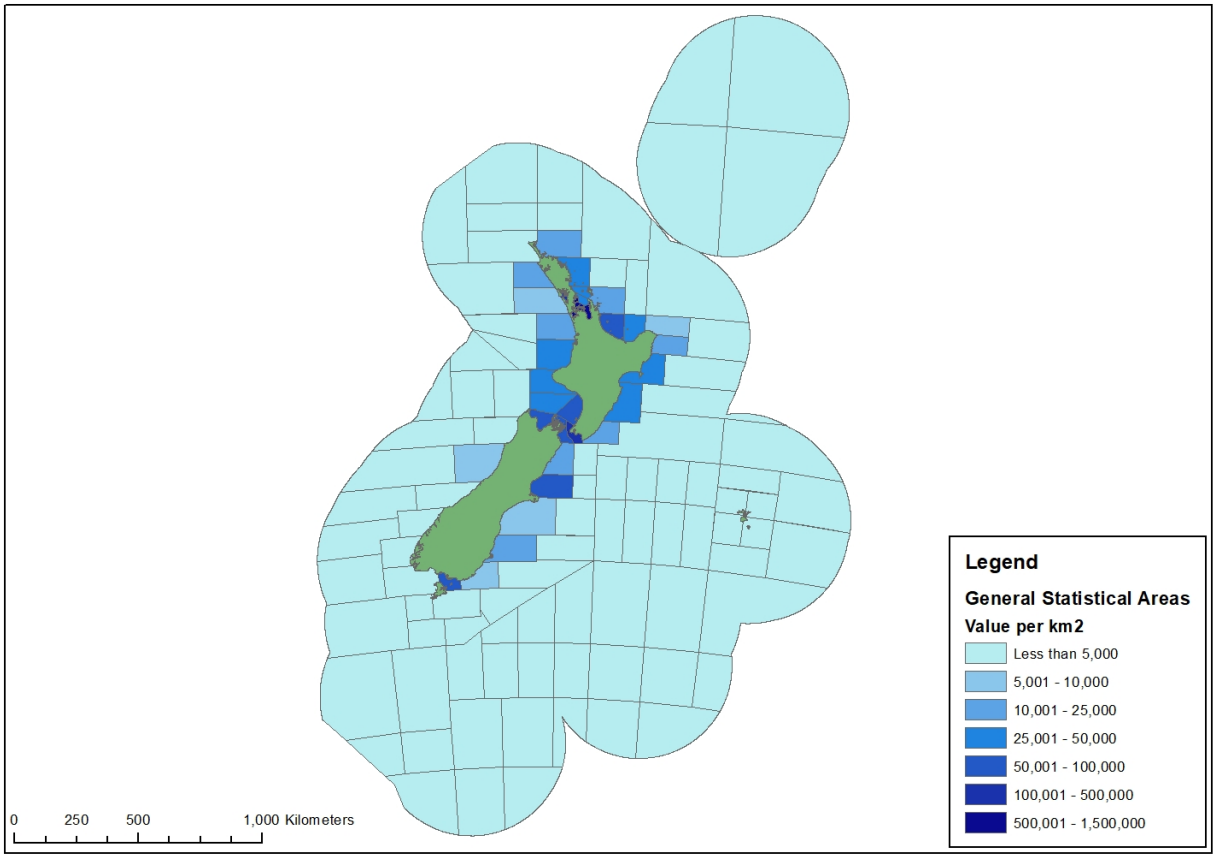


5.5 Density of Economic Benefits

As discussed above, the density of economic benefits received from the BE provides another alternative approach to interpret the relative value of the maritime areas. The density of the economic benefits per square kilometre of sea in 2017 are presented in Figure 5.8. The results show,

- Most of the value is located in the inshore areas.
- The highest value is located in a few of the GSA that are near the main cities (Auckland, Christchurch, Wellington and Tauranga) – i.e. dark blue areas in the map.
- Some of the inshore areas have relatively little economic benefits, including the top of the west coast of the North Island and much of the west coast of the South Island.
- In relative terms the offshore areas do not produce as much economic benefits.

Figure 5.8: Density Map of New Zealand Blue Economy, 2017



6 Conclusion and Recommendations

New Zealand's isolated location on the southern edge of the Pacific Ocean means that the country controls a vast maritime area which contains substantial resources. At over 4,083,000 square kilometres the maritime area around New Zealand is more than 15 times larger than the land area (268,000km^2). The nature of the coastal geography of New Zealand also means that the country has one of the longest coast lines in the world, at 15,134 kilometres there are only eight countries with more coastline.[185]

Until recently, the vast scale and the relatively low utilisation of the maritime area has meant that there have been few instances of conflict between different users of the resource. The majority of conflicts have occurred in harbours and inshore areas, with limited conflicts in the outer areas. While the maritime area is vast, it is not limitless, which means that more conflicts will arise between different users as the population increases.

The nature of economic value that society derives from the maritime area around New Zealand has been changing and growing. Therefore, it is expected that the government will need to control activities in the maritime area to maximise the benefits to New Zealand, while avoiding the negative costs. In order for the government to make informed decisions about potential controls, there needs to be fundamental research to understand the scale, nature, and location of the types of uses that occur currently and historically in the maritime area.

The objective of this report was to establish a basis for developing measures that will support business, community, policy and regulatory actors to encourage a 'Blue Economy' in New Zealand and inform an ecosystem-based management regulatory regime.

This report provides the following key findings,

Sectors of the Blue Economy

- The Sectors in the Blue Economy have a significant role in the national economy. This report estimates that around 3% of GDP in the economy is related to blue economy, with a total of $7.4 billion directly related to sectors that rely on the maritime area. The Blue Economy directly sustains employment of nearly 70,000, which is equivalent to 3.3% of total employment in New Zealand.
- The direct value added associated with the Blue Economy has increased by 2% per annum over the last decade, which is slower than the background growth observed in the economy. Most industries within the Blue Economy have seen strong growth (Commercial Fisheries, Coastal Tourism, Government Services), however the Offshore Minerals industry recorded a substantial drop over the decade (decline of over $1 billion).

Economic Benefits of the Blue Economy

- The economic benefits that are generated by the Blue Economy have been measured using a Total Economic Valuation framework, which measures use and non-use values. This assessment shows that while the economic benefits from use in the BE are substantial (approx. 37%), the economic benefits derived from non-use values are in combination much larger (in the order of tens of billions).

[185] CIA (2017) World Fact Book 2016-17.

- The Total Economic Valuation assessment adopted in this report provides a general understanding of the potential scale of the economic benefits. It is important to include this assessment, as it provides an understanding of the potential magnitude of the different economic benefits relative to each other benefit. However, the results should not be viewed as providing a detailed estimate.

Spatial Distribution of the Blue Economy

- The economic benefits received from the maritime area has grown over the last decade, however the growth has been uneven across the maritime area. Most of the growth was located in a few of the areas near the main cities (Auckland, Christchurch, Wellington and Tauranga). Taranaki is the only area that experienced negative growth over the decade – which is primarily related to the decline in Offshore Minerals.
- The density of economic benefits received from the maritime area provides another alternative approach to interpret the relative value of the maritime areas. The results show, most of the value is located in the inshore areas (near the main cities), while the offshore areas produce relatively little economic benefits.

6.1 Future Research

The research conducted for this report has shown that there are still significant gaps in the knowledge base on the quantum and location of the economic benefits associated with the BE in New Zealand. While this report provides an understanding of the likely order of magnitude of the economic benefits, it does not establish a complete quantification of some of the key values.

The report has noted the following key areas of research could be conducted to improve the estimation of economic benefits associated with the BE,

- Marine Tourism Operators: it would be relatively straight forward to develop a comprehensive understanding of the value that is generated by marine tourism operators. This study has collected data on approximately 200 business which could be used as a basis from which to further develop the quantification of the nature and scale of this activity.
- Government services: again, it would be relatively straight forward to develop a comprehensive understanding of the value that is generated by government services. This study has collected data on approximately 30 government and NGO which could be used as a basis from which to further develop the quantification of the nature and scale of this activity.
- Consumer surplus: obviously the benefits received from consuming goods is likely to be large, but there has been no research on this value. It is acknowledged that it would be a significant undertaking to develop primary research to establish this value. Detailed research of consumer surplus would be relatively expensive.[186]
- Recreational Uses: there is limited research on the value of recreational uses of the maritime area in New Zealand. The range of recreational uses of the maritime area is varied, which is likely to mean that research on this value would be relatively expensive.[187]
- Cultural Uses: there is no publicly available research on the potential value of cultural uses. Given the complexity of the relationships between iwi and hapū to the maritime area it is likely to be a

[186] Consumer surplus research would require more resources than was allocated to this entire report.

[187] Recreational use research would require more resources than was allocated to this entire report.

significant research task to develop an understanding of the scale and nature of the economic benefits.

- **Amenity Value:** while there is some research on this topic for parts of New Zealand, there is insufficient information to establish a value for most parts of the maritime area. It would be comparatively simple to undertake additional research on this topic to expand the knowledge base.
- **Option Value**: there is no publicly available research on the potential economic benefits associated with the option value of the maritime area.
- **Non-use value:** again there is no research on this topic. Based on international literature it is likely that research on this topic would be relatively expensive.[188]
- **Emerging Sectors:** it is likely that new BE sectors will emerge in the future, it would be valuable to undertake research on some of the likely sectors – including Blue Biotechnology, Ocean Energy, Blue Carbon etc.
- **Natural Capital:** this report covers annual value extracted from the maritime area. There are range of capital assets that also generate benefits over longer periods. These values could be assessed in future research.
- **Sustainability:** is another dimension that is commonly considered in BE research. The relative costs that are generated by each use of the maritime area are important factor when considering the competing uses within the maritime area. There have been some preliminary discussions with researchers from Landcare on the potential development of a Systems Dynamic Model, which would account for these costs and relationships.
- **Marine Protection Areas:** there are key areas in the maritime area that have high values to the community, in some cases these areas are protected from extractive activities. It would be interesting to undertake more detailed assessment of the economic value of the existing protected areas (0.5% of the maritime area) and/or proposed areas (proposed Kermadec sanctuary, which is 14.5% of the maritime area).

There is other research that could be conducted to improve the quantification and allocation of the economic benefits form the BE. However, the research above is likely to provide the greatest change in the knowledge base.

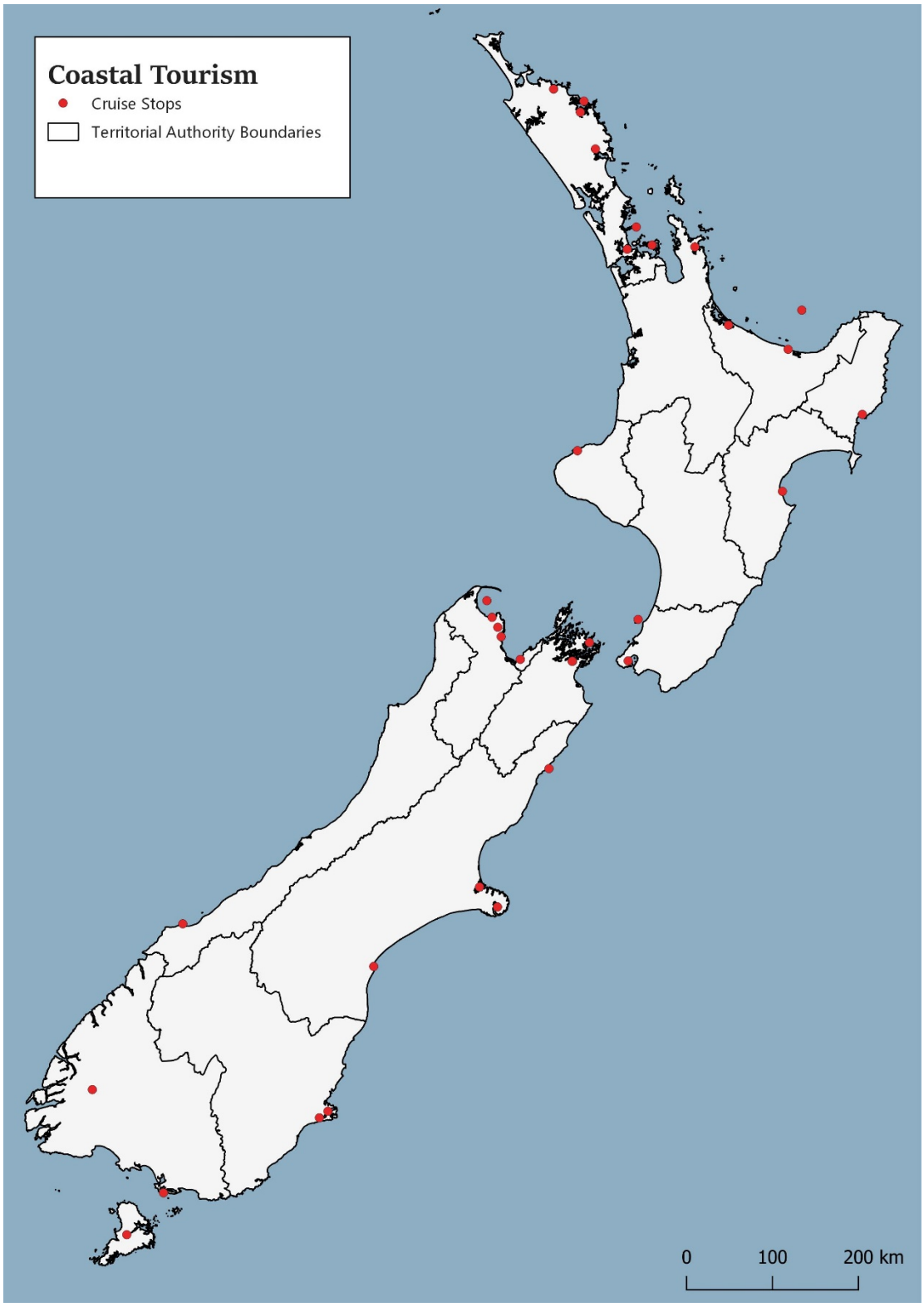
Also as noted in the report, there are interrelationships between all of the economic benefits. There are costs that flow from each activity in the maritime area, which diminution the economic benefits from other activities. This report has not looked at the potential conflicts between the different activities. It is likely that some activities will be more 'sustainable' or provide better outcomes for the wider society than others. Again this type of research would be valuable, however well beyond the scope or resources allocated to this report.

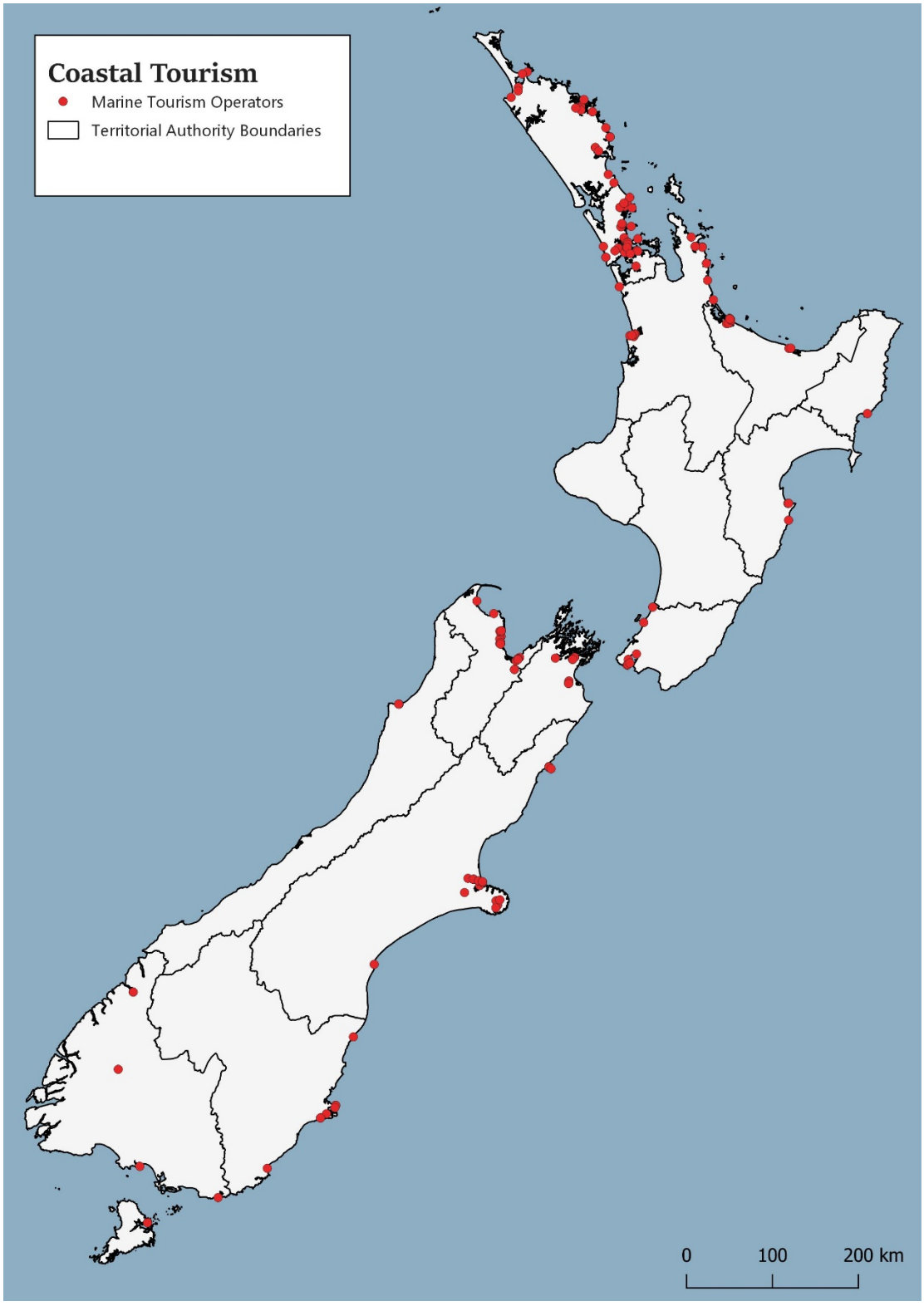
[188] Non- use research would require more resources than was allocated to this entire report.

APPENDIX A: Spatial Layers Description

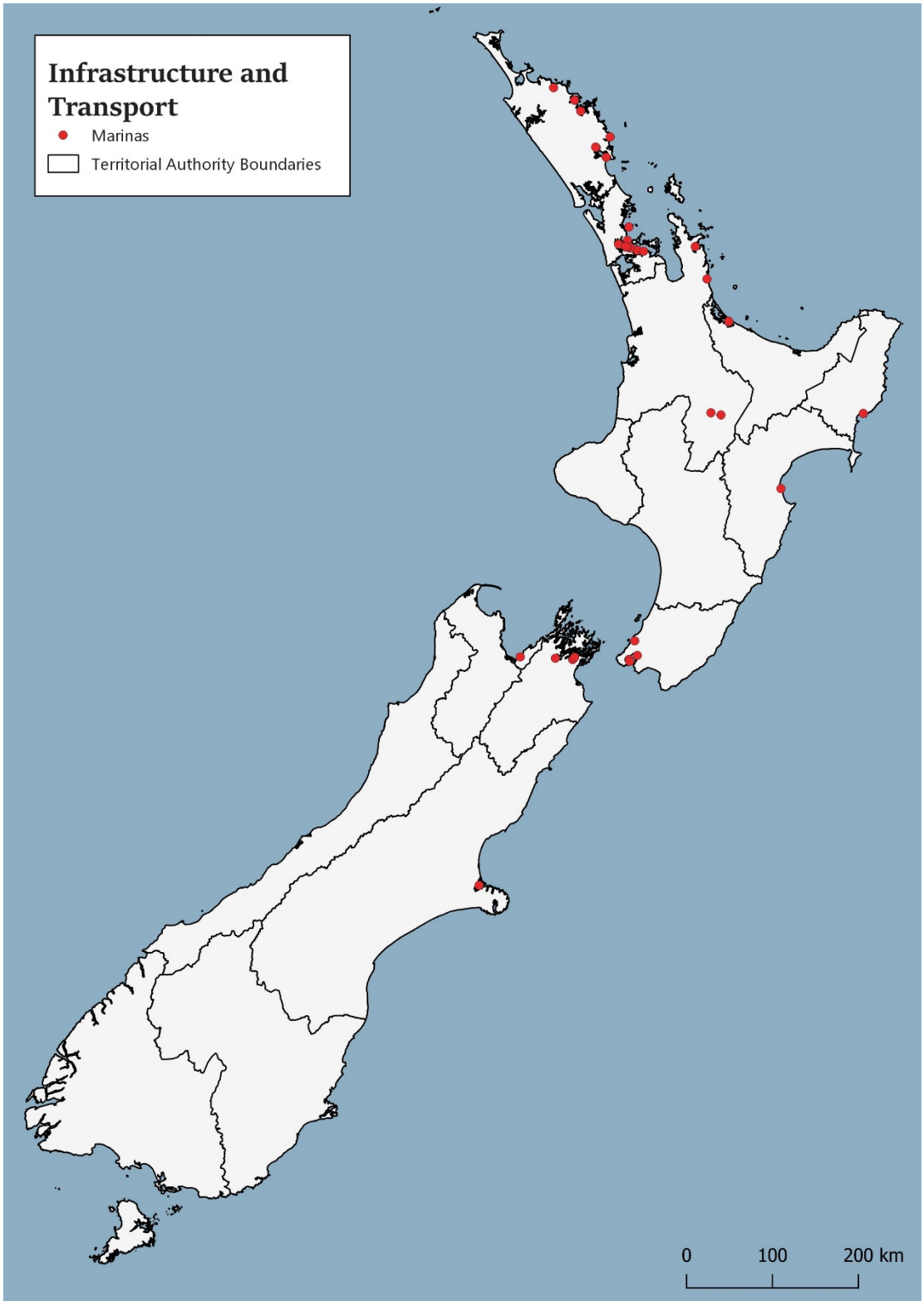
Topic	Layer Name	Layer Description	Type	Source	Created
Commercial Fisheries	Fishing effort				
	Aquaculture Farms		Point	Ministry of Primary Industry	Ministry of Primary Industry
	Commercial Fishing TAC	The allocation of catch for each species to commercial uses.	Polygon	Ministry of Primary Industry	Ministry of Primary Industry
Infrastructure and Transport	Ports	Trading ports, trade value (FOB,CIF) and weight (tonnes).	Point	Statistics NZ	Market Economics
	Marina	Registered Marina.	Point	New Zealand Marina Operation Association	Market Economics
	Travel Lifts and Haulouts	Location and nature of travel lifts and (commercial) haulout facilities.	Point	Market Economics	Market Economics
Offshore Minerals	Oil and Gas Platforms	Oil and Gas fields, value and volume.	Point	Ministry of Business, Innovation and Employment	Market Economics
Coastal Tourism	Marine Tourism Operators	Location and nature of marine tourism operators (scenic tours, wildlife, adventure etc).	Point	Market Economics	Market Economics
	Cruise Stops	Ports and other stops.	Point	New Zealand Cruise Association	Market Economics
	Commercial Accommodation		Polygon	Ministry of Business, Innovation and Employment	Market Economics
	Holiday Homes	Estimate of holiday homes based on number of unoccupied dwellings.	Polygon	Statistics NZ	Market Economics
Government Services	Navy Bases		Point	New Zealand Defence Force	Market Economics
	Airforce Bases		Point	New Zealand Defence Force	Market Economics
	Customs Offices		Point	Customs New Zealand	Market Economics
	Biosecurity Offices		Point	Ministry of Primary Industry	Market Economics
	Local Government		Point	Various Council websites	Market Economics
	Coastguard		Point	Royal New Zealand Coast Guard	Market Economics
	Surf Life Saving New Zealand	Patroled beaches and head offices.	Point	Surf Life saving New Zealand	Surf Life Saving New Zealand
Consumption	Population	Population near each GSA.	Polygon	Statistics NZ	Market Economics
Recreational use	Beaches	Main beaches in New Zealand.	Point	Surf Life saving New Zealand	Surf Life Saving New Zealand
	Surf Breaks				
	Snorkling and Dive locations				
	Harbours				
	Fishing clubs				
	Boat ramps				
	Sailing clubs				
	Fishing effort				
	Recreational Fishing TAC	The allocation of catch for each species to recreational uses.		Ministry of Primary Industry	
Cultural Uses	Marae	Location and iwi marae.	Point	Ministry of Maori Development	Ministry of Maori Development
	Iwi areas of Interest	Identified in the Māori Fisheries Act 2004 and Treaty of Waitangi claims processes.	Polygon	Ministry of Maori Development	Ministry of Maori Development
	Iwi population	Join of census iwi population and iwi areas of interest.	Polygon	Statistics NZ and Ministry of Maori Development	Market Economics
	Customary Fishing TAC	The allocation of catch for each species to customary uses.	Polygon	Ministry of Primary Industry	Ministry of Primary Industry
Non-use values	Population Density	Density of population near each GSA.	Polygon	Statistics NZ	Market Economics

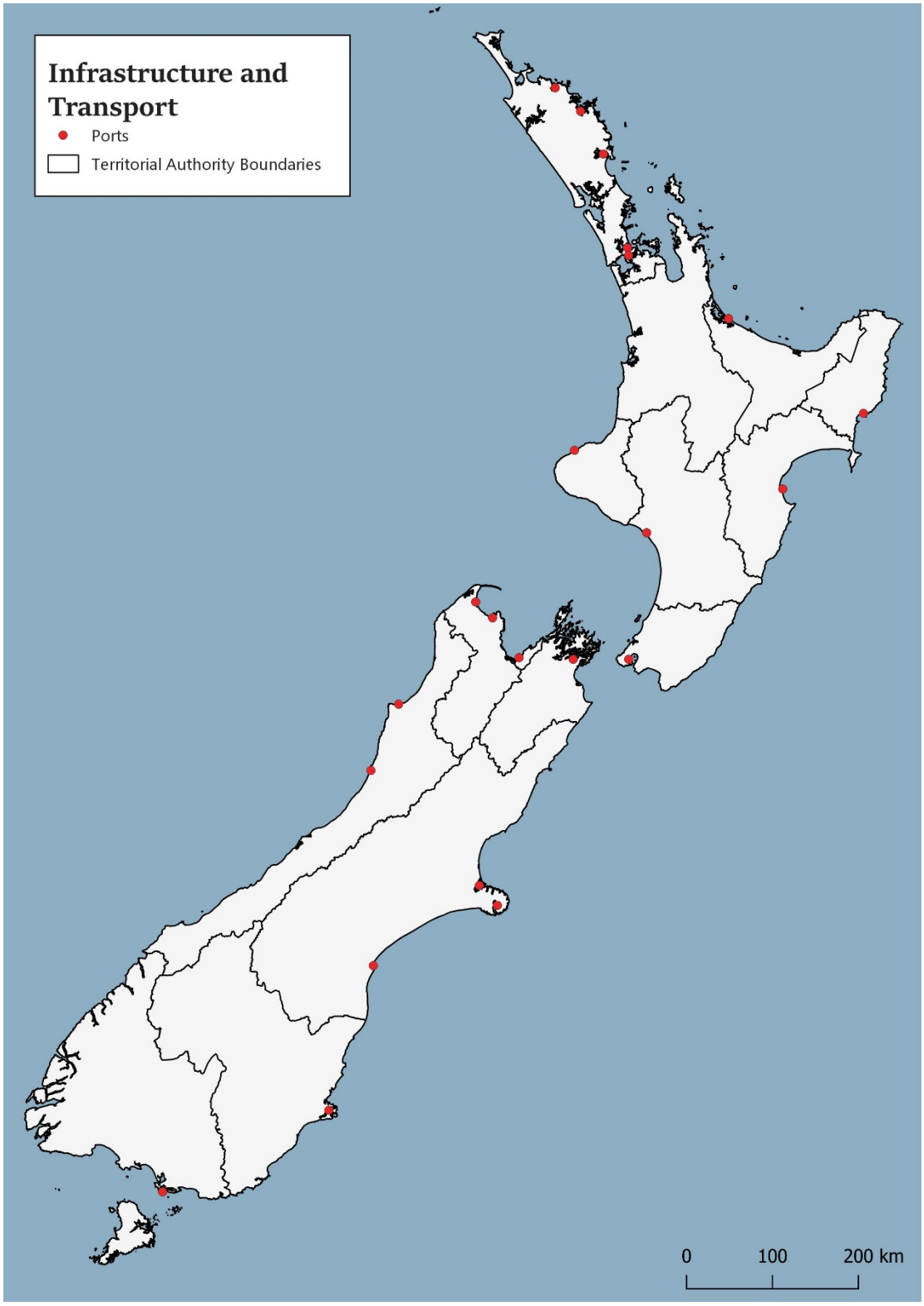
APPENDIX B: Spatial Layers Maps

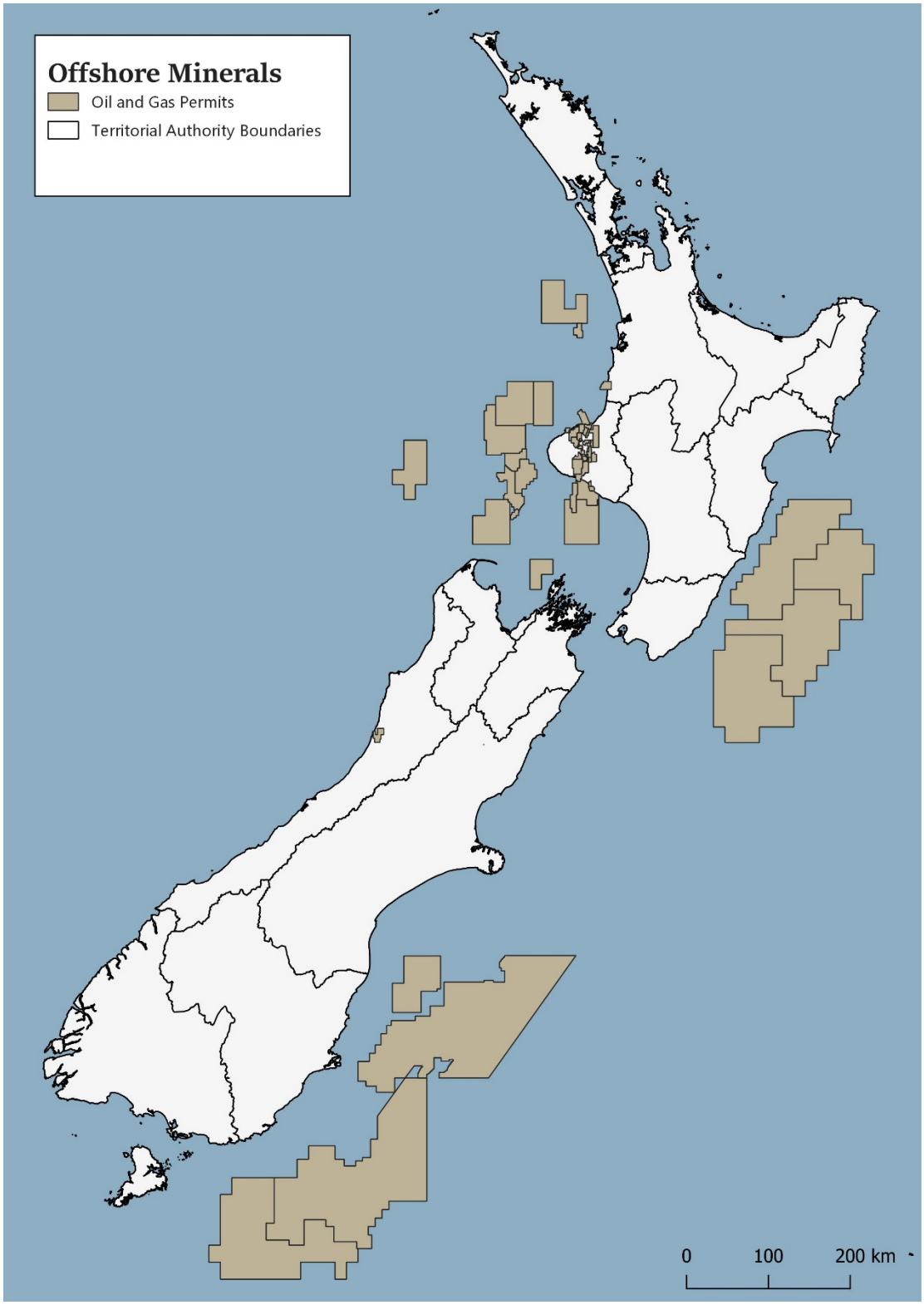



Coastal Tourism
Marine Tourism Operators
Territorial Authority Boundaries
0
100
200 km

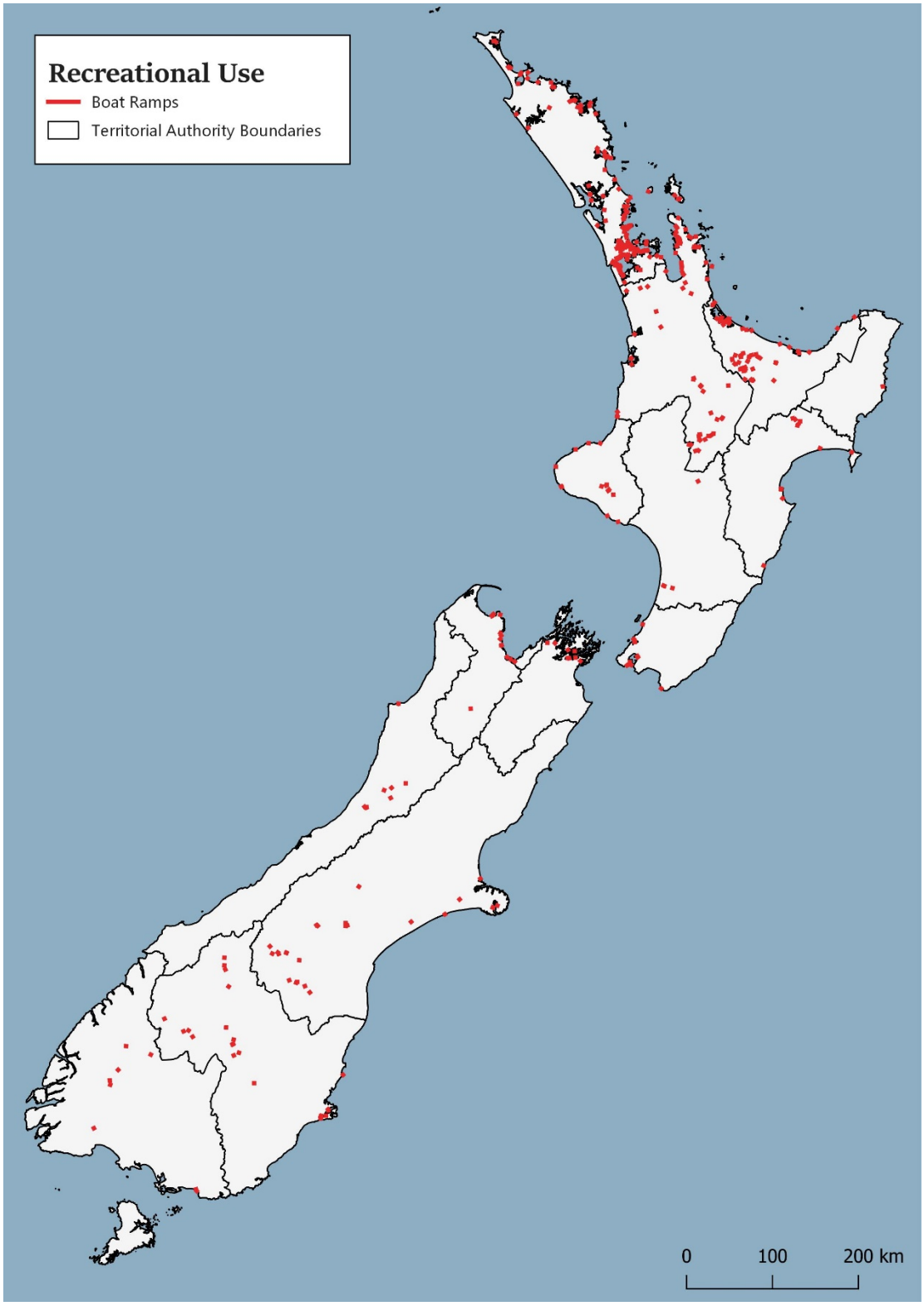

Commercial Fisheries
Aquaculture Farms
Territorial Authority Boundaries
0
100
200 km

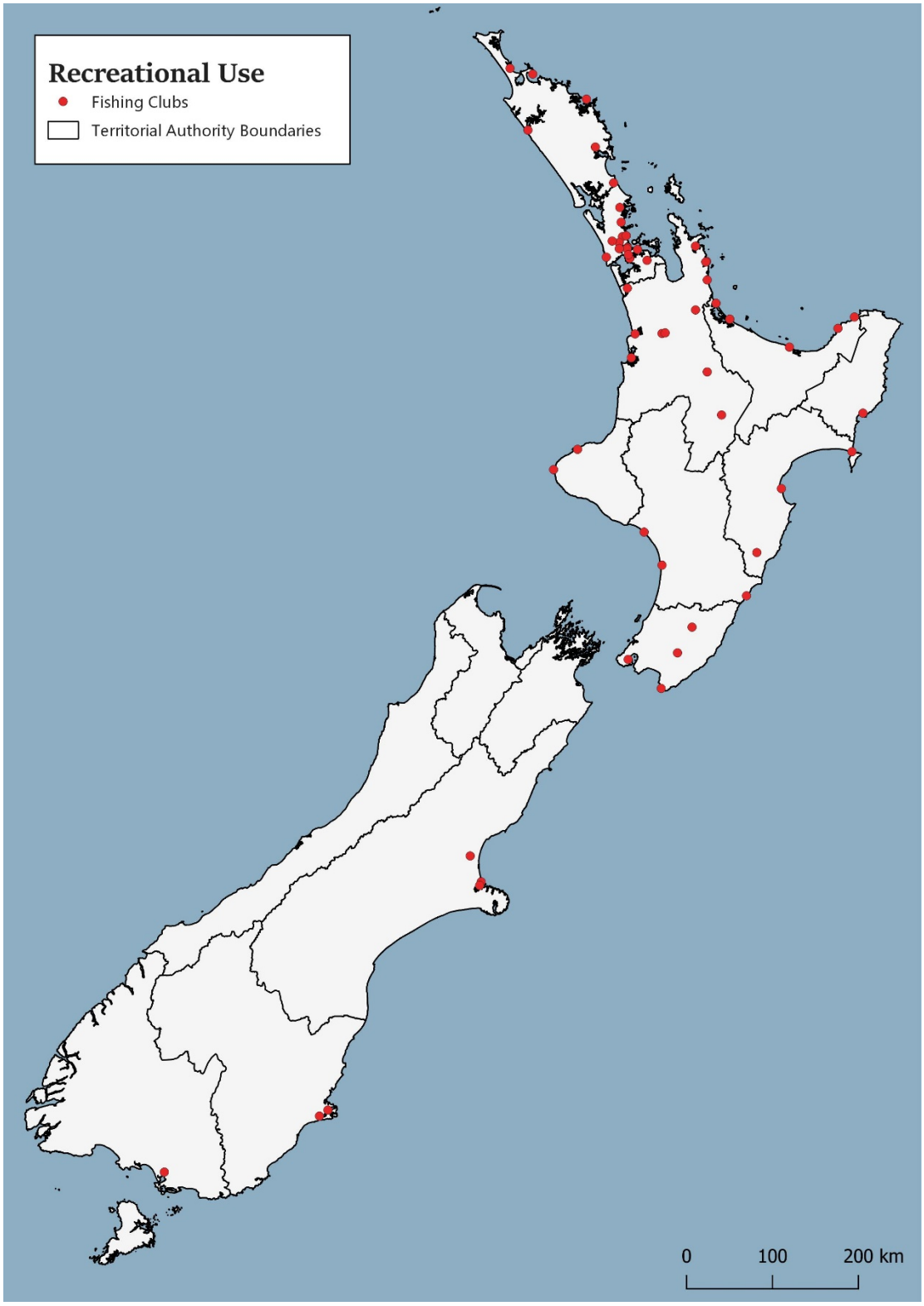

Infrastructure and Transport
Marinas
Territorial Authority Boundaries
0
100
200 km

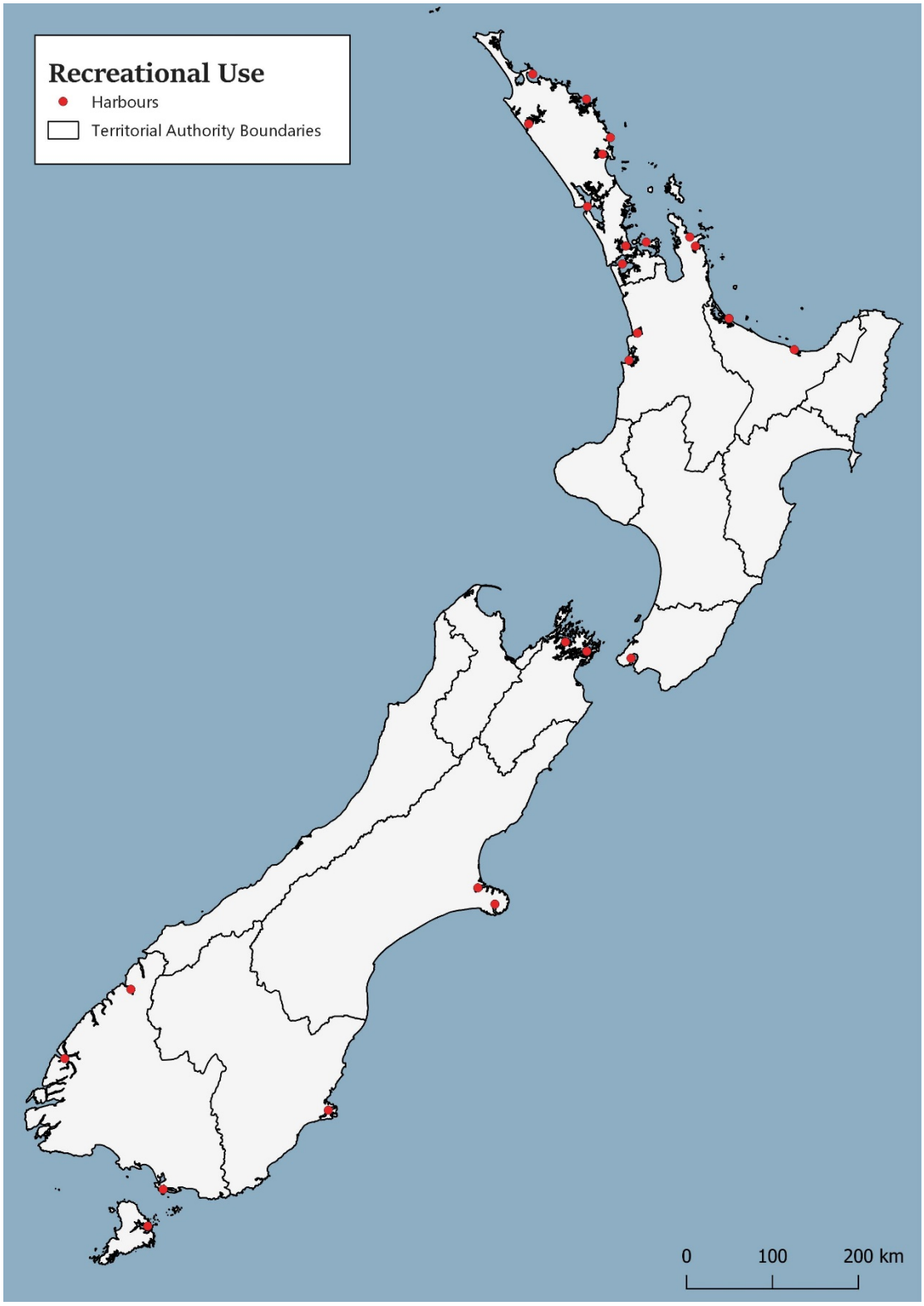

Infrastructure and Transport
Ports
Territorial Authority Boundaries
0
100
200 km

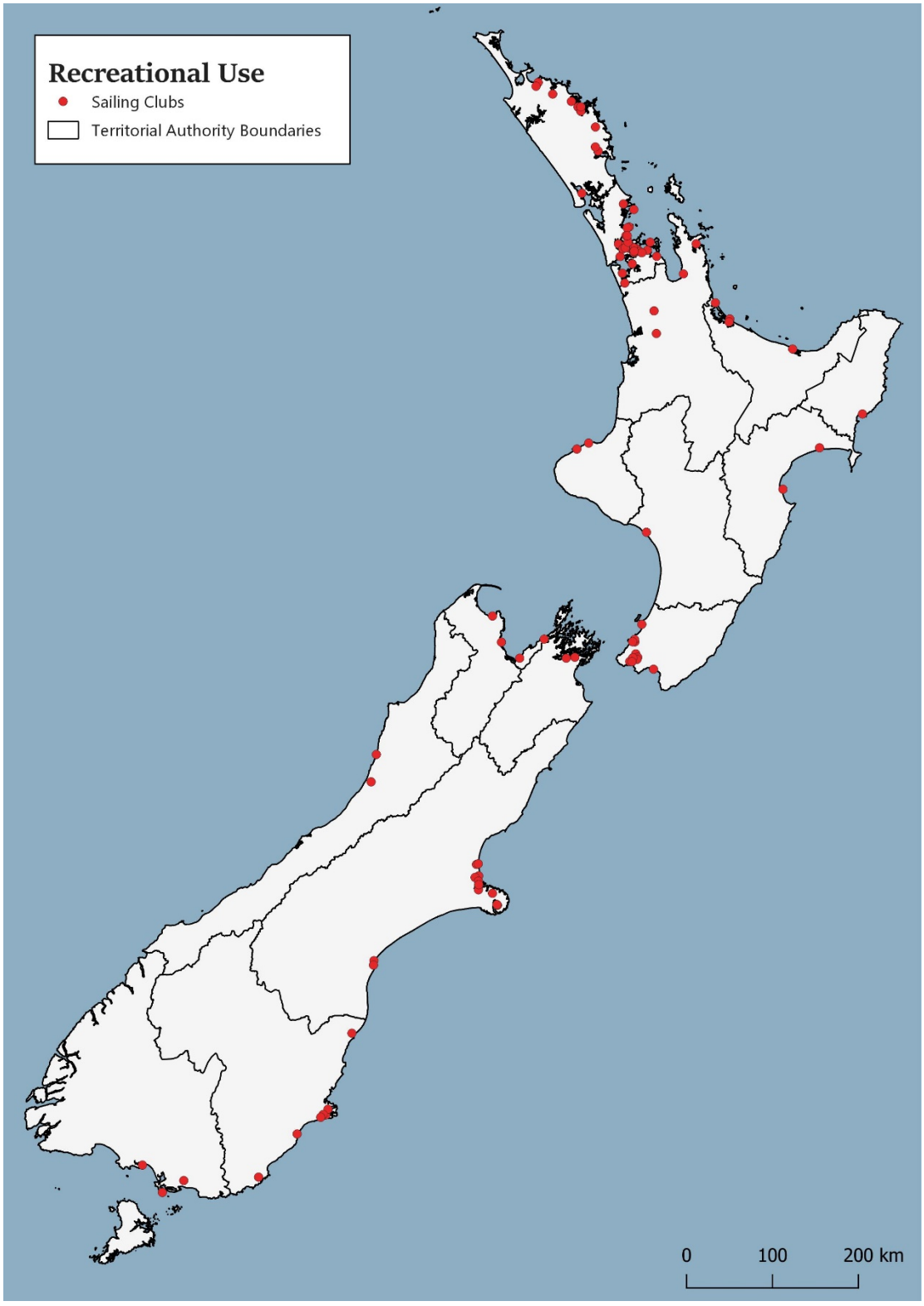

Offshore Minerals
Oil and Gas Permits
Territorial Authority Boundaries
0
100
200 km

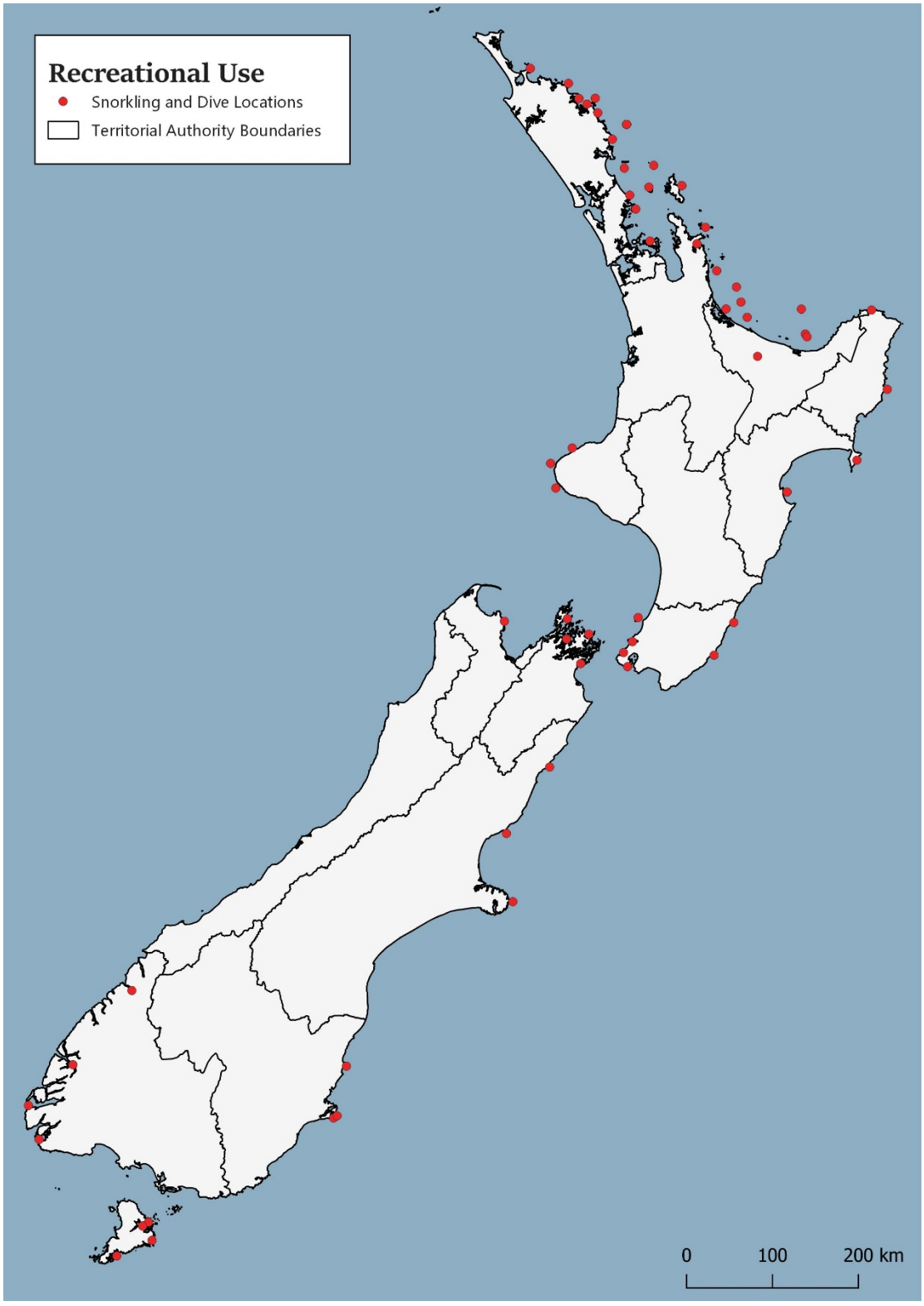

Recreational Use
Beaches
Territorial Authority Boundaries
0
100
200 km


Recreational Use
Boat Ramps
Territorial Authority Boundaries
0
100
200 km

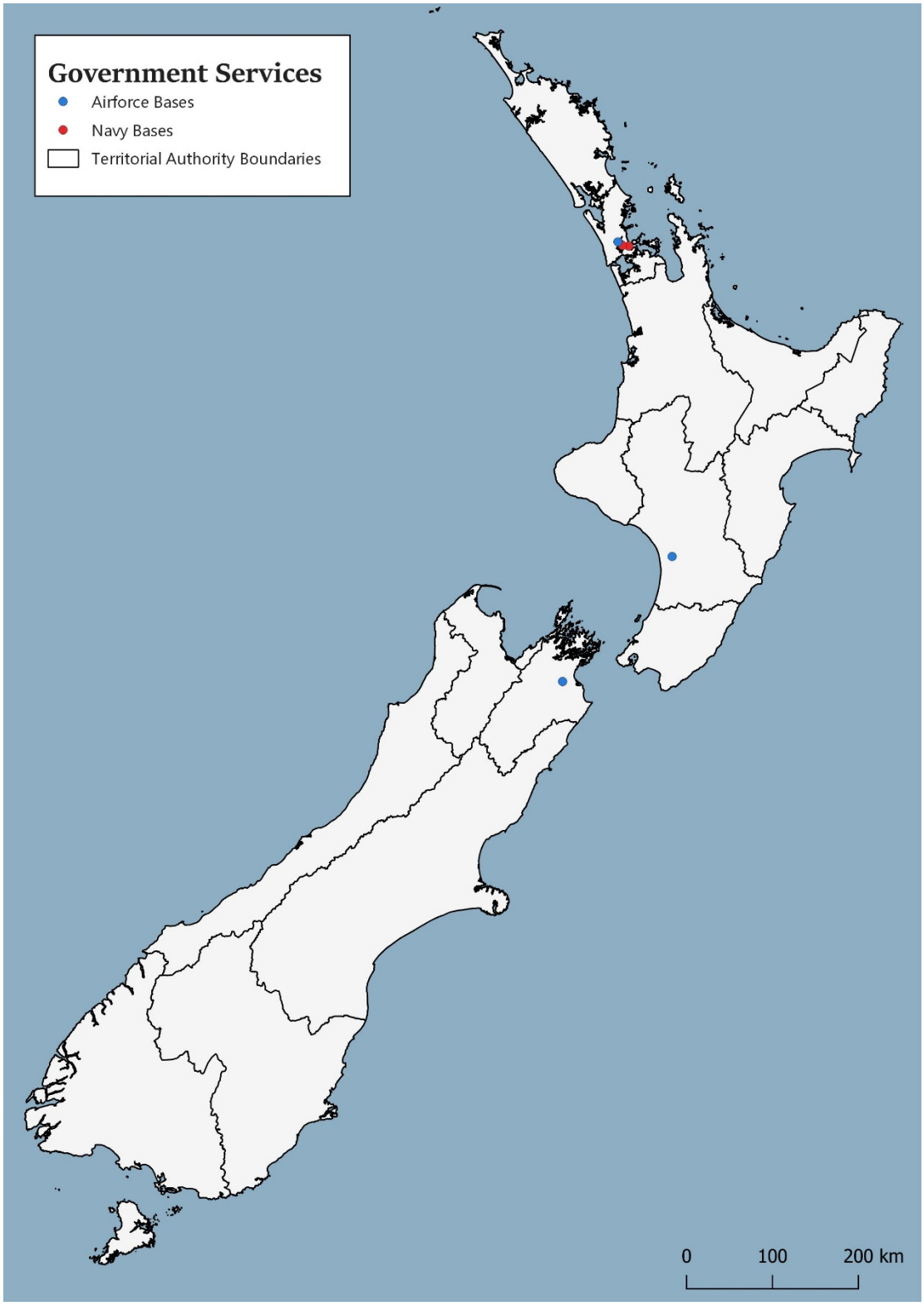

Recreational Use
Fishing Clubs
Territorial Authority Boundaries
0
100
200 km

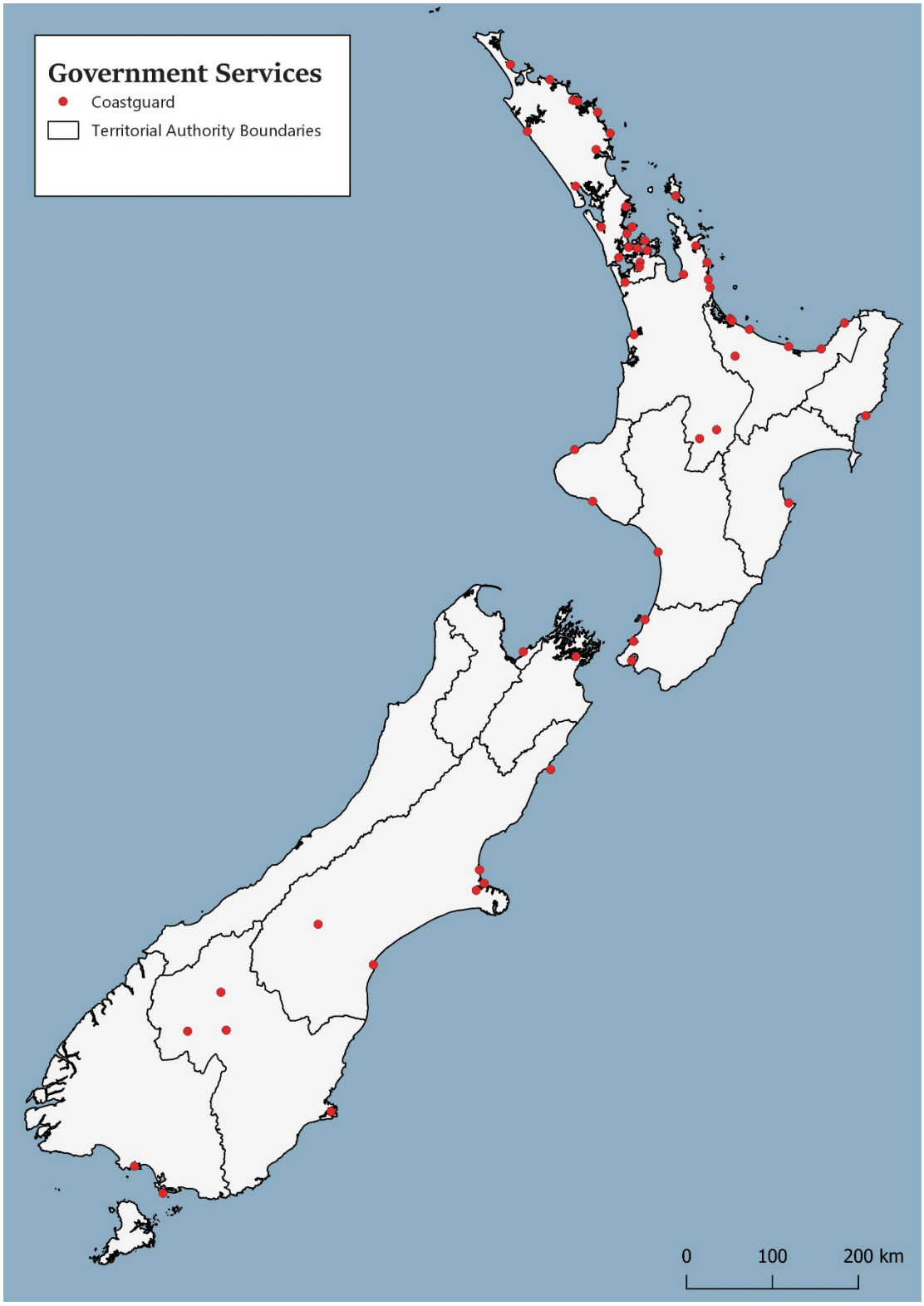

Recreational Use
Harbours
Territorial Authority Boundaries
0
100
200 km

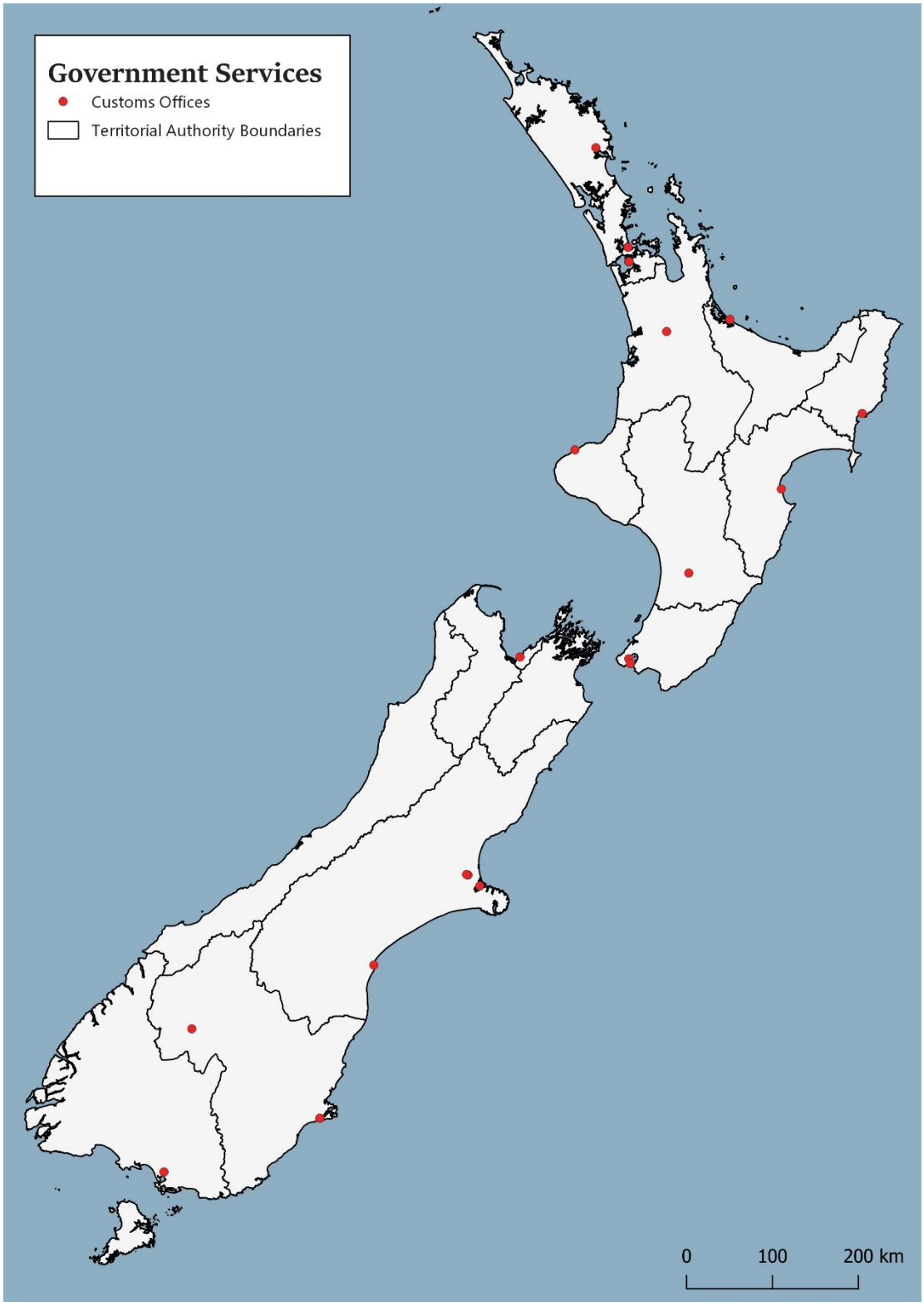

Recreational Use
Sailing Clubs
Territorial Authority Boundaries
0
100
200 km

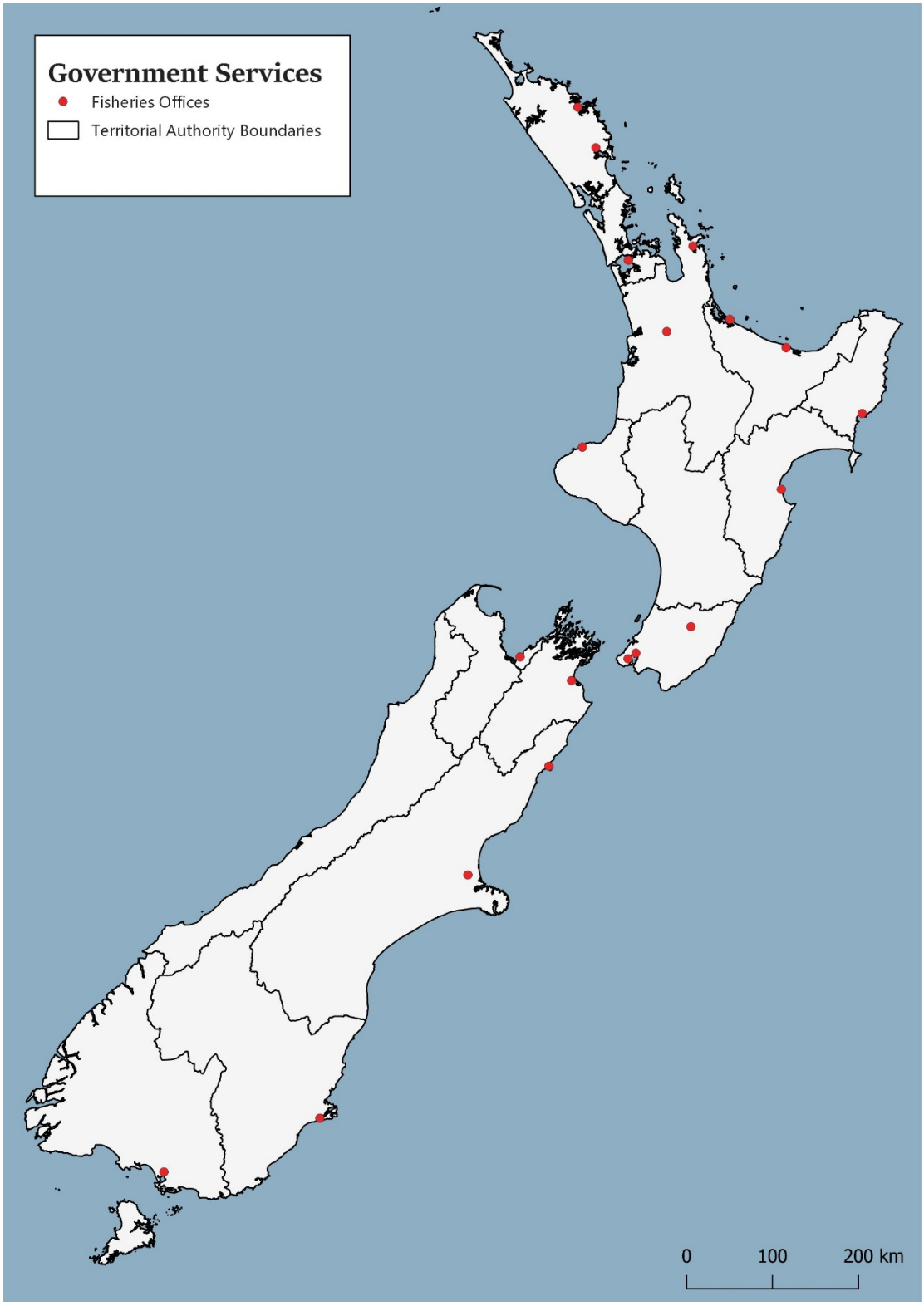

Recreational Use
Snorkling and Dive Locations
Territorial Authority Boundaries
0
100
200 km


Recreational Use
Surf Breaks
Territorial Authority Boundaries
0
100
200 km


Government Services
Airforce Bases
Navy Bases
Territorial Authority Boundaries
0
100
200 km


Government Services
Coastguard
Territorial Authority Boundaries
0
100
200 km


Government Services
Customs Offices
Territorial Authority Boundaries
0
100
200 km


Government Services
Fisheries Offices
Territorial Authority Boundaries
0
100
200 km